

appear as at the left hand of E, and finally by cutting the 2nd and 6th picks in each repeat at one selvage only, and pulling in the proper direction, the left-hand part of each cut loop will be pulled through to the opposite side of the cloth as indicated in one instance at F. As this operation is carried out the plain or ground picks will, naturally, assume equidistant positions between the tufts of pile. The ultimate result will be somewhat similar to sectional sketch G. Every 3rd pick remaining in the

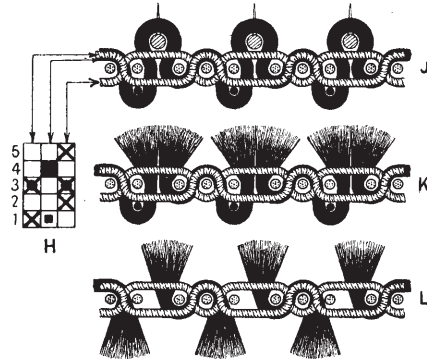


FIG. 234.

fabric shows a cut end at the selvage—a fact which in a measure indicates that the method of production was as described.

It is probably only in extra thick fabrics such as the one illustrated in Figs. 232 and 233 that it would be necessary to cut with a slanting knife edge. It is easily seen, however, from Fig. 234 that a defect would occur in such fabrics if a vertical knife were used. This figure shows another method with the 2-and-1 ground weave, the resulting fabric from design H being illustrated at J. When the pile is cut as at K, the lengths of the pile are

equal, but when the right-hand part of each tuft is drawn through by means of pick No. 3, it is evident that the pile on one side will be longer than that at the other. To be correct the two sides should be as shown in intersection L.

Two such fabrics could be obtained by weaving them on the double plush principle, in which case one of the picks for pulling through the pile warp would be under all ground threads for the bottom cloth, and the other would be above all ground threads for the top cloth. We are not aware, however, that these methods of plush or pile fabric production are extensively practised.

The foregoing detailed description indicates the chief methods by which the ordinary all-over self-coloured and nearly self-coloured plushes are formed. Tappets are invariably used for these types because of the certainty of action of shedding apparatus so controlled. When, however, figured plushes are desired, a dobbie or a jacquard must be brought into use. The introduction of these more complicated machines, however, does not alter the general principles of plush weaving; but, on the other hand, they entail an extraordinary increase of work in the designing. Moreover, since each thread may be called upon at any time to make plush, or to interlace in the ordinary manner in either the bottom or the top cloth, it is evident that each pile thread must be operated independently of every other, and represented individually on design paper. Each pile thread must also be wound separately on to a small bobbin, since the take up of the different threads may vary enormously.

Fig. 235 will give some idea of what can be done in figured plush weaving. This pattern is developed in six differently coloured pile threads, the whole appearing on a

pale-green ground formed by a simple weave. It is actually a plush fabric on a simple rib ground. There are about 40 tufts per inch, so that it would be extremely difficult to construct wires for this pattern. The cloth has been made on the double plush principle.



FIG. 235.

There is one obvious objection to the employment of several colours of pile warp for patterns similar to that illustrated in Fig. 235. In spite of the ingenuity of the designer, which is often remarkable, it is almost impossible

to avoid a more or less defined stripe in the fabric. If coloured yarns are not used, then the figuring with cut pile depends upon solid patches of pile woven upon a ground of plain or ornamental structure, or with part of the figure developed in pile, and the remainder of the figure in ordinary jacquard weaves upon a more or less simple ground structure. The pile could be varied a little by using wires of different sizes, if the pattern were woven with wires; but, since the bulk is woven on the double plush principle, this type of ornamentation may be neglected, as may also all effects obtained by embossing, etc. in the finishing.

A very common and at the same time exceedingly effective method of ornamenting these fabrics is the combined loop and cut pile—often termed uncut and cut pile. Fig. 236 has been prepared to illustrate one method of making a design for the small dice pattern shown at M. In this pattern the marks ♣ represent the cut pile, while the solid marks indicate the loops. The detailed designs N and O show an arrangement where the cutting and looping wires are indicated on successive lines, and we would urge the reader to make sections from the designs. Two points in connection with them are quite evident:—

- 1st. When the cutting wire is being inserted, only those threads represented by the marks ♣ must be lifted.
- 2nd. When the looping wire is being inserted, only those threads represented by solids ■ must be lifted.

The ground weave P is the same in both designs N and O, while plan Q shows the ground weave in relation to the wiring. The blank picks are for the wires, while the

middle pick in each group of three plain ones is marked by an arrow to indicate that all pile threads are raised over this pick. In design O the same pile thread is used for both cut and uncut pile, which is the usual way when all

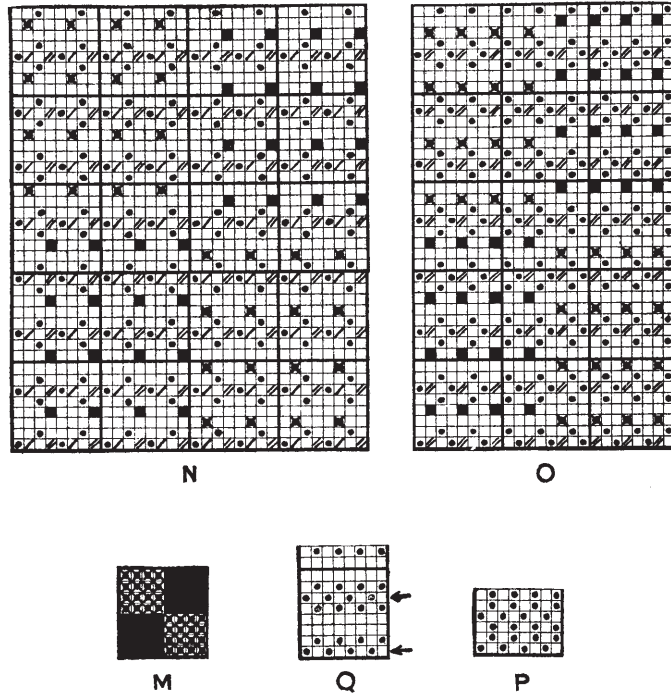


FIG. 236.

the pile warp is the same colour. But although the piles are developed in one colour of yarn, the different effects in the two parts are very striking; the loops reflecting a great proportion of light appear lustrous and bright, whereas the cut pile, which reflects very little light and

absorbs nearly all which falls on this area, has a soft subdued effect. The contrast is really charming, and such fabrics have a very rich appearance.

In design N, separate threads are used for each line of pile; such a method would, however, only be adopted when cut and uncut pile of two colours were used, in which case four distinct shades would be displayed in the four squares of the dice pattern, that is, cut and uncut pile of both colours. Now if four effects can be obtained in dice patterns, the same number of effects can be got in figured fabrics; and, seeing that the ground threads work throughout in precisely the same order, all ground threads may be operated by shafts, and need not appear on the design paper. It is sufficient, therefore, to represent a

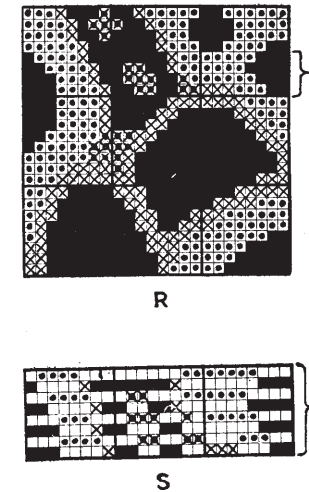


FIG. 237.

figured pattern in four distinct colours; two colours of yarn, and two effects (cut and uncut) of each. Thus a small part of a figured design on point paper is introduced at R, Fig. 237, where the marks have the following meanings:—

- Solid marks ■ indicate parts developed in cut dark plush;
- Marks ■ „ „ uncut „ „
- Crosses x „ „ cut light „ „
- Dots ● „ „ uncut „ „

Each line of design R represents two wires or four

effects, although in some parts of the illustrated portion only three shades appear. Picks 17, 18, 19, and 20 from design R are separated and shown at S, where the marks on odd weft lines indicate the lifted light and dark threads for the cutting wire, and the marks on even weft lines represent lifted light and dark threads for the looping wire.

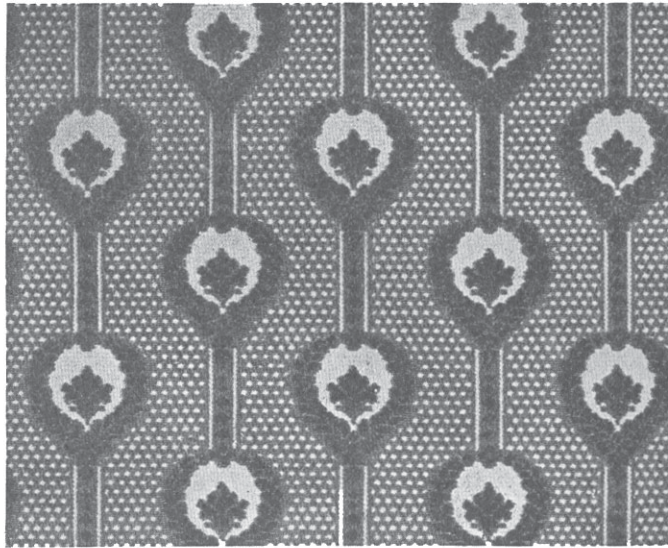


FIG. 238.

For a final example of this particular type of weaving we introduce Fig. 238, which is a photographic reproduction of a beautiful fabric. The warp is arranged:—

6 threads of gold for ground and binder;  
2 „ green for pile.

The following three distinct effects appear:—

- 1st. The dark patches forming the chief parts of the main figures and connections are developed in cut pile.
- 2nd. The outlines of the more or less honeycomb shaped patterns and some of the stripes are developed in loops or uncut pile.

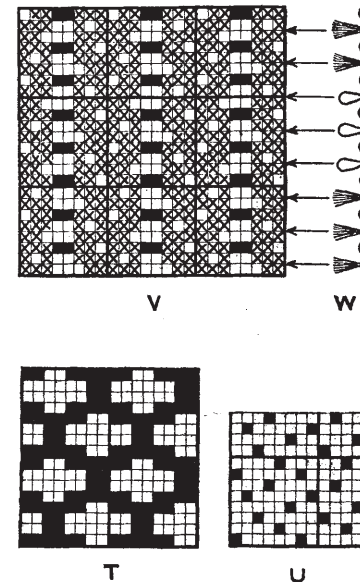


FIG. 239.

- 3rd. The light parts, that is the centres of the honeycomb pattern, some of the stripes, and a large part of the centre of each main figure, are developed by the gold threads in 6-thread sateen twill warp flush.

Fig. 239 illustrates sufficiently well the chief parts.

Plan T shows the order of interlacing or of lifting the pile threads on the looping wires when making the outlines of the honeycomb type of ornament. Plan U is the 6-thread sateen, weft flush, and is practically the same as that illustrated at M, Fig. 106, p. 143. The crosses in design V represent the ground threads which weave in a similar 6-thread sateen, but with warp flush instead of weft. This weave is used for the whole of the ground. The solid marks in design V simply show that the pile threads are raised over every third weft shot in order to make a fast pile. The small arrows to the right of design V indicate where the looping and cutting wires are inserted—both types of pile appear in every line of the fabric—while the small intersection W is introduced to show the path of the pile threads for both types. It will be easily seen that the tufts formed by the cut pile are precisely the same as those illustrated at D, Fig. 218.

## CHAPTER XIX

### BRUSSELS, WILTON, TAPESTRY, ROYAL AXMINSTER, AND PATENT AXMINSTER CARPETS

THE richness of a carpet depends partly upon the length and density of the pile, partly upon the fibre of which the pile is formed, and partly upon the colour effect. It is difficult to say which factor is the most important, but when all three are judiciously combined, the resulting fabric has a charm which few types of textiles can approach. The chief factor, however, in most carpets,

as in most other things, is the price, and when, for competitive reasons, the amount of pile yarn is reduced greatly, and, in addition, an inferior yarn is used, the most important feature of the fabric is the colour scheme. Since this work does not embrace the application of colour to woven fabrics—a phase of the subject which is very extensive, and very difficult to illustrate satisfactorily even by the best known processes of printing—we shall consider these fabrics almost solely from the structural point of view. It is, however, chiefly due to the fact that colour plays such an important part in all the above mentioned fabrics that special makes of machines are used for the production of each type of fabric. By this means the preparation of the designs is materially simplified; as a matter of fact the designs are made without regard to the methods of interweaving, simply because nearly all examples of any particular type are of the same structure, and the latter need not, therefore, be considered by the designer. In some cases the same design without any alteration may be used for different structures.

Perhaps the simplest and cheapest of all pile carpets is that known as Tapestry—a term which, unfortunately, is also applied to distinguish other well known, but more complex fabrics. But since this type of carpet is really a cheap imitation of Brussels carpet, we prefer to leave its brief description until the Brussels and Wilton carpets have been discussed.

Brussels carpet, unlike many other carpets, both inferior and superior, requires a jacquard for its production. The carpeting consists essentially of two kinds of warp yarns, pile and ground, and one kind of weft. Often three kinds of warp are used—pile, ground, and stuffer—and in all

cases a system of wiring is necessary for the formation of the well-known loops.

To facilitate the description we may immediately call the reader's attention to Fig. 240, in which are different views illustrative of what is termed a 5-Frame Brussels Carpet. The term, 5-frame, in its strictest, or most exact sense, means that each point or loop of the pile of the carpet may be formed from one of five distinct pile threads which are drawn through one split of the reed, and any one of which may be lifted at will to form the successive piles along the warp. Each pile thread in each group of five is of a distinct colour, and comes from a separate frame; the latter must therefore contain as many bobbins as there are loops of pile in the width of the carpet. The number of frames indicates the number of pile threads per split in the reed, and, in a sense, indicates the relative quality of the carpet. Should each frame be filled with bobbins all of one colour there will clearly be the same number of threads of each colour in the fabric, although the same quantity of each may not and invariably does not appear on the surface. Each frame in the best class of  $3/4$  wide 6-frame Brussels contains 256 to 260 bobbins, and if more than six colours are required in any pattern, one or more of these frames must contain two or more colours. The frame is then said to be "planted." It will thus be seen that a 5-frame Brussels, which is the one generally used, may, by a system of planting, easily be made to contain six or even more colours. There are, as already mentioned, 256 loops in each row from selvage to selvage, or approximately  $9\frac{1}{2}$  loops per inch; but since the total number of pile threads is, in general, the product of the number of frames and the number of loops in a row, there are far more threads in the fabric than are required

on its surface at any time. The bulk of the material is therefore made to occupy a place between the two sets of picks; it thus acts as a padding to the fabric, and also assists in imparting to it the properties of elasticity and softness to the tread. A 6-frame Brussels may contain  $6 \times 256$  pile threads for the best quality, but a 3-frame Brussels may contain  $3 \times 256$  threads, or three times a smaller number, with or without a few extra threads for planting colours. It will thus be seen that the quality of a Brussels carpet is influenced, not only by the number of loops, say 7 to  $9\frac{1}{2}$  per inch, but also by the number of frames of solid colours which are used; indeed the prefixes 3-frame, 4-frame, 5-frame, and 6-frame indicate, irrespective of material or number of bobbins in a row, ascending qualities of carpets.

In practice the figure and the ground of Brussels carpet designs are painted in colours similar to those intended for the actual fabric, although it is clearly possible to substitute subsequently other colours in the various frames for the purpose of obtaining different colour effects in different carpets of the same design. The ground and the various parts of the figure are therefore painted in their respective colours—such colours indicating lifted threads both for figure and ground.

In the small design D, Fig. 240, we illustrate at A, B, and C three threads and thirteen picks by a scheme of marking which would, in practice, be replaced by five distinct colours. A complete  $3/4$  wide design of the best quality would contain 256 such threads, and a number of picks which would depend upon the length of the pattern or design. It will be evident that, since five different colours are represented in each line, five threads, one of each distinct colour, will be required to develop each line,

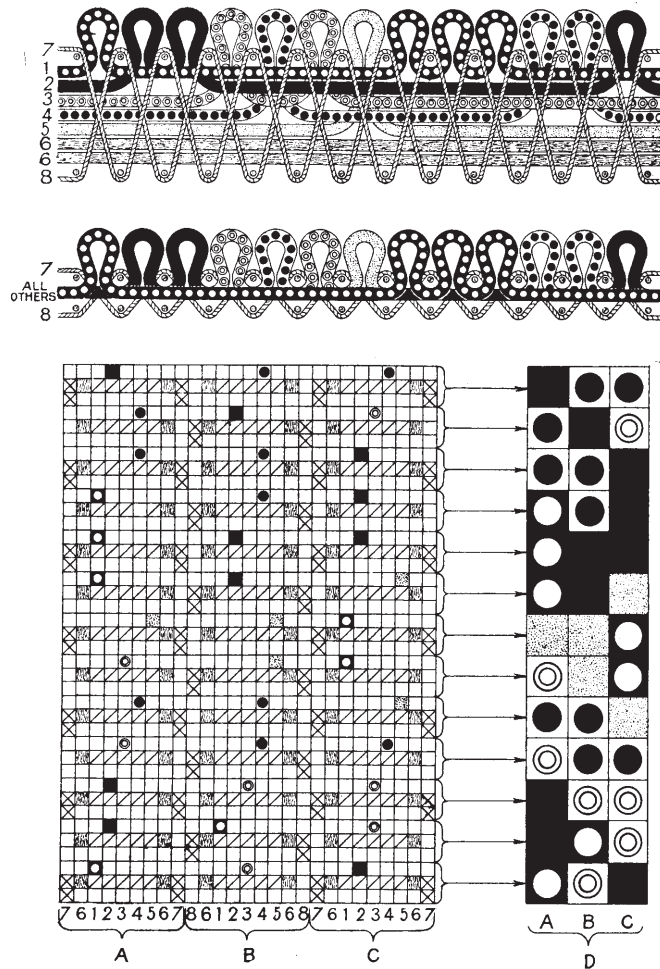



FIG. 240.

or altogether  $5 \times 256 = 1280$  coloured pile threads. In addition, two picks and one wire are necessary for each line of weft. The actual structure for threads A, B, and C, and for the corresponding ground and stuffer threads is shown to the left, no fewer than nine distinct threads of warp being used for each warp line of the design D. The numerals 1, 2, 3, 4, and 5 indicate the five different colours of pile warp; 6 and 6 the two threads of stuffer warp; 7 and 7, or 8 and 8, the two threads of binder warp. Altogether nine threads pass through each split of the reed, but one only appears on the surface to form the loop. The weft lines are bracketed in groups of three, the last one in each group indicating the wire which passes, as indicated under one and only one thread of each group A, B, or C. The wire is inserted simultaneously with the pick represented by the middle line—a double shed being formed for these two lines. Twenty-six picks, instead of 39 as shown, are therefore required for the 13 lines of the design. If now we imagine the wire lines to be superposed on the lines immediately preceding, we shall see that the binding warp threads 7 and 8, shown in crosses ( $\times$ ), interweave in 4-thread basket or hopsack order. The complete order of lifting for the first three lines is as follows:—

- 1st pick. All pile threads (1 to 5 inclusive), all stuffer threads 6, and half the binder warp threads down, the remaining half of the binder threads being lifted.
- 2nd pick. All pile warp threads, all stuffer threads, as well as the same half of the binder threads lifted for the shuttle to pass under, and the particular thread in each group of the pile warp, as indicated by the first line in design D, lifted by the jacquard

to a higher plane to permit of the wire being inserted. For this pick the whole of the pile warp is lifted to the medium position by the comber board—knots on each harness cord permitting of this operation.

From this it is evident that :—

1. All figuring threads work plain as indicated by the diagonal marks ( $\diagup$ ), but selected ones from the design (one thread in each group) are lifted higher by the jacquard itself.
2. All stuffer threads work plain throughout, as shown by marks .
3. All binder threads work  $\frac{2}{2}$  in 4-thread basket order.

An intersection through the weft is illustrated at E. This shows the course followed by all the threads in group A, in addition to a binding thread similar to 8, but placed in front of all the other threads. The markings of all the pile threads and the stuffer threads are similar to the marks in both designs, while the numbers immediately to the left of the threads correspond to the similar numbers in the detailed design. All threads, 1 to 6 inclusive, are under the top row of picks (1st pick in each group in detailed design), but are over the bottom row of picks (2nd pick in each group in detailed design). The intersection is much deeper than the actual fabric, which appears more or less like the intersection F, where all pile and stuffer threads are evidently in the same plane. Intersection E, however, enables one to follow the path of each thread clearly, and thus to see the structure in a favourable light.

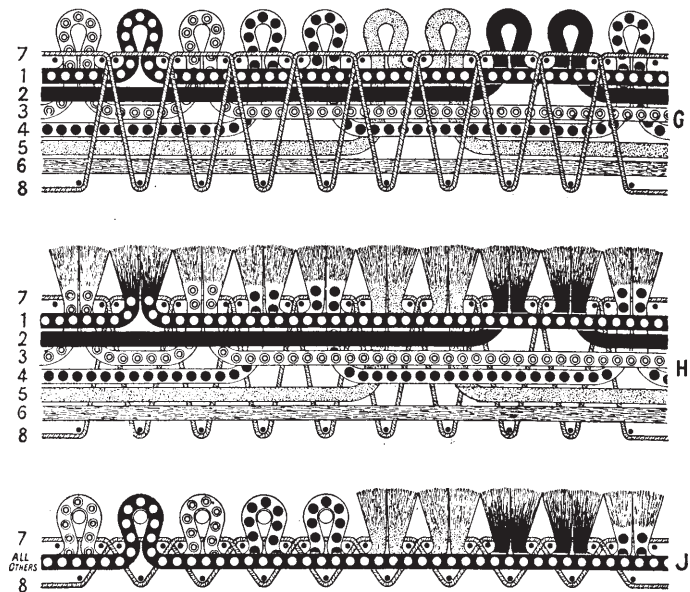
It will be seen from the detailed design, and from the intersection, that the bulk of the pile yarn lies in the body of the fabric; in general, two-thirds, three-fourths, four-

fifths, and five-sixths of this yarn occupy such a position in 3, 4, 5, and 6-frame Brussels respectively. This gradually increasing quantity of dormant yarn in the ascending qualities naturally increases the cost of the fabric, but at the same time it provides a kind of cushion which does not obtain in those fabrics which are not so provided with padding of elastic material.

The loops in Brussels carpets are made by the use of wires very similar to that illustrated at K, Fig. 219. If the wires had cutting ends as shown at J in Fig. 219, it is evident that cut pile would be produced, and a less lustrous, but deeper colour effect obtained. In some of the cheaper makes of carpet a cutting wire is used, and the fabric is then termed "Wilton Carpet." Such a method is, however, resorted to only for convenience and for cheap production. For the sake of variety a number of plain wires are sometimes introduced alternately with the same number of cutting wires, say three or four of each, to produce alternate horizontal bands of uncut and cut pile. The surface of a real Wilton carpet is certainly composed of cut pile but the binding warp threads interlace differently from those in Brussels. This will be seen by reference to illustration H, Fig. 241, which is a section through 30 weft shots of such a fabric. The binding threads are in the front in illustration G, and are therefore clearly seen to pass alternately over three picks and under three picks. The ten loops in illustration G are taken from thread B in Brussels design D, Fig. 240, but it is evident that if this method of weaving were adopted for Brussels it would be much more expensive. Twenty picks of weft would suffice for the ten loops in Brussels weaving, whereas thirty picks are necessary by the method shown at G, Fig. 241. Since all pile loops in Brussels are



uncut there is no danger of withdrawal, but when the pile is cut there is such a danger, and the tufts should therefore be securely bound. On this account it is advisable to











- |  |   |
|--|---|
|  Red pile warp. |  Blue pile warp. |
|  Brown ,,       |  Green ,,        |
|  Yellow ,,      |  Stuffer warp.   |
|  Weft.          |  Binder ,,       |

FIG. 241.

adopt the particular method of binding shown at G and H, Fig. 241, in the manufacture of Wilton carpet.

The method of reeding, and also of operating the pile threads for the wire, are the same as for Brussels; the pile and stuffer threads require to be down for two picks and

up for one, and the cutting wire is inserted on this latter pick, that is, when all the pile picks are above the shuttle. This arrangement of binding threads lessens the production, but the pile threads are more securely held. The left-hand part of illustration J shows the general appearance of the actual section with the five wires under the loops, while the right-hand side shows a part where five cutting wires have been withdrawn. The differently marked pile

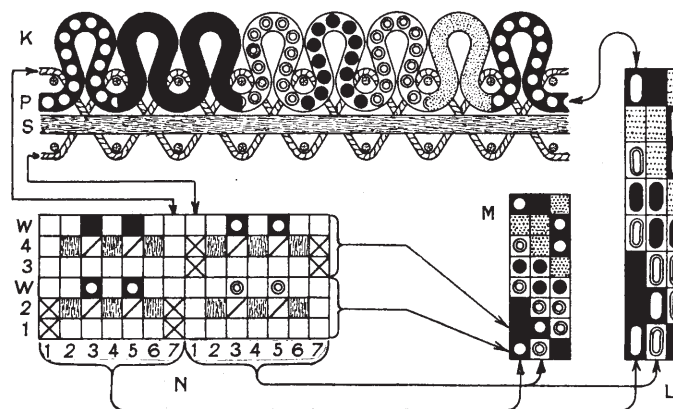


FIG. 242.

threads may be considered as representing the colours mentioned at the bottom of the figure.

*Tapestry Carpets.*—Fig. 242 illustrates the chief parts of a tapestry carpet which, as we have already stated, is a cheap imitation of Brussels carpet. No jacquard is required for tapestry carpets, but a wiring motion is a necessity. The preparation of the warp threads for the loom is an elaborate process, but the actual weaving is not very complicated; indeed, with the exception of the mechanism for the wiring, the process is comparatively simple. Each

pile thread in a Brussels or Wilton carpet is a particular colour throughout its entire length (if two differently coloured threads are twisted together the yarn would still be considered as an unvarying colour) and rarely more than six colours are used unless in very elaborate planting. On the other hand, each pile thread of a tapestry carpet is printed, at different parts of its length according to pattern, with all the colours which appear in one length or one thread of the design. The printing is done on each thread separately, and for a considerable number of repeats, while the yarn is wound tightly round a large drum, but since the length of yarn which is required to make each loop is much longer than the space occupied by such loop in the cloth, it follows that the effect of the printed pattern on the various threads of the warp will be elongated in proportion to the difference between the measurements. The difference between the two clearly depends upon the more or less sinuous course taken by the pile yarn; it is chiefly affected by the size or depth of the wire, and by the number of wires per inch, and may vary between two and three times the length of the cloth. Illustrations M and L, Fig. 242, will make this point clear; the former is part of a design painted on design paper to the actual size of the cloth, while the latter shows the same pattern as it would appear in elongated form on the pile threads before weaving. In this example the lengths of pile yarn and cloth are as 7 to 4.  $6\frac{1}{2}$  to 8 threads per inch multiplied by the width of the fabric represents the total number of pile threads in a cloth, and as all these threads are over every wire, it follows that the resulting fabric will lack the weight of a Brussels carpet unless a large number of stuffer threads are used. Design N shows that three stuffer threads are inserted for each looping or

pile thread, so that each split of the reed will contain one pile thread, three stuffer threads, and two binder threads. For the better grades of Brussels, Wilton, and Tapestry Carpets the pile warp is usually threefold twofold worsted; the binding warp threefold hard twisted cotton; and the weft flax. Stuffer warps may be either flax or jute.

*Axminster Carpets.*—The preparation of the pile warp in all types of Axminster carpets, as in tapestry carpets, involves elaborate and lengthy processes; the weaving mechanism for the production of Axminster carpets is much more elaborate than that employed for tapestry carpets, although it is similar to it in that no jacquard is required.

There are two distinct types of Axminster carpets—Moquette or Royal Axminster, and Chenille or Patent Axminster—each type involving its own distinct preparatory and weaving processes. In the former or “Royal” type of fabric each tuft of pile is securely bound into the body of the fabric by one or other of many different interlacings, whereas in the “Patent” type the pile is laid as it were on the surface of a substantial foundation and is secured to it by means of special binding threads. When completed, both kinds are very similar in appearance. Theoretically there is no limit to the number of colours which may be employed in either type of Axminster, and in this respect each has a decided advantage over the Brussels or Wilton types. This statement must not be regarded as implying that the beauty and effect of carpet designs depends mainly upon the number of colours used, for exceedingly rich effects may be obtained with a number of colours which is quite within the compass of a Brussels machine. On the other

hand, the liberty of a choice of any number of different colours is certainly an advantage, as no restriction is then placed upon the designer with regard to the production of designs having elaborate colour schemes.

One structure, which is common to many Royal

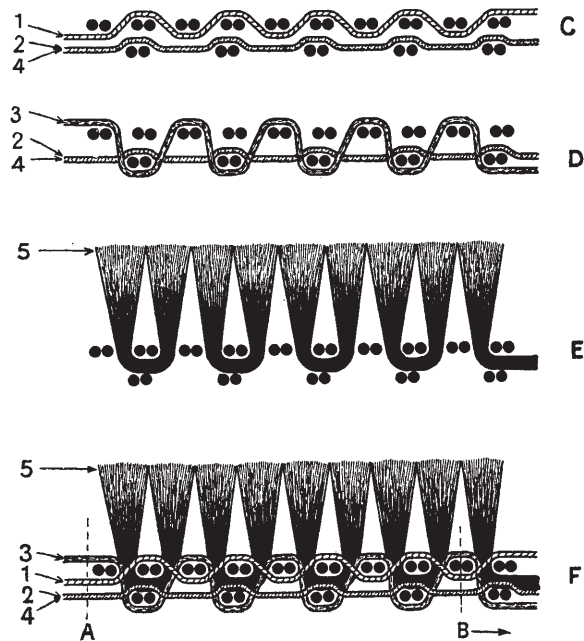


FIG. 243.

Axminster carpets is illustrated in Figs. 243 and 244, which represent respectively sections through the weft and the warp. In the particular type illustrated there are five warp threads and three double picks in each repeat. The picks are double because the weft is carried through the shed by means of an eye in the end of a long steel

wire or needle; the needle eye, in its return stroke, simply slides along the second half of each double shot, the latter being held secure by a catch thread inserted at the selvage opposite to that from which the needle acts. This catch thread is contained in a very small shuttle which moves in a crescent-shaped guide and passes through the loop of the weft thread formed by the needle eye as it projects through the open shed of the fabric. The sequence of

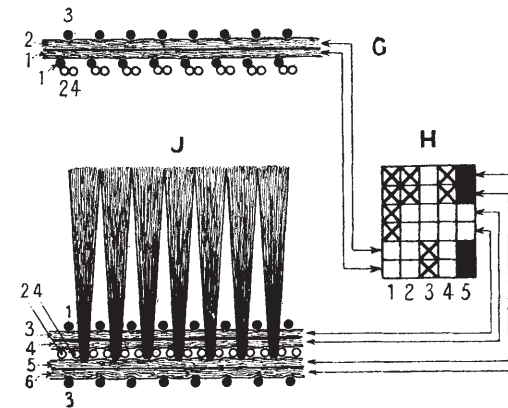


FIG. 244

the double shotting is clearly seen in each sectional view of Fig. 243, where :—

- C shows threads 1, 2 and 4 as well as 5 repeats of weave H, Fig. 244.
- D „ 2, 3 and 4 „ „
- E „ thread 5 or tufting thread „ „
- F „ all 5 threads „ „

Threads 2 and 4, being identical in movements, are represented by one thread only in each view, although the 4th thread would naturally appear behind threads 1, 2, and 3, and not in front of all as illustrated.

For 20 units of length of cloth there are required approximately :—

22	units of length of thread	1,	4/14 <sup>s</sup> white cotton ;
21	„	threads 2 and 4,	4/12 <sup>s</sup> brown cotton ;
42	„	thread 3,	7 <sup>s</sup> brown flax ;
88	„	„ 5,	6 skeins wool.

The length of the pile yarn varies in different fabrics according to the length of pile wanted, but it is seldom less than that stated which provides for a pile which rises  $\frac{1}{4}$  inch above the foundation of the texture. The weft is  $\frac{2}{7}$  lbs. brown jute, and since it is practically straight, the length of each single shot is simply the reed width.

In the complete intersection F the picking is reckoned from the left (dotted line A), and the weave corresponding to this order of picking is illustrated at H, Fig. 244. Intersection G in the latter figure shows the positions of all warp threads, except the pile yarn, when the first double pick is inserted, while intersection J, which shows all threads, is taken along the dotted line B, Fig. 243, when viewed in the direction of the arrow.

The pile warp for this type of Axminster is arranged and run on to small beams or wide bobbins with small flanges; each beam is the exact width of the fabric, and the number of beams employed is identical with the number of horizontal rows of tufts in one repeat of the pattern. Each beam contains the same number of individual pile threads, and the colour arrangement of the threads on the different beams corresponds with the order of colouring required in the respective rows of pile from selvage to selvage of the carpet. In extreme cases no two beams will have exactly the same order of colouring, and in most cases a considerable number of beams must, naturally, differ from each other. All the beams are

supported at both ends in an endless chain, which is led forward over the loom to a position directly over and parallel to the fell of the cloth, so that the several beams may be presented in succession for the selection of the successive rows on the tufting picks. The movement is somewhat similar to the action of the endless lag chain of an ordinary dobby, but the analogy differs in that, whereas the set of lags remains intact throughout the whole process, the small beams must, in succession, be detached bodily from the chain, and placed, with the pile threads which they contain, near the cloth or shed when their time of selection arrives. This movement is accomplished automatically by special mechanism, which also replaces the beam in its respective position in the chain. It will thus be seen that the number of patterns which can be woven from these small beams is obtained by dividing the total length of each warp thread on the beam by the length of warp required for each pattern, while the length required for each pattern is the product of the number of pile rows per pattern and the length of each tuft.

*Patent Axminster Carpet.*—Quite a different method is used for the patent or Chenille Axminster, although it is equally essential to adopt a system which will admit of a free choice of the number and position of coloured yarns in order to reproduce all possible colour arrangements. The preparation and introduction of the pile yarn in Royal Axminster constitute the most difficult operations in the process, and in like manner the corresponding operations in the manufacture of patent Axminster involve the maximum amount of trouble.

Fig. 245 is introduced to demonstrate the chief features of the structure of a patent Axminster.

The binding warps may interweave in various ways in different fabrics of this type, but the preparation of the pile yarn is practically common to all. Although this pile yarn is ultimately introduced into the fabric as weft, it must first be woven in a loom before it can be used as such. Chenille or Patent Axminster is therefore the

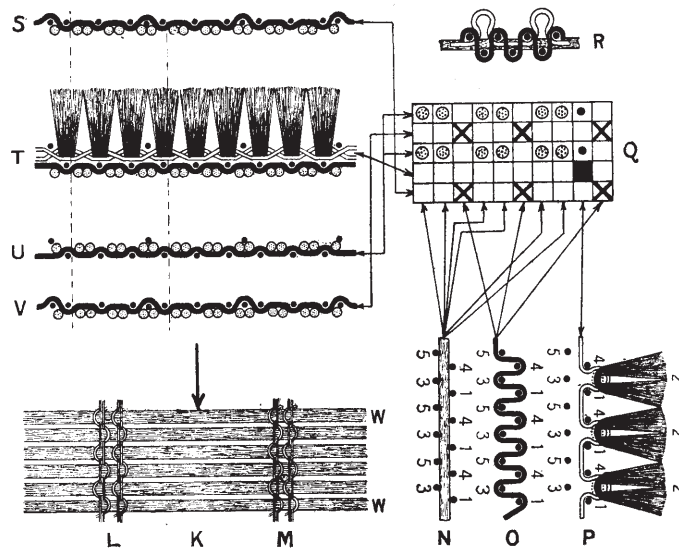


Fig. 245.

result of two perfectly distinct weaving operations. The *modus operandi* for the development of the pile thread, or rather the pile pick, is illustrated at K, Fig. 245. Two groups of six threads each are shown at L and M. In each group four threads weave perfectly plain, and these four threads are locked together by two crossing threads, which are manipulated on the principle known as gauze weaving (see pp. 453 to 476), and therefore take the circuitous

path shown. The six threads in group L pass through one split of the reed, and those in group M pass through another split. The two groups, however, are not in adjoining splits, but are separated from each other by a number of splits which occupy a space equal to the total length required to form one complete tuft, which will ultimately appear as shown at 2 in illustration P.

By introducing into an ordinary loom a warp beam containing a series of groups similar to L or M, and by separating adjoining groups in the reed by the desired length, we may clearly insert the weft W, which for simplicity is shown in one colour only. Any length may, therefore, be woven, and when completed the groups may be separated by clipping each weft thread along a line indicated by the arrow in illustration K. When so separated each group of six threads holds, and is in the middle of, a quantity of short weft shots, each about  $1\frac{1}{4}$  inches long, which form a kind of double fringe. The projecting fringes are then bent upwards by grooved rollers until they assume the form shown in the three groups in illustration P. Here the six threads in each group appear at the bend—in illustration K, four threads out of the six appear at the top, but in illustration P they are at the bottom; they may clearly be either way in practice, but they have been arranged as illustrated for convenience. The number of threads in each group may be fewer than six, and it may or may not include crossing threads.

Now if all the weft used were of the same colour, the tufts would, naturally, be of one shade, and the process of weaving them would be of the simplest possible nature. Such extreme cases are, however, seldom attempted unless for self-coloured curtains and similar

chenille fabrics; the more usual plan is to introduce five, six or more colours, in which case it is necessary to change shuttles repeatedly, at predetermined intervals according to pattern, in order to introduce the proper colours of weft. The order of colouring along every group L, M, . . . etc., would be the same, and each group would be identical with the colouring in the carpet as obtained by following the picks of weft of the design from left to right, then right to left, and so on until every pick of the design had been passed over. The effect of this to-and-fro movement along the picks has its counterpart in the pile thread or pick as it follows the shuttle from selvage to selvage and back again until the full pattern is woven. One complete colour arrangement therefore extends for a considerable length; indeed the length must be, in every case, the product of the reed width and the number of pile picks per pattern. With four tufts per inch, the length of woven pile required for each square yard of carpet would be:—

$$\frac{4 \times 36 \times 36}{36} = 144 \text{ yards.}$$

Three to six tufts per inch are common numbers, and these determine the outline of the pattern along the piece. More liberty is given in the outline from selvage to selvage, and when comparatively fine divisions are required, each weft line W, in illustration K, Fig. 245, may consist of two or more separate shots. Sharper contours may therefore be obtained. Perfect rectilinear lines may be produced in the way of weft, but it is difficult, indeed almost impossible to produce similar perfect lines in the way of the warp.

The chenille is obviously a cumbersome form of thread

to be manipulated as weft, but ingenious contrivances are now in vogue for inserting this weft mechanically. The operation is, however, often performed manually, the weaver inserting by hand the weft, which has been previously wound on pegs, laths, or cops. As already mentioned, this pile yarn is laid on a strong foundation, the structure of one kind of which will be gathered from the intersection R, Fig. 245. This shows one of each kind of the warp threads in position, as well as seven picks; the two pile picks are, however, omitted. The three threads shown in this view are the last three threads of design Q viewed from the right-hand side. In all ten threads are required, six of which are of one kind forming the body of the structure, three of another kind for the foundation binders, and one for binding the chenille. The lines from the weft intersections N, O and P to the design Q show the respective positions of these threads. Intersections S, T, U, and V, which represent all five picks (3rd and 5th are identical) and 31 threads, indicate the positions when viewed on the successive picks; while the part enclosed by the dotted vertical lines embraces the ten threads which appear in the design Q. Intersection T is the most important since it shows how the chenille pick is placed on the foundation structure; it also shows the position of the chenille binder when it is over the chenille pick. In the chenille pick itself the gauze or crossing threads are omitted, but the remaining four plain threads are shown gripping the tufts.

Suitable particulars for the above-mentioned fabric are as follows:—

Warp: Referring to design Q.	The Order in Loom.
2 threads 3/5 lbs. brown jute.	1 thread 3/5 lbs. brown jute.
1 thread 10 <sup>s</sup> flax.	1 „ 10 <sup>s</sup> flax.

Warp : Referring to design Q.	The Order in Loom.
2 threads $3/5$ lbs. brown jute.	2 threads $3/5$ lbs. brown jute.
1 thread $10^s$ flax.	1 thread $5/12^s$ brown cotton.
2 threads $3/5$ lbs. brown jute.	1 ,, $10^s$ flax.
1 thread $5/12^s$ brown cotton.	2 threads $3/5$ lbs. brown jute.
1 ,, $10^s$ flax.	1 thread $10^s$ flax.
	1 ,, $3/5$ lbs. brown jute.

Cloth length	= 20 units.
Length of jute stuffer thread ( $3/5$ lbs.)	= 20 ,,
,, flax binder ,, ( $10^s$ )	= 40 ,,
,, cotton chenille binder ( $5/12^s$ )	= 25 ,,
,, weft	= 20 ,,
16 picks per inch in ground ;	
4 chenille picks per inch ;	
9 binding threads per inch ;	
18 stuffer threads per inch.	

## CHAPTER XX

### TURKISH TOWELLING, OR TERRY FABRICS

ALTHOUGH the term "terry" may be used to designate any fabric on the surface of which a pile of uncut loops has been formed, it is usual, on account of the great diversity of looped fabrics, to apply the term solely to those in which the loop is formed in the loom without the aid of wires. Such fabrics almost invariably go by the name of Turkish towelling or terry cloths.

The production of a terry pile fabric depends partly upon the weave structure, as do all other fabrics, but chiefly upon a variable movement given to the reed every few picks, and upon a difference in the tension of the

ground and pile warps. The two distinct warps, which are essential for the manufacture of terry pile fabrics, interweave with the same weft in many different ways, and the usual sequence of weaving operations, which is general for most types of terry cloths, will be explained

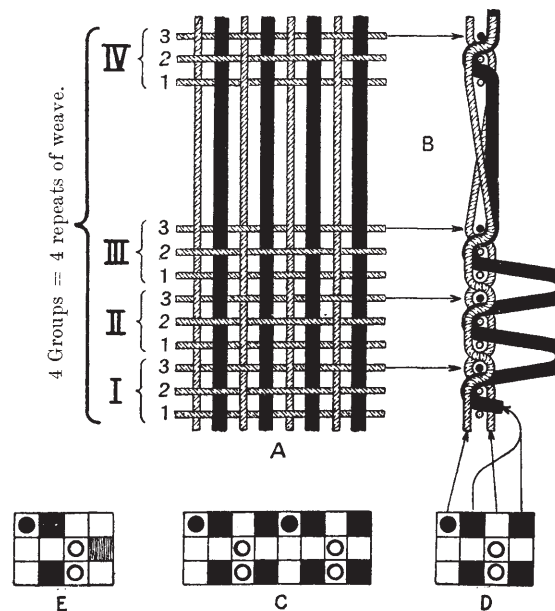


FIG. 246.

briefly in conjunction with the description of Fig. 246. This figure illustrates a 3-pick terry, in which all the pile appears on one side of the cloth. Few fabrics are made exclusively in this manner, but the figure illustrates the principle of terry weaving with fewer parts than are necessary for the description of a fabric in which the pile appears on both sides.

Illustration A is a plan of a fabric in which there are nine equidistant picks interweaving with eight threads, and forming three repeats of the weave in groups I., II., III.; a similar group of three picks is shown at IV., but these picks are separated from the other groups by a long gap B. Plan C shows two repeats of the weave in the way of the threads, while plan D is the unit weave from which the arrows point to the threads in the intersection. The solid black marks indicate the pile threads, and it will be seen that these threads are formed into loops opposite nine equidistant picks, but that they are perfectly straight between the last of these and the first pick of group IV. The last pick shown in group III. represents the fell of the cloth, and the three picks in group IV. must be beaten up together to join the other groups already in position. It is during this beating up process that the straight pile threads, extending over gap B, are caused to double up and to form loops similar to the others. Clearly then the reed has two functions to perform:—

1. To move picks 1 and 2 forward only a limited distance in order to leave the gap B; and
2. After pick 3 has been inserted to move forward its normal distance, as in an ordinary loom, and thus beat up all three picks to the fell of the cloth.

When the reed makes its minimum journey and leaves the pick a short distance from the fell, the loom makes what is termed a "loose pick"; but when the reed moves its maximum distance and reaches the fell of the cloth the pick is termed a "fast pick." (In all these intersections on terry weaving the fast picks are indicated by solid marks.) In Fig. 246 the first two

picks of each group are "loose picks," but the third pick is a "fast pick"—indicated as above, and also by arrows from the plan—when the reed, held rigidly, moves forward the full distance of its travel, and pushes in front of it the three picks last inserted to meet the cloth already formed. As these three picks are being carried forward by the reed, they slide along the highly tensioned and dressed ground threads, and carry forward with them the lightly tensioned pile threads which double up, as shown, to form loops.

As previously stated, this illustration has been

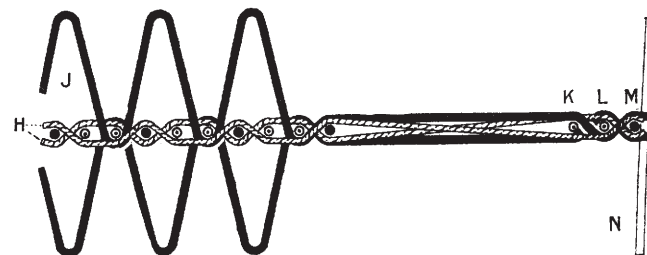


FIG. 247.

introduced mainly to show the principle involved; if, however, we arrange the weave so that the pile threads cut with each other, as do the ground threads, we shall obtain design E. The first three threads would be identical with those in intersection D, but the 4th thread would form loops on the under side of the fabric, and the structure would then be similar to the section illustrated in Fig. 247. This is the structure which obtains in the simplest type of terry fabrics, and it is evident that four leaves and three picks only are required for its manufacture. It is obvious, however, from design F, Fig. 248, that satisfactory selvages cannot be made with



the ground shafts alone, because the weft would return in the same shed twice in every six picks, or once from each selvage. A suitable though slightly imperfect selvage may be made if a few threads from the extreme edge of the ground warp be drawn through the four shafts; this will be apparent from design G. It will be understood that continuous terry weaving would produce cloth suitable for roller towelling, but if hand towels are

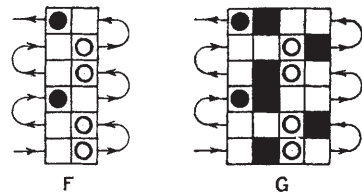


FIG. 248.

required with headings or cross borders, extra tension must be placed on the pile threads at these parts, and the reed made to travel its full distance every pick. Coloured picks of various yarns and counts may also be introduced, and ordinary weaving may alternate with pile weaving to give variety to the border; coloured threads may also be used to form stripes, but no choice of weave or structure is permissible in these simple cases beyond that of the alternate use of pile and ordinary weaving.

It will be observed that the ground warp threads H in Fig. 247 work  $\frac{2}{1}$  and  $\frac{1}{2}$ , but at different times to the similar movements of the pile threads J; the latter cross between the two "loose picks" K and L, but the former do not cross at this time. This arrangement enables picks K and L to grip the pile yarns firmly, and thus facilitate the formation of the loops when the three picks are beaten up by the reed N on fast pick M.

In Fig. 249 the design, draft and weaving plan are given for the usual 3-pick terry arranged to form equal pile on both sides of the cloth, and for a one-thread

pile to one thread ground order of drafting. Nine shafts are necessary for the draft given, four of the nine being extra or skeleton shafts for selvage work only; but for the

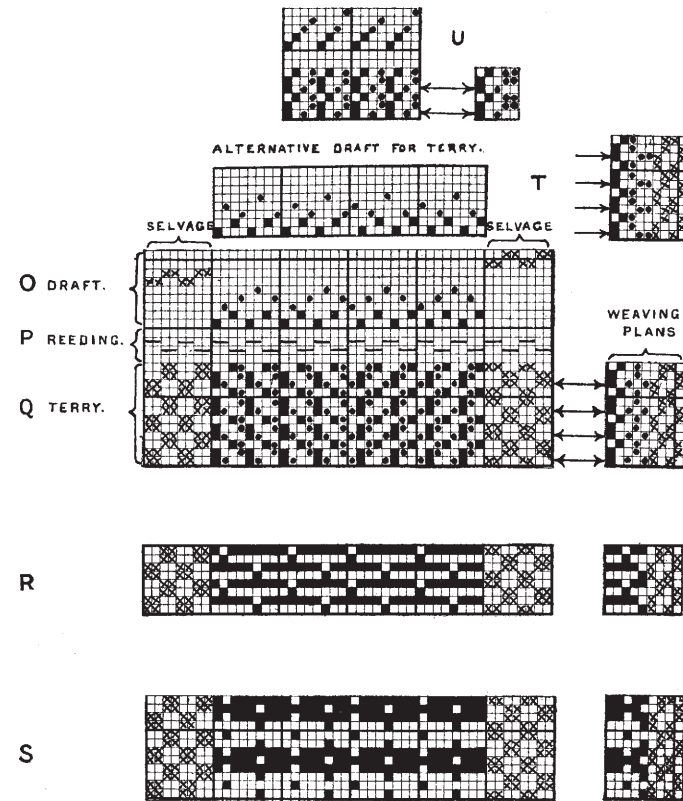


FIG. 249.

simple terry design illustrated at E, Fig. 246, four shafts only are required—two for the pile warp and two for the ground warp. When this type of terry is woven in a

dobby loom, it is customary to employ five leaves for the body of the cloth, and to draw the threads as shown by draft O, Fig. 249, so that a further variety of shedding may be obtained when it is necessary to insert the headings or cross borders of individual towels. With regard to the draft given it will be observed that, as arranged, shafts 3 and 5 carry only half the number of threads taken by the other three shafts; they are therefore knitted only half as fine as shafts 1, 2 and 4. By adopting the alternative draft and weaving plan T, these two coarsely knitted shafts become Nos. 4 and 5, and are therefore placed together at the back of the camb. In practice the three shafts which operate the ground threads are invariably in this position, the pile warp being drawn on the shafts nearest the reed so that the best shedding results may be obtained. Eight threads only are shown at each selvage, but twelve or sixteen may be used according to requirements. Since the weave of the selvage portion repeats on four picks, and the terry weave repeats on three, both must be extended to twelve picks at least if the shedding operations are to be controlled by a dobbie. Suitable weaves for cross-border purposes are shown at R and S arranged to suit the draft O. The picks which are beaten up by a rigid reed are indicated in design Q by double-headed arrows.

Terry warps are usually arranged in equal proportions of pile and ground threads, although they may be drafted either 1-thread pile, 1-thread ground as shown, or 2-threads pile, 2-threads ground. The former order is perhaps the more widely adopted, although the latter gives equally satisfactory distribution of the pile in the finer setts, and has certain practical weaving advantages to commend it. In the 1-and-1 arrangement, one pile thread and one ground thread are drawn together in one split of the reed,

but in the other method two pile threads are in one split and two ground threads in the next, and so on. Now terry weaves are so arranged that the two pile threads forming a pair work in opposition, a method of working which also applies to each pair of ground threads. But a pile thread and a ground thread, forming a splitful, sometimes shed in the same direction, and sometimes in opposition, with the result that the highly tensioned ground thread has a tendency to prevent the free movement of the lightly tensioned pile thread in the same split. By the 2-and-2 method of drafting, pile and ground threads are separated by the reed wires, while each pair of pile threads, as well as each pair of ground threads, is in turn separated by the shedding apparatus, thus enabling a fairly open shed to be presented for the passage of the shuttle. The actual draft of the warp is also materially simplified for both drawer and weaver, as will be evident on reference to U, Fig. 249, where this alternative method is shown.

When the 1-and-1 order of drafting is adopted it is usual to arrange the warps as follows:—

- 1-thread pile, 1-thread ground to the centre of cloth; then
- 1-thread ground, 1-thread pile to the other selvage.

Design Q, Fig. 249, is so arranged—the pile threads being first for half the width, then the ground threads are first. This is done also to avoid a further tendency which the tight ground threads have of controlling the loose pile threads. It is well known that warp threads under tension, and particularly those near the selvages, have a distinct tendency to pull towards the centre of the cloth, and thus to bear against the inner reed wire of the split through which they pass. If the pile threads are drawn to occupy the outer position in each split on both sides of the centre

of the reed, they will, in all probability, have greater freedom of movement, and be less liable to be influenced by the highly-tensioned ground threads than if they are drawn in the same order throughout.

Cross borders may be of different types, but the following arrangement with reference to Fig. 249 gives a fairly good effect.

- 18 picks (weave S) single Turkey-red cotton weft ;
- About  $1\frac{1}{4}$ " (terry weave Q) usual weft, with reed rigid and pile warp beam under tension giving ordinary cloth ;
- 30 picks (weave S) heavy twist cotton weft ;
- 18 " ( " S) single Turkey-red weft ;
- 24 " ( " S) heavy twist cotton weft ;
- 18 " ( " S) single Turkey-red weft ;
- 30 " ( " S) heavy twist cotton weft ;
- About  $1\frac{1}{4}$ " (terry weave Q), usual weft, reed rigid and pile beam under tension.

Total length of border about 5 inches. A good average sett is about 55 threads per inch in the reed ;  $25^s$  lea linen for both pile and ground warps ; ordinary weft  $12^s$  to  $16^s$  cotton ; about 35 shots per inch in terry portion, and 50 to 60 shots per inch in plain portion of borders. In some cases the number of picks per inch is practically the same throughout, but these proportions may be varied, between limits, by the proper control of the uptake motion. If desired, weave R, Fig. 249, may be substituted for weave S in the Turkey-red portions of the border. In the cheaper grades it is customary to use single waste cotton weft in place of the heavy twist cotton in the cross borders. Terry pile is also introduced into the borders for the sake of variety.

Most pile fabrics of this character are developed entirely

in cotton yarns, although a considerable number of all linen towels and of union towels in cotton and linen are made. When developed as unions these so-called Turkish towels may have the ground warp and the weft cotton, and the pile only linen ; or both warps may be linen and the weft only cotton ; or again, ground warp only may be cotton and the pile warp and the weft linen. Cloths produced on this principle are very full, and, on account of the looped and comparatively loose nature of their surface, are eminently suitable for bath and other towels, where the power of absorbing moisture is essential, and where a semi-rough surface is desired.

In terry weaving it is, in general, only necessary to put in two "loose picks" in succession, viz. the last pick of the float which is to form the loop, and the succeeding pick or that which binds the pile warp with the weft (see K and L, Fig. 247). Any further picks in the repeat of the weave are usually for the formation of the ground cloth, and for further binding purposes ; these "fast picks" must be beaten up with a rigid reed. Terry weaves are few in number, and are designated 3, 4, 5, or 6-pick terrys, according to the number of picks contained in each horizontal row of loops. By far the greater portion of these fabrics is made in the above described 3-pick terry, the other weaves being used only when it is desired to make heavier and firmer fabrics with the pile in some cases exceptionally well bound into the body of the cloth. It is necessary to observe, however, that while a firmer fabric may be made by increasing the number of picks per row of loops, the density of the pile or the rows of loops per inch will be correspondingly reduced unless the number of picks per inch be increased in proportion.

4, 5 and 6-pick terrys differ only slightly from those on

three picks. In the 4-pick variety the pile warps work in opposition to each other in  $\frac{3}{1}$  and  $\frac{3}{3}^1$  order, while the ground warp may be either  $\frac{2}{2}$  and  $\frac{2}{2}^2$ , or  $\frac{3}{1}$  and  $\frac{3}{3}^1$  in opposition. Fig. 250 illustrates the design, weaving plan, and intersection of the 4-pick terry with the 2-and-2 ground weave. The weaving plan, which shows two repeats like the design, is arranged for the draft given in

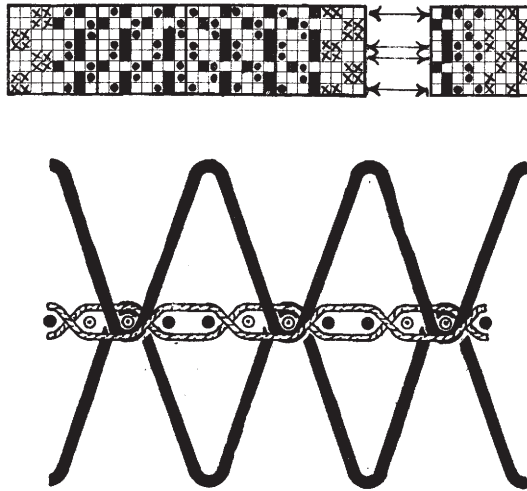


FIG. 250.

Fig. 249. When the 2-and-2 order is adopted for the ground warp it is possible to dispense with two of the selvage skeleton shafts suggested in that draft, since the selvage threads at one side could be drawn upon, and controlled by the shafts which operate the ground warp. Double-headed arrows again show the picks which are beaten up by the rigid reed, and solid black circles in the intersection show that two fast picks alternate with two loose picks.

The 4-pick terry with the 3-and-1 order of ground and pile weaving is illustrated in Fig. 251 in exactly the same manner as Fig. 250 illustrates the 2-and-2 order. With the 3-and-1 order, however, all four selvage shafts are necessary if the 2-and-2 basket or matt order is desired for selvage weave. From the weaves illustrated in Figs. 250 and 251 it will be seen that special

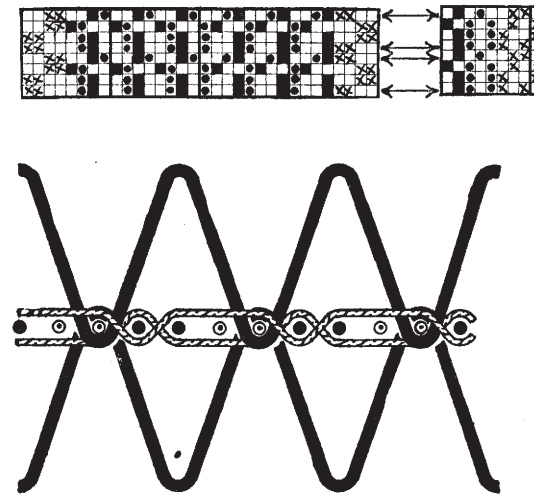


FIG. 251.

provision must be made for the selvages, seeing that in the former the 1st and last, or the 4th and 5th picks of the terry portion are alike in every respect, and in the latter the 1st and 2nd picks are identical. Catch bands might, of course, be used, but it is preferable to use the basket weave as illustrated and to arrange the picking to suit the shedding. As the designs are arranged the first pick in each case should travel from left to right.

Five-pick terrys are usually woven, both ground and pile warps, in the  $\frac{2}{1}\frac{1}{1}$  order, arranged as usual in opposition as indicated in the design base V, Fig. 252. Two repeats of the weave are given, and the "fast picks" are again indicated by arrows. Although this weave may be used for ordinary piece goods and towellings, its most important application is in the manufacture of bed covers,

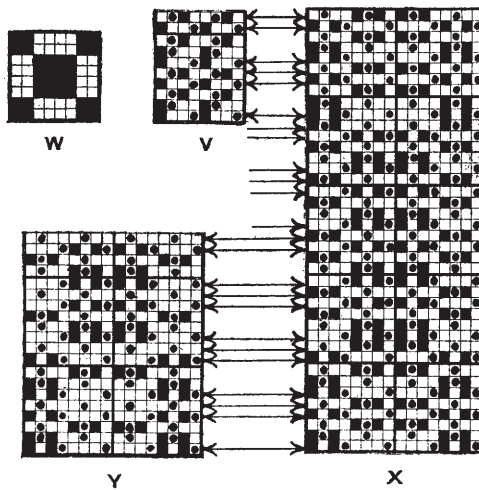


FIG. 252.

furniture cloths, and other fabrics which are figured on both sides by means of a terry pile on a plain or bare ground. For this purpose only 1-pile warp is necessary, since all pile threads loop simultaneously, but the side of the fabric on which the loops will be formed is determined by the jacquard which controls the pile warp. Ground warp threads work throughout in the same order, and may therefore be controlled by two or three shafts in the usual way. This feature sets the jacquard free to control pile

threads only, and reduces the preparation of designs to form or outline alone. Card-cutting is, in consequence, materially simplified, since all pile threads, which are to loop on the top side of the cloth, work exactly alike; in a similar manner all those which are to loop on the under side also work alike, although in opposition to those looping on the top side. The cards will therefore be cut solid in some parts and missed entirely in other parts, according to the design. Five cards will be required for each horizontal row of the design paper for an ordinary full harness jacquard. At W, Fig. 252, a small motive or design is given as it would appear for jacquard work, while its full thread by thread and pick by pick working is shown at X.

In some cases the terry structure shown at X is modified in that the pile threads when looping at the back of the fabric interweave with the weft in  $\frac{1}{4}$  order instead of in the order given at X. If the  $\frac{1}{4}$  order be desired, no modification of the design as prepared for card-cutting is necessary, but the card-cutter will require to be instructed to the effect that threads forming pile on the under side are to be lifted only on the second loose pick of each repeat of the terry motion. This result is indicated in detail at Y, Fig. 252, which shows the lower half of the motive W developed in the modified form.

There are several 6-pick terrys, but practically only one of note, viz. that shown in design form and in section in Fig. 253, and generally known as the "Osman." As far as design, draft and weaving of the shafts are concerned, it is practically identical with the 3-pick terry illustrated in Fig. 249. The reed control, however, is different, in that there are four fast picks and two loose picks, as shown by double arrows. This arrangement causes the

pile warp threads to be much more intimately woven into the ground fabric as shown in the sectional view, and is the chief reason for this modification of the ordinary 3-pick terry.

Without entering into a description of the different methods of controlling the backward swing of the reed when in the so-called "loose" position, for the purpose of

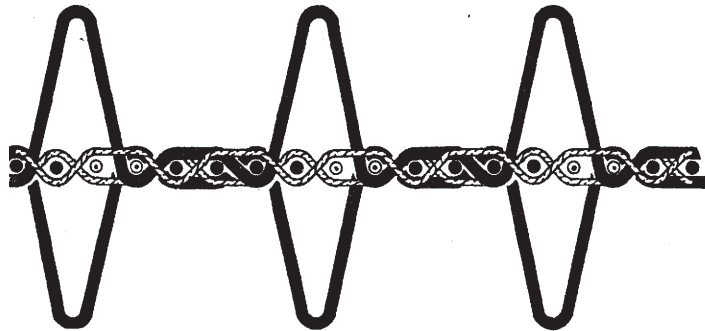
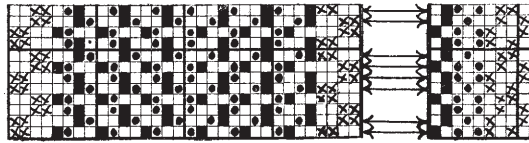


FIG. 253.

determining the length of the pile to be formed, it is sufficient to say that in most terry looms this may be regulated at will, so that the pile warp required may be varied in length from about four times to eight or nine times the length of the ground warp. In practice, however, it is not unusual to determine whether the pile is a satisfactory length by the weight of the first piece or of the first dozen towels woven, as the case may be.

## CHAPTER XXI

### WEFT PILE FABRICS

A CASUAL glance reveals very little difference between certain kinds of warp pile and weft pile fabrics, although the two methods of weaving and of pile development are quite distinct. In general the weft pile textures are made of comparatively cheap materials, and the pile itself is as a rule shorter than that of the better class warp pile and plush fabrics. When the pile is formed of cotton weft—which is invariably the case with the short weft piles—the fabric is termed a "velveteen." These weft pile cloths are woven in the loom in the ordinary way with a single weft, certain picks being intimately bound with the warp to form a ground fabric, while others are less securely stitched at longer intervals. Afterwards the long weft floats are cut, either by hand or by machine, to form a projecting pile. When cut by machinery, one or more rows or races may be cut at the same time—usually one for the sake of accuracy—and the cutting is more rapidly done than by hand. Hand-cutting is, however, extensively practised, and probably always is employed for the very long weft pile such as obtains in imitation lambskins and similar fabrics.

The method employed in the manufacture of velveteens will probably be more clearly understood by a reference to Fig. 254, which shows parts of a very simple structure. This example is introduced specially to demonstrate the principle, the usual velveteens being somewhat different. Two repeats of the complete weave for this fabric appear

at D in Fig. 255, the first three picks of which are shown

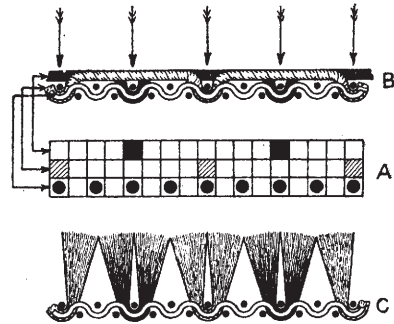


FIG. 254.

at A in Fig. 254. These three picks, before they are cut, are shown at B; the long floats, indicated in distinctive

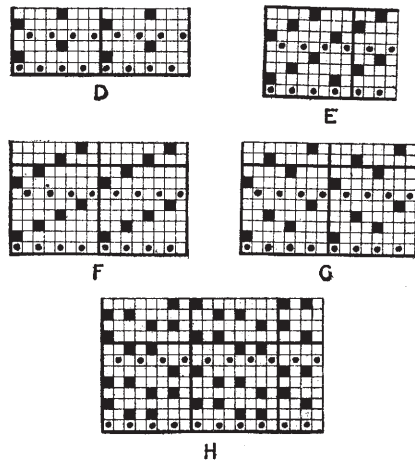


FIG. 255.

marks for easy reference, are the weft pile picks. When the fabric is removed from the loom the long pile picks are

cut through the middle by a special knife at the points indicated by the arrows. All the warp threads and the ground picks, being undisturbed, form the foundation of the fabric, from the body of which the cut-pile picks stand erect as indicated in illustration C.

Design E, Fig. 255, is extensively used for velveteens; it is an 8-pick plain back, capable of being drafted to four leaves, but usually woven on six, so that the heddles will not be crowded, and that the 3-leaf twill back may also be used with the same draft. The weave is reproduced at J in Fig. 256 in the order often woven, two repeats again being shown as is the case with all these velveteens. The plan of the fabric, showing two plain picks and three pile picks, is illustrated at K, each pile pick appearing in a distinctive mark. From what has been said

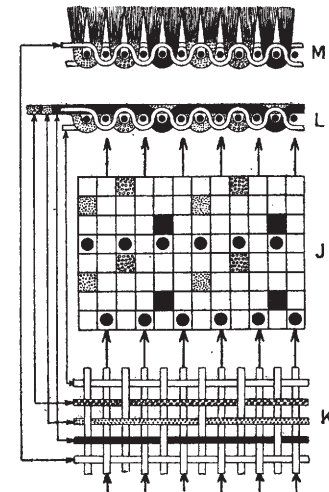


FIG. 256.

with respect to cloths backed with warp, it will be easily seen that these three-pile picks will overlap each other more or less and form a compact body. The appearance of the yarns when the cloth leaves the loom is shown by intersection L. The cutting knife runs along three races in each repeat as indicated by the arrows, and after the floats of weft have been cut, the pile picks in each group appear in a straight line between two ground picks as shown by the cut intersection M. These tufts, although made of

weft yarns, are precisely the same shape as the warp yarn tufts illustrated at A, Fig. 218. Two 10-pick velveteens are introduced at F and G, Fig. 255, each with four-pile picks between each pair of ground picks; while design H is a 12-pick fast pile velveteen, each pick being

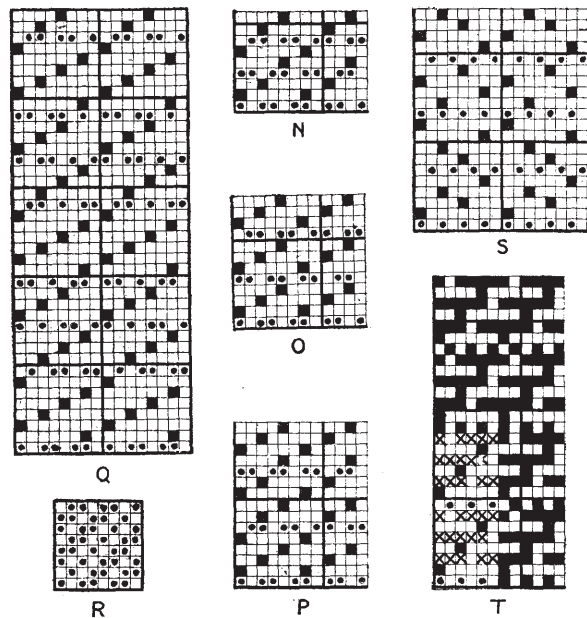


FIG. 257.

bound twice and having a form when cut similar to that shown at D, Fig. 218.

The above velveteens have plain backs, *i.e.* the ground picks interweave with all the threads in  $\frac{1}{1}$  order. Designs N, O, and P, Fig. 257, have 2, 3, and 4 pile picks respectively between each pair of ground picks; the latter interweave with the threads in  $\frac{2}{1}$  twill order. A twill

back of this kind places the weft floats at the back of the fabric; hence there is less danger of cutting the ground picks during the operation of cutting the pile than would be the case if the weft floated above the threads. Design Q is a somewhat similar fabric, the ground weave being shown at R. Since there are 40 picks, of which 8 are ground, the fabric is equivalent to one with 4-pile picks between each pair of ground picks. Design S is another 4-pile to 1-ground velveteen with a plain back; the pile picks, however, are arranged to start at different points in the four sections. The particulars for common makes of the above are from 80 to 88 threads per inch of 28<sup>s</sup> to 32<sup>s</sup> cotton or equivalents in 2-fold yarns, and from 300 to 400 picks per inch of 40<sup>s</sup> to 60<sup>s</sup> cotton. Design T shows four repeats of a reversible velveteen, but we are not aware that there is a large trade in this type. Fig. 258 shows a design for a weft pile imitation lambskin fabric, the weft of which is usually woollen or worsted, and is, naturally, much thicker than the corresponding yarns employed for the ordinary velveteens.

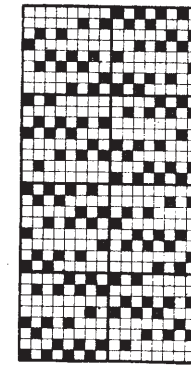


FIG. 258.

The ordinary velveteens, termed plain velveteens, have practically a flat surface, *i.e.* all the tufts are approximately the same length. It is possible, however, to obtain the "Patent Velvet" or velvet cord from some of the designs which are used for the plain velveteens. Thus, designs F and G, Fig. 255, or design Q, Fig. 257, may be used for this purpose. In Fig. 259 we reproduce the first four pile picks of designs F or G crossing 33 warp threads; the latter are shown only in very thin lines. Immediately



under these picks is a series of arrows, each one of which is numbered. The numbers indicate the place and order of cutting. One complete round is bracketed U, and the effect which results from cutting one round in this order is shown at the top of the illustration. The numerals immediately under each line of uncut weft show which

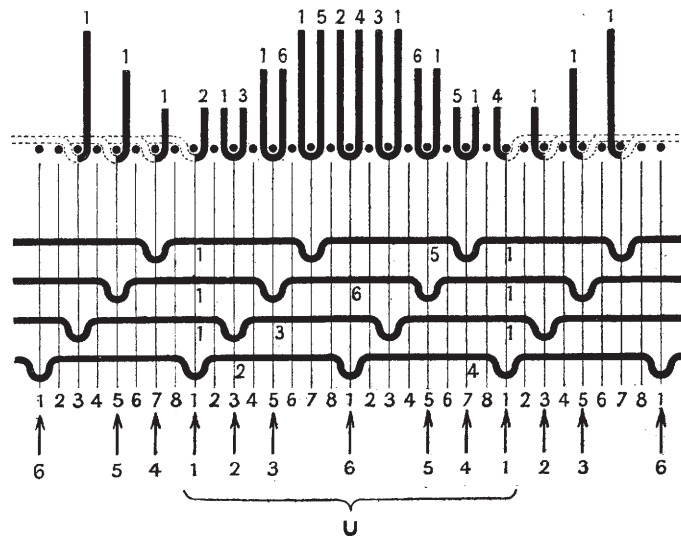


FIG. 259.

floats would be cut in the successive races, while the corresponding numbers above the tufts indicate where the two ends of each cut float would appear in the fabric. Although the design is complete on 8 threads, it requires 16 threads to the round for cutting, the finished fabric having a rounded or corded appearance, as shown in the top part of the figure. The above principle of weft pile weaving is applied to figured fabrics, although not to the

same extent as warp pile; the cutting of the pile for the former is a difficult operation.

Closely associated in appearance with patent velvets, but more extensively manufactured than they, are the corduroys, fustians, cotton or Genoa cords. They are usually of

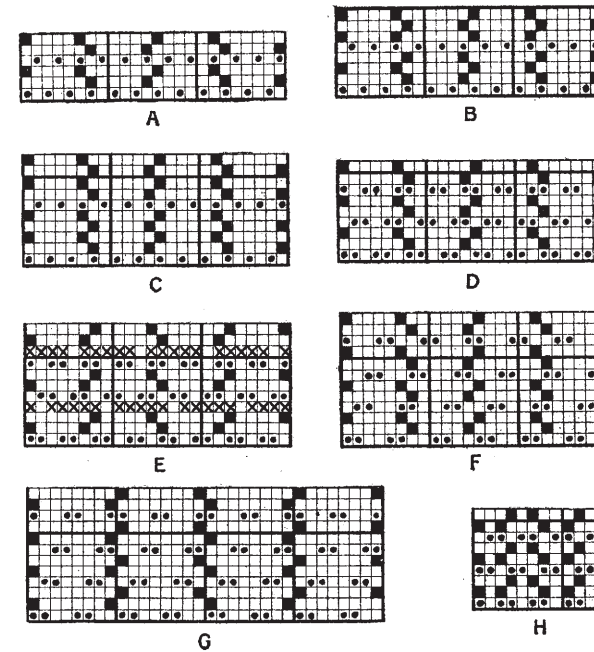


FIG. 260.

heavier makes than the velveteens and patent velvets, and are used mostly for men's clothing. In general, they are made with two picks of pile to one pick of ground, but occasionally three or more pile picks are used for each ground pick. Every second thread in velveteens takes part in the binding of the pile picks, whereas corduroys

are bound on 2, 3, or more successive threads, and hence the cutting process is much more easily done. Fig. 260 illustrates different kinds of corduroys, each design showing two repeats.

- A, B and C are 2, 3 and 4 pile pick corduroys with plain backs, each weave requiring six leaves ;  
 D is an 8 leaf, 9 pick corduroy or Genoa cord,  $\frac{2}{1}$  back ;  
 E is the same weave as D, but with backing picks which are shown in crosses ;  
 F is an 8 leaf, 12 pick corduroy or Genoa cord,  $\frac{2}{2}$  back ;  
 G is an 8 leaf, 12 pick corduroy or Genoa cord,  $\frac{2}{2}$  back, with longer floats for more prominent cord.  
 H is a 6 leaf, 9 pick "thickset" cord,  $\frac{2}{1}$  back.

The general structure of these fabrics will be understood by the various illustrations in Fig. 261. J and M show the first three picks from A and G respectively, Fig. 260. K and N show the positions of the warp and weft yarns before cutting, while L and O illustrate the appearance of the finished fabric. The arrows show the points where the pile picks are cut by the knife, and it will be seen that each odd tuft has a short and a long side, whereas each even tuft has a long and a short side. When in conjunction in the fabric, the successive pairs form a rounded or corded effect similar to that illustrated. All the designs in Fig. 260 produce cloths of the same character. Designs P, Q, and R, Fig. 262, show corduroys of a slightly different construction; they are termed "constitution cords," and it will be seen that every alternate pile pick is more securely bound than are those illustrated in Fig. 260.

The foregoing examples illustrate the chief makes of warp and weft pile fabrics produced as follows :—

1. By wires during weaving ;
2. By double plush weaving ;
3. By cutting the floats after the piece leaves the loom.

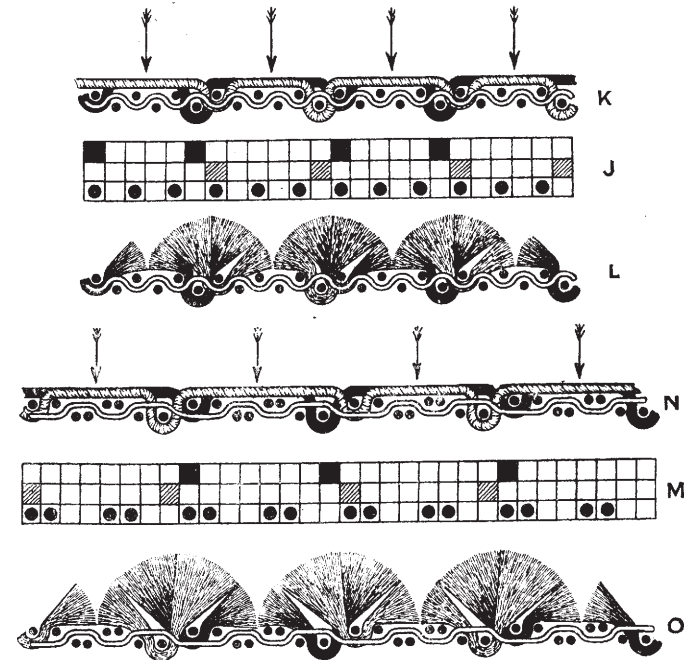
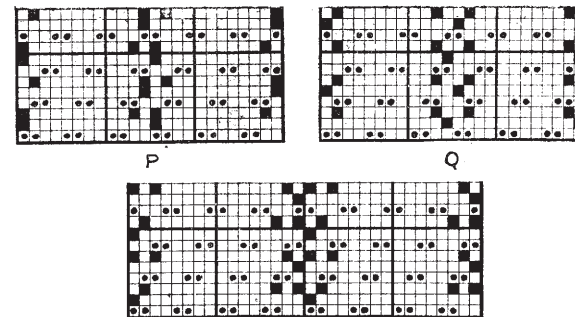


FIG. 261.



R

FIG. 262.

We shall close the chapter on pile fabrics by a short description of the processes involved in the manufacture of the cheaper imitation sealskins and plushette fabrics—fabrics which are produced without the aid of any of the above methods. Photographical reproductions of the cloth in various stages appear in Fig. 263, where A and B show the face and back of the cloth as it leaves the loom. The cloth contains about 30 threads per inch  $2/20^s$  white cotton, and 28 picks per inch of  $6\frac{1}{2}$  skeins (104 yards per ounce) weft composed of cow or calf hair and a small quantity of dark wool; the weft appears above each pattern. C shows the face of the cloth in the milled state,

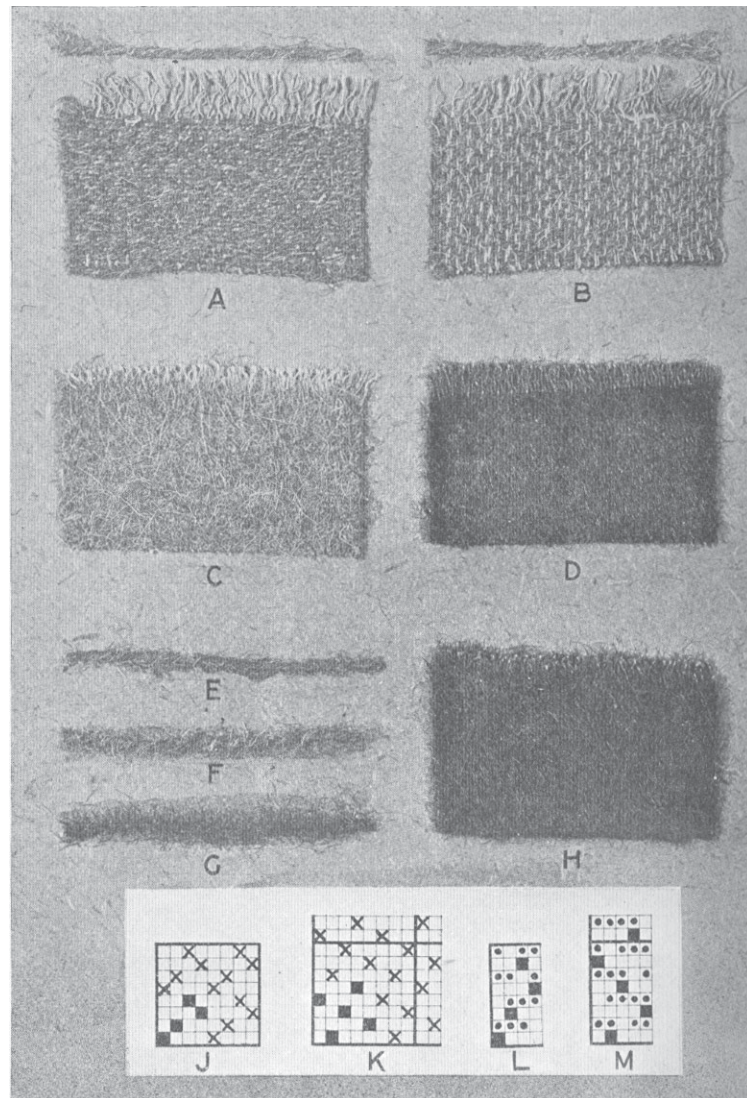


FIG. 263.  
438

FIG. 264.

while D is the same fabric after having been raised and dyed. The exhaustive processes of raising and beating raise the pile which, when dyed to the proper colour, is a good imitation of skin. Threads E, F and G show the weft in the three stages—loom, milled and washed, dyed and finished; while pattern H is a cloth with a pile on both sides. Pattern D is made with weave J, the 4-thread broken twill or swansdown, while pattern H is made on the principle of backing with weft; the design for this pattern is L, which is simply the 4-thread broken twill, weft flush, backed with weave J. Plan K is often used for similar fabrics of a better quality, while M is the 5-thread sateen backed with weave K, and intended for

a better class double-faced plush. These fabrics are extensively used for curtains, portières and similar articles. They may be finished off in self colours as shown at D or H, or afterwards ornamented by a process of printing. Fig. 264 illustrates part of a pattern of this nature; the cloth, which was originally exactly like pattern D, Fig. 263, has a red ground upon which the figure is printed in green and yellow. The same type of cloth is often printed in imitation of leopard and other animal skins, and is then used for carriage rugs; it is also frequently used in the printed and unprinted conditions as a cheap fabric for the upholstering of furniture.

## CHAPTER XXII

### BEDFORD CORDS, PIQUÉS, TOILET COVERS, ETC.

BEDFORD cords and simple piqués are very similar in appearance to corduroys; they differ from them, however, in that the corded effect is developed in plain cloth instead of in different lengths of cut pile. The ribs in Bedford cords are in the direction of the warp threads, whereas those in piqués run from selvage to selvage. Bedford cords were originally used mostly for equestrian purposes, but they are now made of many different materials for dresses, trimmings, etc., and are sometimes termed "new corduroys." The piqués, on the other hand, are made mostly of cotton, and are used for blouse and light dress materials. Fig. 265 illustrates two typical Bedford cord designs, and the method of making them. A, B,

and D show the same design, and the reader will readily remember the construction by studying these plans. The first pair of picks in each design floats over seven out of eight threads, and then weaves plain for the next eight threads, whereas the second pair of picks does the reverse. Two repeats in the way of the weft are given at A, B, and D, as well as in the weaving plan C, which requires six leaves. This weave forms, perhaps, the

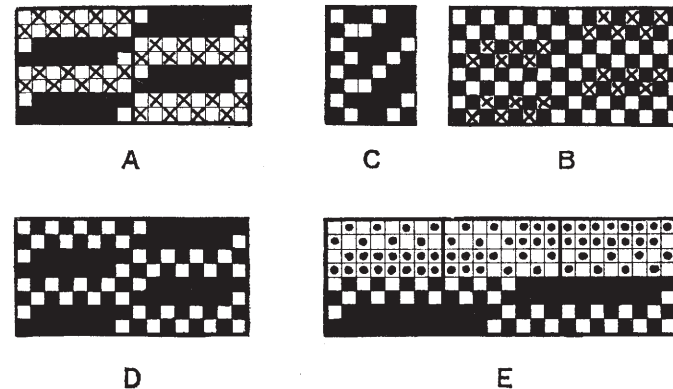


FIG. 265.

simplest effective cords, *i.e.*, cords without stuffer threads. By extending the floats, as shown in design E, a more prominent rib or cord is obtained without increasing the number of leaves, but necessitating a slightly different draft.

Fig. 266 illustrates the general appearance of these fabrics; it is a half-tone reproduction of the same cord in seven different colours—red, pale green, Oxford blue, pink, Cambridge blue, white, and heliotrope, represented by H, J, K, L, M, N, and O respectively. The particulars for the warp and weft are as follows:—

Face warp : 96 threads per inch of 30<sup>s</sup> cotton ;  
 Stuffer warp : 8 " " " 6<sup>s</sup> cotton ;  
 Weft : 68 picks " " 24<sup>s</sup> cotton.

The design for these fabrics appears at P, Fig. 267 ; it is the same as design E, Fig. 265, except for the threads marked with arrows, which represent stuffers. One or more stuffers may be used as desired in each cord, but stuffer threads must be warped on a separate beam. A

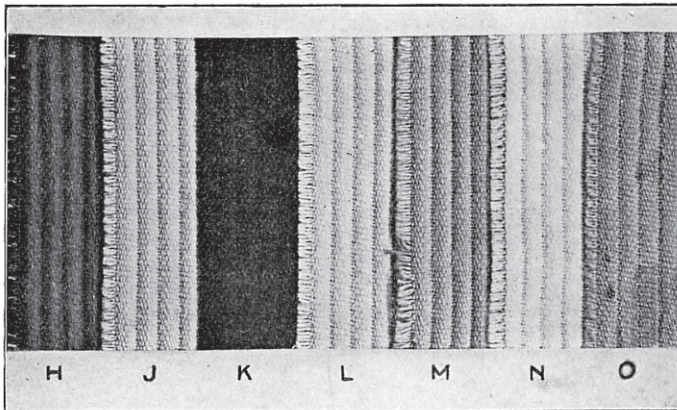


FIG. 266.

design showing a slight modification of the ordinary cord is illustrated at Q, in which two stuffer threads appear in each face cord. The intersections for P and Q, Fig. 267, are shown at R and S respectively in Fig. 268, a complete repeat in each case appearing between the dotted vertical lines. The numbers refer to the picks of weft, but in S only four are shown, because the remaining four would be immediately behind. The stuffer threads appear in the gaps between the plain cloth and

the floating picks, and they lie approximately straight. If the stuffer thread be removed from intersection R, the figure would represent design E, Fig. 265.

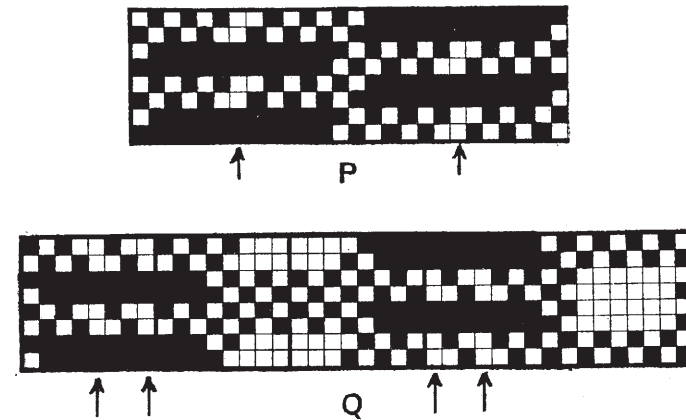


FIG. 267.

Similar types of cords may be obtained in the way of the weft, and the cloths are then termed piqués, as

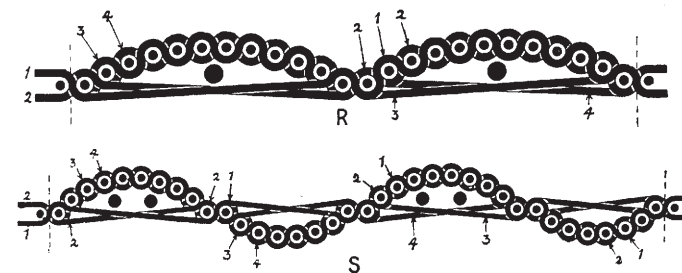


FIG. 268.

already stated. Designs T and U, Fig. 269, are two of these weaves, differing only on the first three picks ; each

design shows three repeats in the way of the warp. The cloth from which the design U is taken is shown at X, Fig. 270, where the cords are horizontal, as opposed to the vertical ribs of the Bedford cord shown at W. A selvage appears in both patterns, that of the Bedford cord being the 4-thread basket weave. In order to obtain a well-defined rib it is necessary that threads 2, 5, and 8 (T and U, Fig. 269), along with the other back threads, should be placed on a separate warp beam, so that they may be heavily paced in comparison with the threads for the face of the fabric. Illustration Y, Fig. 270, is

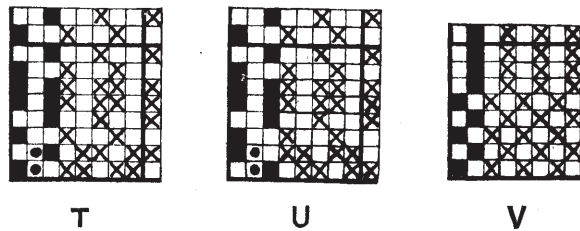


FIG. 269.

also a corded fabric, but this is obtained by thick and thin weft, as explained in connection with Fig. 11 (p. 12). The design, which shows four repeats, is given at V, Fig. 269, but since the last four picks are introduced at the same time, the weave is equivalent to  $\frac{1}{1}$  plain. There are 320 threads per inch of silk (2-fold 24,000 yards per ounce) in the warp, and the weft is:—

- 5 picks of 12,000 yards per ounce silk.
- 4 picks of 2/60<sup>s</sup> worsted inserted as one pick.
- 36 picks (6 repeats) per inch.

The photographical illustration of this cloth at Y, Fig.

270, demonstrates clearly the difficulty of forming a perfect selvage with comparatively thick weft.

Figured toiletings and toilets are constructed on much the same principle as piqués, from which fabrics they differ chiefly in pattern. Both structures require two warp beams; one for the ground, moderately paced, and the second for the stitching, binding, or figuring threads,

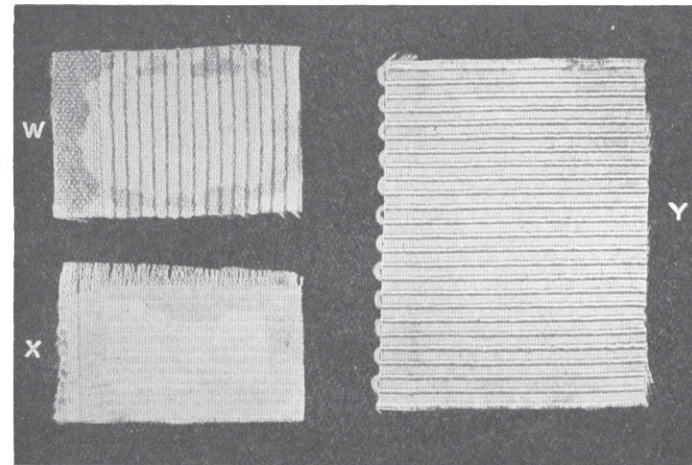


FIG. 270.

which must be tightly paced. In piqués the stitching threads all lift over the same two picks to form a groove or hollow across the fabric, but in toilets or toiletings the stitching threads are operated by the jacquard, and, according to the type of toilet, are lifted for 2, 3, 4, 5, or 6 successive picks, according to the pattern, in order to stitch the face cloth. In accordance with the number of picks over which a stitching thread is lifted to form the

figure the cloth is termed a 2, 3, 4, 5, or 6-pick toilet. The face cloth is almost invariably plain, although twills may be used, and the face warp, which is controlled by shafts, is arranged in the proportion of two threads face to one thread back or stitching. When the face weave is plain, two of the picks over which the figuring threads float are for the face cloth; the remainder of the picks (1, 2, 3, or 4, as the case may be) over which the figuring threads float are utilised for padding or backing purposes.

Toilettings may be divided into three types—loose back; semi-fast back, sometimes termed “stocking” back; and fast back. In the first type the stitching warp always floats loosely at the back of the cloth when not lifted over the weft for stitching purposes. This is necessarily the case with all two-pick toilettings, because there is no extra pick available for interweaving at the back of the cloth with the floating back threads. Three-pick toilets may, however, be either loose back or semi-fast back, since there is one pick in each float available either for filling only, or for filling and interweaving with the floating back threads. This pick is, in general, used as a padding pick only, and in the lower grades the same medium count of weft is used all through in order that a single shuttle loom may be employed. In finer grades two wefts are used, and, where a pick-at-will loom is available, the wefts may be inserted 2 picks face, 1 pick back; but in many, and perhaps most cases, the arrangement is 4 picks face, 2 picks back, in order that boxes may be required at one end of the lay only. When a three-pick toileting is desired with a semi-fast back, it is usual to lift the stitching warp over the padding weft in plain cloth order once in every 18 picks, and in this manner to bind the threads at the back and thus reduce

the length of the floats. With a single shuttle or a pick-at-will weave all odd figuring threads would lift on the 9th pick, and all even threads on the 18th pick, but a slightly different order is necessary when the order of wefting is 4 picks face, 2 picks padding. This plain cloth binding is usually accomplished by dividing the comber-board, which controls the figuring harness, into two equal sections, one section having all odd backing or figuring threads, and the other section all even ones; all the harness cords are knotted immediately above the boards, and the boards are worked as two shafts. In all cases special combinations of shafts and harnesses are employed for the production of these fabrics, and, as a general rule, it is only necessary to cut the figure on the cards.

In fast back or full toilet, the harness and shafts are so controlled that two perfect cloths—a fine one and a coarse one—are always formed independently of the figuring, or of the padding picks. When making the design, the figure only, or rather the outline, is painted, and no two adjacent threads should be lifted on the same pick; nor should any thread be lifted for two picks in succession, since such marking would cause the stitching thread to float over four face picks and thus nullify the effect desired. Further, it is best to adhere to one method of painting, and always to mark odd threads on odd picks, and even threads on even picks, so that were the design paper completely filled in, a perfect plain weave would result. This method of marking is indicated at A, Fig. 271, which shows the smallest diamond possible, and which is complete on 4 threads and 4 picks. This little motive is developed in each of the designs B, C, D, and E, but in each successive design the floats of

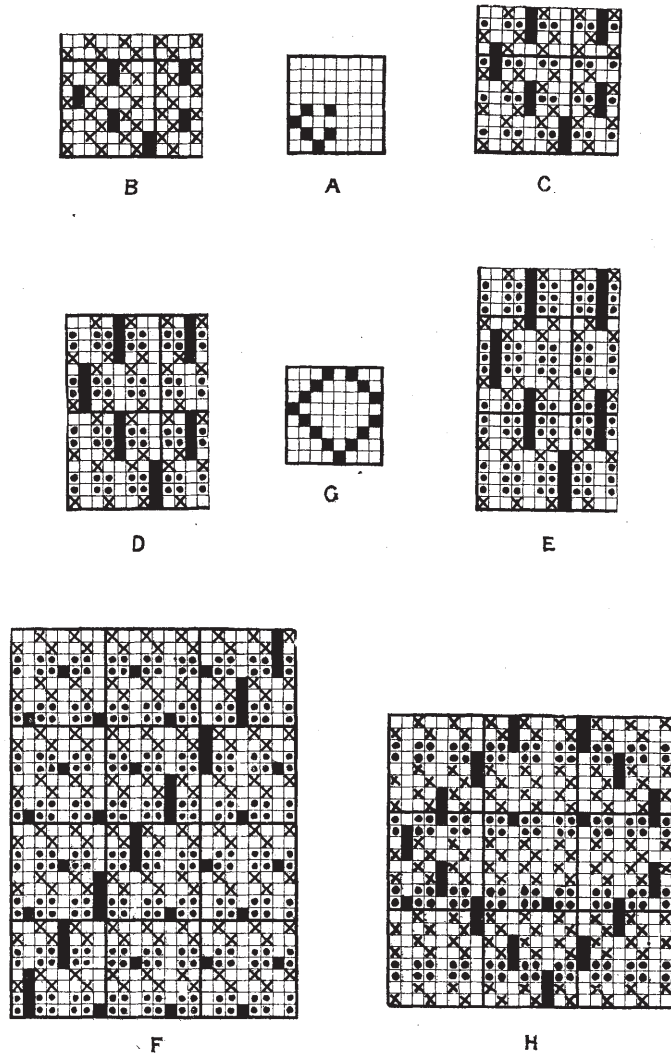


FIG. 271.

the figuring or stitching threads are increased by one pick. In all the designs the face weave (plain) is developed in crosses, while the dots in designs C, D, and E indicate the lifting of the face threads for one, two, and three picks of padding or backing weft respectively. If cards were cut according to the motive A, they would be equally suitable in most cases for 2, 3, 4, or 5-pick toilets, provided all other arrangements as to shedding, picking, and box motions were properly made. Weaving is materially simplified when wefting can be arranged in multiples of two picks of the same kind of weft, and for this reason design C is, as already indicated, generally woven with one shuttle, and the same weft used for both face and padding. When a different weft is desired for padding purposes the order of wefting is usually 4 picks face, 2 picks padding, so that multiple boxes are required only at one end of the lay. Design D is arranged as a four-pick loose back, although a four-pick semi-fast back, in which the padding picks interlace every twelfth pick with the back warp, is common. The five-pick toilet is the best generally made, and is used for most high grade fabrics. It is usually fast back, and where a pick-at-will loom is available, the wefting order shown at E, 2 picks face, 3 picks padding, will be suitable; but, in order to employ looms with boxes at one end only, it is not unusual to bind the backing threads with face weft, and to use a secondary or coarser weft solely for padding purposes. In such a case the order of wefting may be as indicated in Fig. 272.

The wefting is therefore equivalent to—

4	picks	fine	weft	:	picks	9, 10, 1, 2	in	Fig.	272
2	"	coarse	"	"	3, 4	"	"		
2	"	fine	"	"	5, 6	"	"		
2	"	coarse	"	"	7, 8	"	"		



The full thread-by-thread working of a four-pick fast back toilet is illustrated in design F, Fig. 271, where the isolated marks indicate stitching threads lifted by the sectional comber-board for binding purposes on one of the padding picks. Designs G and H show respectively a small motive on 8 threads and 8 picks and its thread-by-

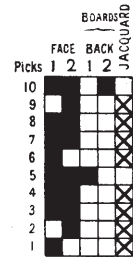


Fig. 272.

thread development as a three-pick semi-fast back toileting, with the wetting order, 4 picks face, 2 picks padding. Four isolated solid marks on the 9th and 16th picks indicate where the stitching threads are lifted above the padding weft by the sectional comber-boards for binding purposes. The repeat of the ground texture in this case is on 18 picks.

Fig. 273 illustrates the construction of the "patent satin" quilt. The name satin in this case has no reference whatever to the weave of that name, since the fabric is an intimately stitched double plain cloth in the proportion of 2 threads face to 1 thread back. For symmetry the yarns for design J are arranged as follows:—

- Warp: 1 thread medium white cotton for ground;  
 1 " fine " " figure;  
 1 " medium " " ground.  
 66 to 84 threads per inch.
- Weft: 1 pick medium white cotton for ground;  
 1 " thick blue " " figure.  
 88 to 112 picks per inch.

The thick blue weft covers the fine white warp and gives a comparatively solid blue figure.

Alternative arrangement:—

- Warp: 1 thread medium blue cotton for ground;  
 1 " fine white " " figure;  
 1 " medium blue " " ground.
- Weft: 1 pick medium blue cotton for ground;  
 1 " thick white " " figure.

In design J the figuring threads have only two movements,  $\frac{2}{2}$  in both ground and figure; they may, therefore, be drawn on two shafts. The ground threads are drawn alternately through the two sections of the movable comber-board which controls them for plain cloth weaving,

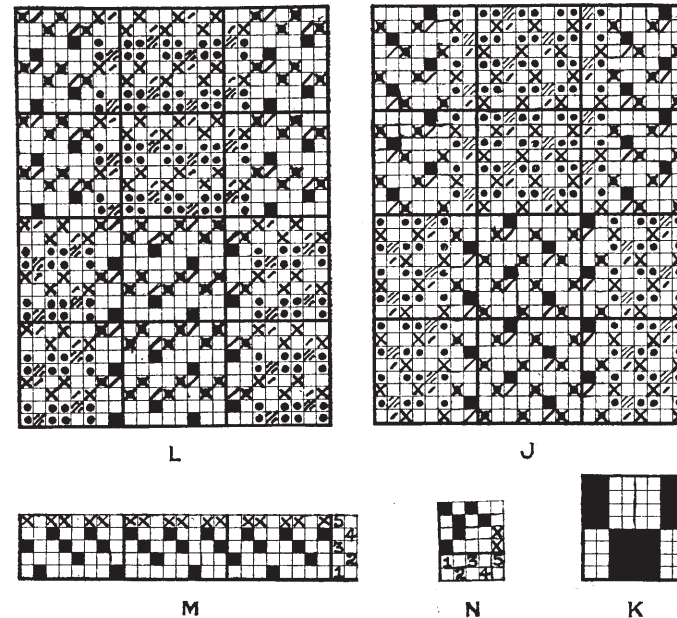


FIG. 273.

while the jacquard controls them for pattern. The different marks in the design have the following significance:—

- = white figuring threads weaving plain with thick white weft on surface;
- || = " " " " " " " " back;
- × = blue ground " " " " " " " " medium blue weft on surface;
- ★ = " " " " " " " " " " back;
- / = lifting of figure threads over ground picks in figure;
- ∖ = " " " " " " " " " " ground;
- = ground threads lifted for thick weft to pass to back.

Each needle of the jacquard controls two adjacent ground threads (Nos. 1 and 3, 4 and 6 in the design, although they are usually arranged 3 and 4, 6 and 7, etc.), since they work together on even picks, while the two sections of the comber-board control them individually on odd picks to produce the plain weave indicated by  $\times$  and  $\star$ . In order to obtain weave J it is only necessary to paint the design paper as shown at K. Each vertical cord on the design paper represents three threads in the cloth, and each pick on the paper is equal to four picks in the cloth. With 66 threads and 88 picks per inch the ratio of the vertical ruling to the horizontal ruling would be:—

$$\frac{66}{3} : \frac{88}{4} = 22 : 22, \text{ or } 8 \text{ by } 8 \text{ paper for } 400^s \text{ machine, and} \\ 12 \text{ by } 12 \text{ ,, } 600^s \text{ ,,}$$

Similar square paper would clearly be required if the cloth contained 84 threads and 112 picks per inch. Consequently the simple dice' pattern, fully worked out at J, would appear on design paper as shown at K.

In almost every case of toilet or quilt weaving, arrangements are made to weave the cloth with multiple boxes at one end only, and to do this with the cloth under consideration the wefting must be arranged, 2 picks heavy weft, 2 picks medium. The development of motive K by this method is indicated at L, where the various marks have the same significance as at J. The draft for both J and L would be the same, and is given at M, but the weaving plan would be different—that for design L appears at N.

Line No. 1 of the draft is shaft No. 1 taking odd figuring threads ;  
 " 2 " " 2 " even " "  
 " 3 " " the front section of comber-board taking odd ground threads ;

Line No. 4 of the draft is the back section of comber-board taking even ground threads ;  
 " 5 " " jacquard harness taking all ground threads.

From weaving plan N it will be seen that shafts 1 and 2 work in opposition in  $\frac{2}{2}$  order, and that shaft 2, which is up on the second heavy pick (pick No. 2), remains up for the first fine pick (pick No. 3). Similarly shaft 1, which is up on the second fine pick (pick No. 4), also remains up for the first heavy pick (pick No. 1). In this way the cloths are intimately bound together, and a firm and durable fabric results. The jacquard works also in  $\frac{2}{2}$  order, being up on the two heavy picks, and therefore lifting ground warp over figuring weft (it should be remembered that ground and not figure is cut on the cards), while it remains down on the two fine picks while the sectional boards work the plain ground cloth.

## CHAPTER XXIII

### GAUZE AND LENO FABRICS

ALTHOUGH gauze and leno fabrics depend upon the interlacing of at least two sets of threads, as do all woven fabrics, their construction is quite distinct and characteristic with respect to the path followed by some of the warp threads. In all the foregoing types of fabrics the warp and weft, although following a sinuous path according to the structure, move in more or less horizontal and vertical planes. Certain threads may diverge slightly, as in the case of oatmeal and spider fabrics (see Figs. 64, 65, 77, and 78), but on the whole the principle is that of

rectilinear interlacing, and all threads retain their relative lateral positions throughout the process of weaving. With gauze and leno fabrics, however, an entirely different principle is introduced. The weft and part of the warp interweave in the ordinary manner, but certain warp threads are made to change their relative positions, to cross, in fact, from side to side of one or more other warp threads, and thus produce a fabric which resembles, in some degree, that of a net or lace texture. Such being the case, it is evident that gauze and leno fabrics will be of a comparatively open nature, and, consequently, are useful only for decorative and for light clothing purposes, or for embellishing other heavier materials. It is, perhaps, natural to find that the production of any really characteristic effect involves some kind of difficulty in the manufacturing process. This is certainly the case in the weaving of gauze and leno cloths, the difficulties being found in the operation of the various parts involved in the successful working of the crossing threads. The simplest type of this cross weaving is probably that which is employed for the production of centre or patent selvages (see *Jute and Linen Weaving*, Part I, Figs. 217 to 221, pp. 361 to 364), in which the very simplest apparatus is utilised. When this system of cross weaving is required to extend continuously or intermittently from side to side of the fabric, the best results are obtained by the use of other and proper apparatus. It is not essential that the gauze or crossing thread should cross from side to side every pick, but, whenever it does cross, it must be lifted over the weft to ensure its remaining in that position. In pure gauze or "simple gauze" weaving, however, the crossing thread does pass from side to side every pick, and this is the type which will be described first.

In the formation of the cloth by the two picks which constitute a repeat in the way of the weft, there are two types of shed, known respectively as the "open shed" and the "crossed shed." The nature of these two sheds, and the means adopted for procuring them, will be understood by reference to Figs. 274 and 275, in which the former figure shows the "open shed," and the latter figure indicates the "crossed shed." The threads run in

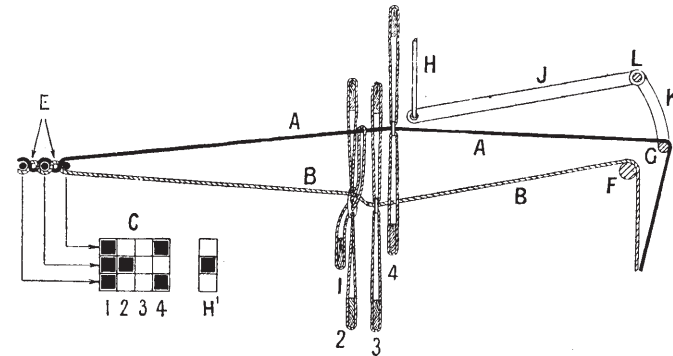


FIG. 274.

pairs, which are identical, but two threads only are shown in each figure.

1st. The dark thread A, or crossing thread, which is over every shot as indicated by thread No. 1 in plans C and D, and also by the picks at the fell of the cloth. Three picks are shown in Fig. 274, and four picks in Fig. 275.

2nd. The light thread B, or crossed thread, which is under every shot of weft, as indicated by the 3rd thread in weaves C and D, and by the picks at the fell of the cloth.

Now, since all dark threads A are over every shot, and all light threads B are under every shot, it is evident that some method of locking the yarns together, other than that practised in the ordinary methods of weaving, must be employed to make a coherent texture. The warp yarns are bound together between each pair of picks by the apparent crossings of both threads of each pair (see parts E between the picks). In reality, the mechanical operation

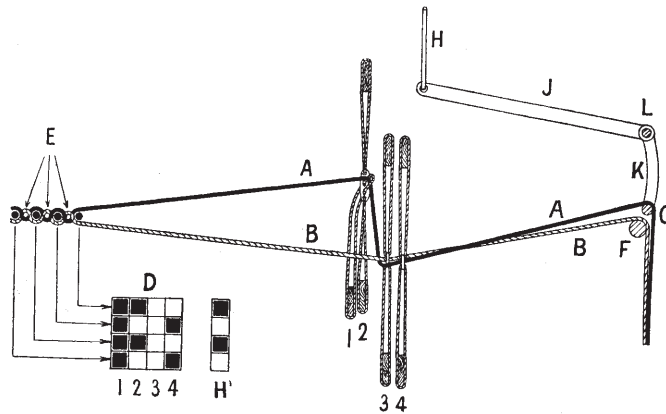


FIG. 275.

of crossing is performed only by the black thread, although each thread ultimately bends about equally. It therefore follows that one warp beam only is necessary for this particular example. As the two sets of threads leave the warp beam, however, they are separated into two layers, so that the crossed threads B pass over the stationary back rest F, and the gauze or crossing threads A pass over the movable back rest G. This latter is usually termed the "slackener" or "easer," being so named because it is capable of being moved towards the

back rest G when the crossed shed is being formed. At this time it is obvious that a greater length of yarn A is required between the yarn beam and the cloth than is sufficient for the same thread when forming the open shed, as in Fig. 274. The provision for this regular alteration in the lengths of the dark threads for the two sheds is obtained by lifting rod H from the position shown in Fig. 274 to that shown in Fig. 275, when the levers J and K, turning about stud L, place the rest G in the position shown in Fig. 275. They thus place the thread A in practically the same path as thread B as far as the combs; beyond this, the extra length required to form the crossed shed is equivalent to the amount of yarn yielded by the inward movement of rail G.

Three picks are shown in design C and four picks, or two repeats of the weave, in design D; while the lifting of the rod H, when the crossed shed is being formed, is indicated by the detached plan H'. To complete this brief description of the working of gauze, it will perhaps be as well to consider Fig. 276 along with Figs. 274 and 275. In all figures the lettering and numbering refer to similar parts. The threads from the back rails F and G in Fig. 276 are shown as being drawn through four leaves, and the characteristic effect of gauze is due partly to the peculiar method of drawing the threads through the leaves, and partly to the unique method of operating, jointly or separately, the combined leaves numbered 1 and 2.

No. 1 is termed the loose slip or doup; the heddle twine which forms this doup passes through two eyes of the mail of No. 2 leaf. Many ways obtain of threading the doup, but the one shown will illustrate the principle quite clearly.

No. 2 is the doup carrier.  
 Nos. 3 and 4 are two plain leaves through which the whole of the warp is drawn, as illustrated in Fig. 276.  
 After the warp has been drawn through leaves 3 and

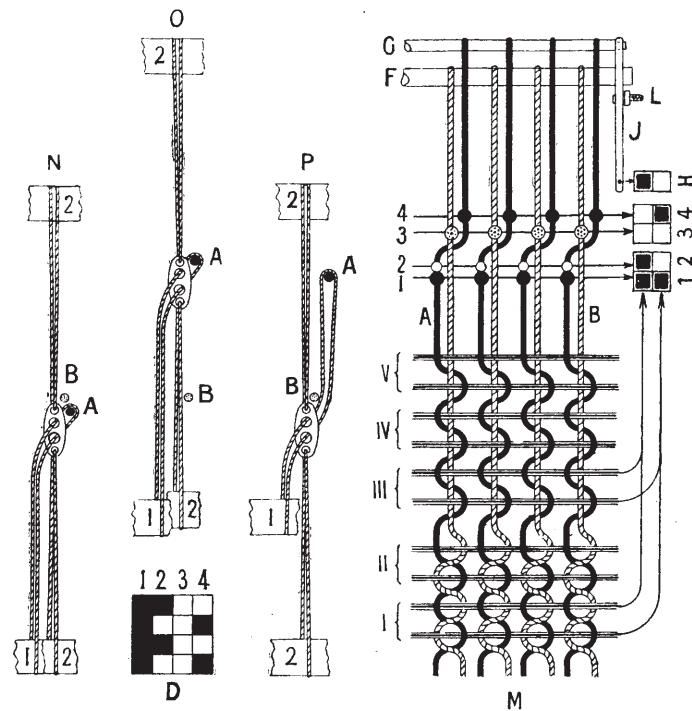


FIG. 276.

4 alternately as shown, each thread from leaf 4 is crossed under its neighbouring thread on leaf 3, and is finally drawn through the eye of the slip or doup, but not through the mail of the doup carrier. The solid black circles in the draft show that the black threads are drawn

through leaves 4 and 1, being crossed between these points under the light threads which are drawn on leaf 3. Five repeats of the weave are illustrated in groups I to V in diagram M, the first two groups representing the cloth approximately as it appears, with both threads equally bent, and the last three groups showing, for facilitating the description, the bending of the black threads only. Consider the first pick in group V, where the black threads are on the right-hand side of the light threads. This is the "open shed," in which the doup and shaft No. 4 are lifted—the shaft of the heald is lifted by the wyper, but the doups themselves are drawn upwards through the mails of the doup carrier by the threads which are lifted by shaft 4, see diagram P, Fig. 276. After the shuttle has passed through the open shed, the two leaves descend and their lowest position is shown by diagram N. Now it is evident that if the doup carrier 2, and the doup 1, be lifted as indicated on the second pick, thread A will be lifted on the left of thread B as shown in diagram O, which is the same position as that illustrated in Fig. 275. When these two shafts are lifted the "slackener" must also yield to supply the increased length of yarn required for the crossed shed. The repetition of these two picks is represented by groups III, IV, and V, Fig. 276, but the actual appearance of the cloth more closely resembles that shown in groups I and II.

When the cloth is formed by the crossing of half the number of threads in the warp on every pick, first to the left, and then to the right, the resulting fabric is usually termed "pure gauze," or simple gauze, but the same type of weaving may be employed in conjunction with ordinary rectilinear weaving of any kind. In addition, the gauze

threads may be made to move symmetrically, so as to form a type of ogee pattern, and this without any addition to the number of doups and slackeners. Each alternate slip or doup must, however, face in the opposite direction to the remainder, and the threads must be drawn in to suit. Thus in Fig. 277 we have the same combination of 1 doup, 1 doup carrier, and 2 leaves as in the last example. Each pair of threads marked Q is identical with each pair in M,

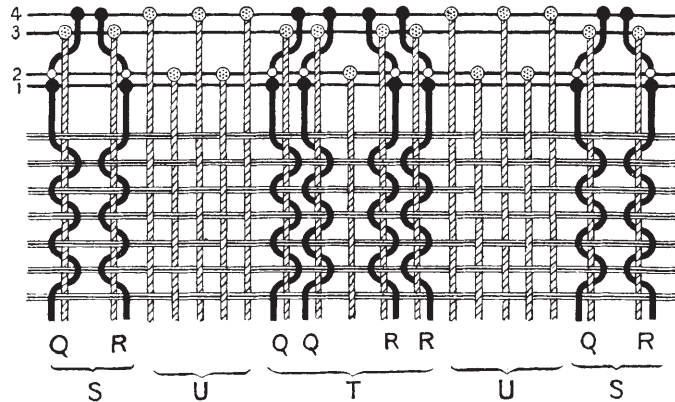


FIG. 277.

Fig. 276, but the gauze threads in parts R cross under the light threads in the opposite direction. Consequently, when doup 1 and doup carrier 2 are raised, each dark thread in parts Q will appear on the left of the light crossed threads, whereas each dark thread in parts R will appear on the right of its neighbour. On the other hand, when doup 1 and leaf 4 are lifted to form the open shed, both dark threads in groups S will appear between the two light threads. A similar arrangement obtains in group T, but here the threads move in pairs, instead of singly. It

is quite clear that since the threads embraced by parts U are drawn alternately on leaves 2 and 4, without passing through the doups, they will weave plain with the weft (see plans D, Figs. 275 and 276), and thus add variety to the structure. A choice selection of coloured threads adds beauty to the fabric, and it will also be quite evident that any twill or fancy weave may be obtained by employing the necessary number of shafts behind those shown in the figure, and operating them according to the pattern required. This will probably be sufficiently well illustrated in Fig. 278. The same four shafts which are shown in Fig. 277 would suffice to produce pattern W, Fig. 278, provided that they move as indicated by design X. In this pattern the central thread is drawn through a mail on the doup carrier; both will therefore rise and fall together. We have already seen (see design D, Figs. 275 and 276) that the doup carrier rises and falls alternately when making simple gauze, so that if a thread be drawn through a mail of this shaft, and not through the loose slip or doup, it will weave plain as indicated in the plan of the cloth and in design X, while gauze is being formed, and also in those parts where the gauze or crossing thread is in the crossed position. The crossing thread can also be made to weave plain when leaf 4 is prevented from rising—see picks 12 to 16, W and X. When, however, the crossing threads are on the “open shed” side, *i.e.* the inner position of W, the doup carrier must remain down, hence the middle thread, which is drawn on this leaf, must also remain down, although the crossing thread may at the same time be weaving plain, see picks 7 to 11. If, therefore, plain weaving be desired in conjunction with the system of cross weaving illustrated in Fig. 278, the threads which are to form the plain cloth must be drawn

through two separate leaves as at Y, and the two leaves operated as shown at Z. From this it is evident that if any other weave were required at Y, it could be introduced by using the proper number of shafts in place of

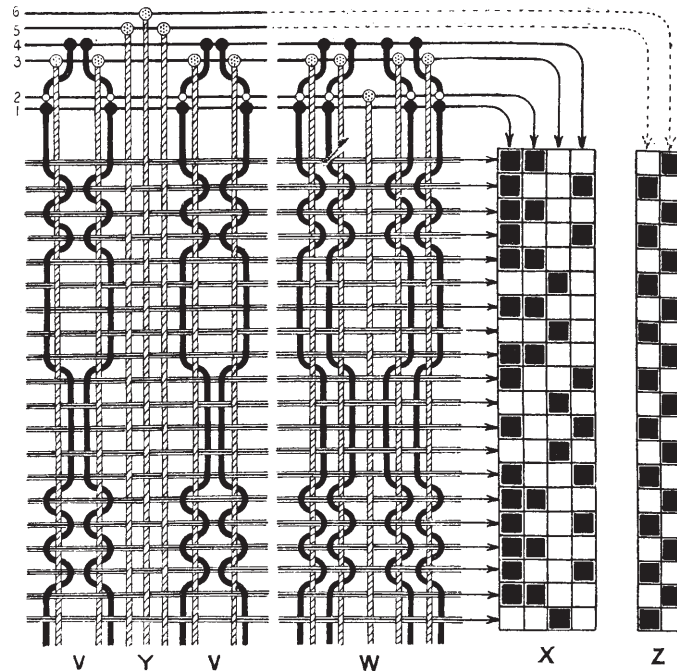


FIG. 278.

the two plain shafts, and substituting a new weaving plan for Z.

When the crossing thread is operated by the healds in this manner behind the reed, it is obvious that it must be in the same split of the reed as the thread or threads round which it partly travels. In the illustration given

the threads should be two in a split in the gauze parts, and three per split in the plain part.

The above designs are made for use with what are termed "bottom doups," that is to say, with a set of leaves in which the doup or loose slip is situated as shown in Figs. 274 and 275. When operated in this manner the cloth is woven face downwards. As a result weaving faults are not easily detected, and the doups, which break frequently, are difficult to repair. The cloth may be woven face upwards if "top doups" are employed; irregularities in the weaving are then more easily detected, and broken doups are quickly seen and more readily replaced. It will be understood, however, that the use of "top doups" will require the gauze threads to cross over the crossed threads instead of under, and that the weft passes over the crossing thread instead of under—indeed, all movements are reversed.

Fig. 279 is a photographical reproduction of a fancy gauze or leno fabric in which bands of plain cloth A alternate with the gauze portions B, C, B. Fig. 280 illustrates part of the design for this fabric, and is arranged for top doups. Two doups are required, the threads for each doup being drawn to right and left alternately so as to develop the more or less ogee or diamond forms. In the weaving plan E, 8 leaves are shown, and these are attached by dotted lines to the 8 horizontal lines which represent the leaves.

- No. 1 is the loose slip or doup for the large gauze figure ;  
 „ 2 „ doup carrier „ „ „ „  
 „ 3 „ loose slip or doup „ small „ „  
 „ 4 „ doup carrier „ „ „ „  
 „ 5 } are for the plain cloth in parts A, and for the plain weave double  
 „ 6 } warp in parts D—the centres of the large gauze figure ;  
 „ 7 is the leaf working in conjunction with doup and doup carrier 1 and 2 ;  
 „ 8 „ „ „ „ „ „ „ „ „ 3 and 4.

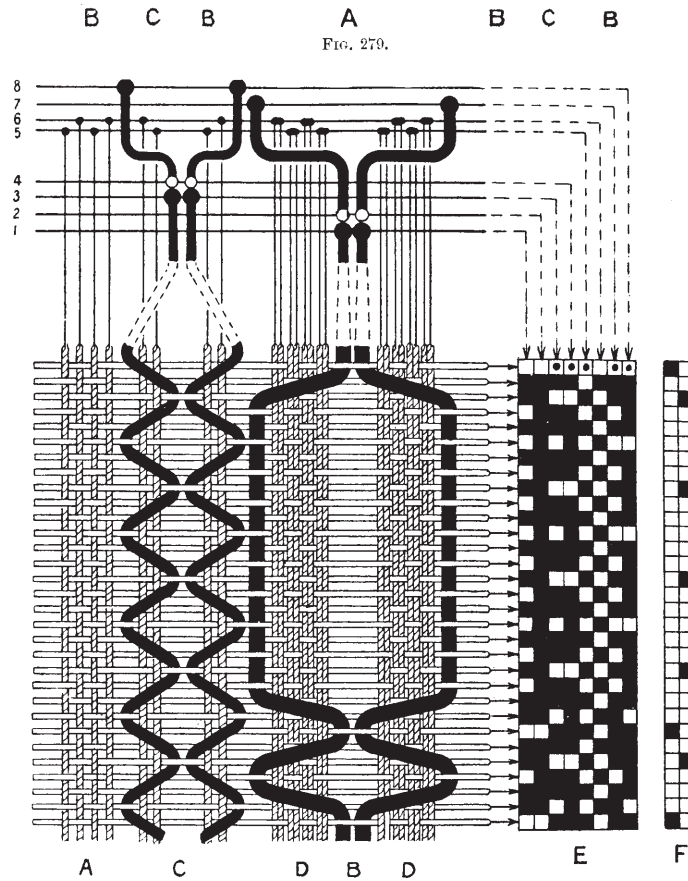


FIG. 279.

FIG. 280  
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An ordinary reed with regularly spaced wires could be used for this pattern, but a special reed would probably be more suitable. The reed may be built specially, or reed wires may be withdrawn at certain parts to suit the gauze portions. We have stated that the crossing thread and all the threads which it crosses should be in the same split if the crossing thread is operated behind the reed. If the reed for this cloth were built specially as in Fig.

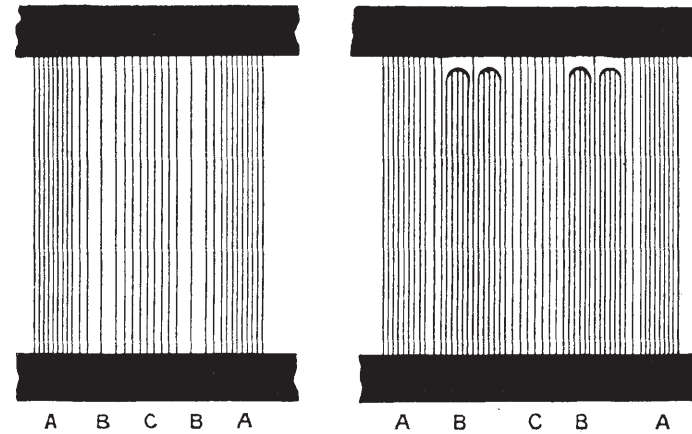


FIG. 281.

FIG. 282.

281, the parts A would contain two threads per split, and the parts C three threads per split. At B, however, nine threads constitute one group, and an extra wide split, about three times as wide as the ordinary ones, would be used for this group. In some fabrics the gauze threads have to cross over more threads than that shown, and in such cases the crossing thread is operated in front of the reed, or else the reed is made specially as indicated in Fig. 282. In this illustration the reed is intended for four splitfuls,



say of plain cloth, and in these parts B the reed wires are secured only by the bottom ribs of the reed; the crossing threads move from side to side of these four splits, being permitted to do so by the large gaps at the top of the reed.

When the crossing threads have absolutely distinct

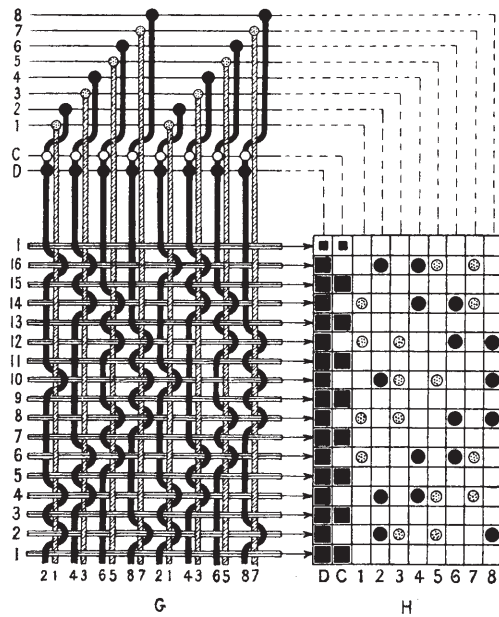


FIG. 283.

movements, a separate doup and a separate slackener are required for each. It is, however, almost impossible practically to increase the number of these beyond two or three, but this restriction does not prevent the formation of patterns which have the appearance of requiring such a number, or even a larger number, of doups and slackeners. Thus, consider plan G, Fig. 283, which shows

two repeats of the pattern in the way of the warp. Here the threads 2, 4, 6 and 8 are crossing at different times; hence, on the principle just described, it would appear that four doups are necessary. As a matter of fact the pattern may be woven with one doup and one slackener, but before showing how this may be done, we illustrate,

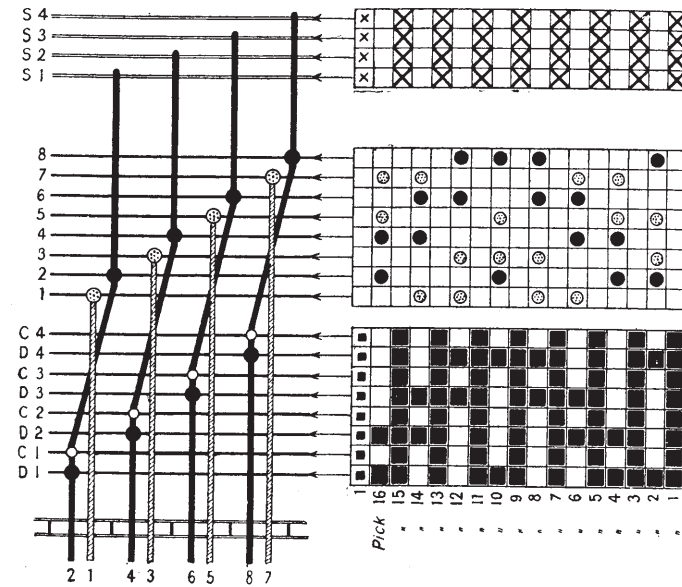



FIG. 284.

in Fig. 284, the apparently necessary four doups. We also show four slackeners, although one is sufficient even when four doups are used. In Fig. 284:—

- D1, D2, D3, D4 are the four loose slips or doups;
- C1, C2, C3, C4 are the four corresponding doup carriers;
- S1, S2, S3, S4 are the four slackeners;
- 1, 2, 3, 4, 5, 6, 7, 8 are the eight ordinary shafts, the even numbers of which work in conjunction with the doups.

Whenever the doup and doup carrier rise together, the slackener must also come into play, and it will be seen that these movements take place on all odd picks, *i.e.* when the crossing thread is on the left hand side of the crossed thread with the draft as shown. If the draft be reversed, then the conditions are reversed. Now, since the slackeners yield only when the doup and doup carrier rise together, it follows from the above that they are inoperative on even picks, *i.e.* when the crossing thread appears on the right of the crossed thread. Thus, each of the slackeners yield on odd picks, but remain motionless on even picks, therefore all crossing threads might just as well be over one and the same slackener. And since each doup carrier rises on odd picks, and is down on even picks, it is clear that one doup carrier is sufficient. It would be almost impossible, however, to operate four doup shafts in connection with one doup carrier, and four doups are necessary according to Fig. 284. If, therefore, the pattern be woven on this principle, it would be essential to use four doups, four doup carriers, and one slackener. The weaving plans (or lifting plans as we have termed them in this figure) for each set are detached, and represented by distinguishing marks.

Now whatever principle is employed for the production of the pattern illustrated in Fig. 283, it is evident that there must be four distinct movements either on the part of the doups themselves, or of the doups and doup carriers combined, simply because there are four distinct orders of crossing the gauze threads. If, therefore, it is decided to allow the four distinct movements to be made by the loose slips or doups and four ordinary leaves, one doup carrier only will be required. Thus, in Fig. 283, the crossing threads are drawn through leaves 2, 4, 6 and 8, crossed

under threads 1, 3, 5 and 7 respectively, and then all the even threads are drawn through the loose slips D of the same doup carrier C. On odd picks all even or crossing threads appear on the left of the odd threads, and they are placed in this position by the lifting of the doup carrier and the doup. On even picks two crossing threads appear on the right, this position being determined by the lifting of the doup D and the two leaves which control the crossing thread (shown by solid black circles in plan H). Two other threads are also lifted on even picks, shown in plan H by marks . It is easy to see that plain cloth may be made at any part by lifting doup D and doup carrier C on odd picks, and by lifting leaves 1, 3, 5 and 7 on even picks, or *vice versa*. The chief drawback in the one doup arrangement for this class of work is that, when the doup rises to form the open shed, only part of the loose slips are required to form gauze—the remainder, although lifted by the doup shaft, should really be down. As a result the loose slips double up and sometimes cause yarn breakages or faulty weaving.

The single doup method is, however, extensively applied in jacquard gauze weaving, and it may, and almost invariably does work in conjunction with the mails of the harness from one or two long rows of hooks. With 10 rows of needles it is usual to operate 12 rows of hooks, in addition to the doup, and to cross the threads as desired by the particular type of fabric. Thus, in Fig. 285, where we show 13 horizontal lines and a small part of the comber-board, the front line represents the doups or loose slips which may be operated by special heavy hooks in the jacquard, or by ordinary hooks in the spare row at each side of the jacquard. The cords from the 1st and 2nd rows of the machine pass through part A of the comber-

board; these cords are for the doup carriers, which must work in unison with the hooks for easing the warp. The 11th and 12th, or two back rows or cords in part C, are for easing the threads on the crossed shed, *i.e.* when the

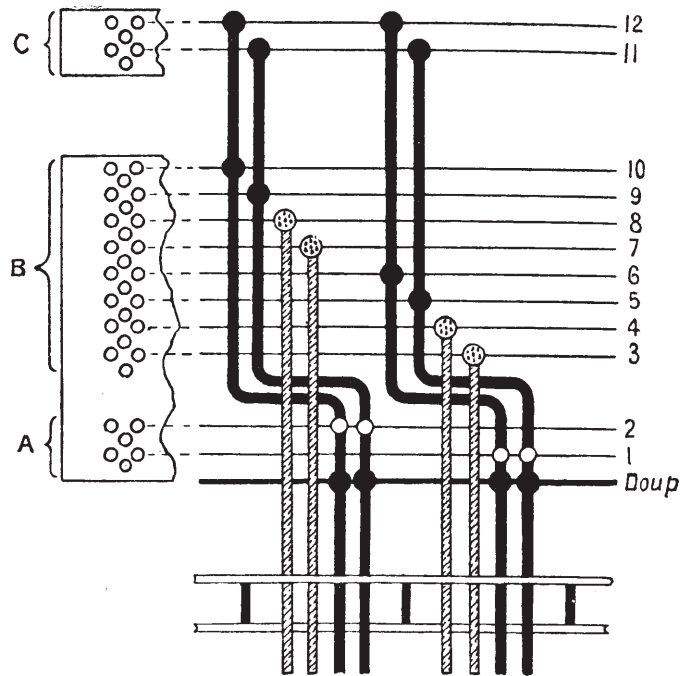


FIG. 285.

doup carriers rise; hence, each needle in the 1st row controls a hook in the 1st row and another hook in the 11th row. Similarly, each needle in the 2nd row controls two hooks—one in the 2nd row and another in the 12th. Since the easing hooks in the two back rows are not required to rise as high as the ordinary hooks (half

the distance is usually sufficient) they are operated by a separate griffe. Both griffes are lifted by the same lever, but the point of connection of the lever with the hooks of the easing griffe is nearer the fulcrum than is that for the ordinary hooks, hence a shorter movement is obtained. Rows 3 to 10 inclusive, or cords in part B, are for forming the figure. The harness is shown drawn from back to front, and two threads from separate rows cross two ordinary threads; they are then drawn separately through the two slips of the doup carriers. It will be seen that rows 3 to 10, along with the doups, are used for figuring purposes with an open shed, and that rows 1 and 2, part A, with their corresponding easer rows 11 and 12, part C, are used only when forming the gauze portions or crossed sheds.

Since there are 10 needles to be operated, it would appear at first sight that 10-row paper would be the most suitable, but if we refer to Fig. 285, we shall see that, although there are 10 rows of needles, there are only 8 individual threads actuated by each short row. Consequently, if the cloth be square, which is often the case, it will be very convenient to use 8 by 8 paper, and to use proportionate paper if the number of picks per inch differ from the number of threads per inch. If 10-row paper were used, it is clear that, since there are only 8 threads for the 10 rows, it would be necessary to use 10 by 8 paper for fabrics in which the number of threads per inch equals the number of picks per inch, and to use proportionately ruled paper for under and over shotted fabrics.

Before showing how the 8-row paper may be used for these 10-row machines, we will consider the designing of gauze fabrics without regard to the number of hooks in a

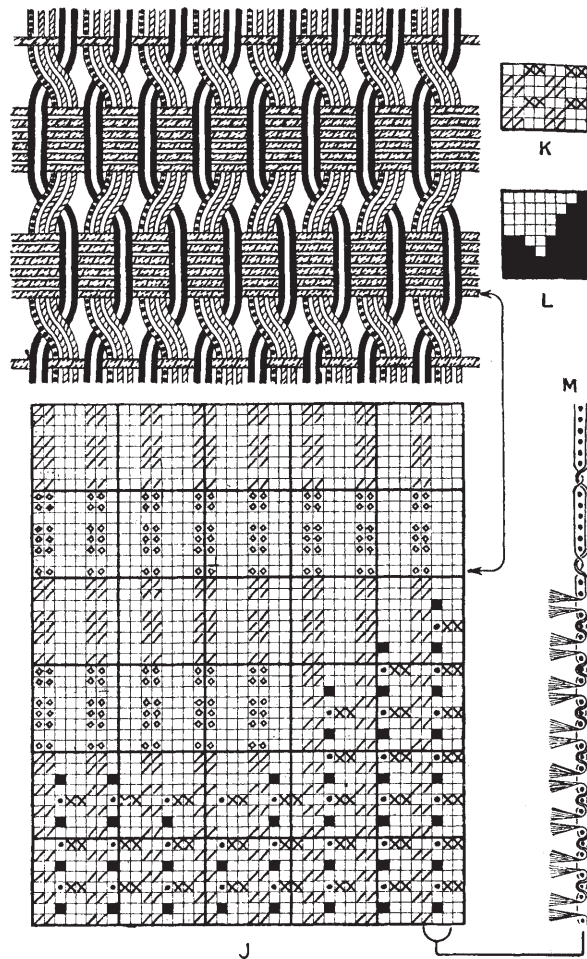


FIG. 286.

row. Fig. 286 is the design for part of a fabric in which a plush figure is developed upon a gauze ground; in the gauze portion there are six picks in each open shed, and six in each crossed shed. Design J shows 40 threads of the pattern, each individual thread being shown separately. The drawing or plan of the fabric immediately above the design shows the same 40 threads as they appear in the fabric when forming the gauze ground with the weft. The warp throughout is as follows: 2 crossing threads, 1 pile thread, 2 ground threads. The two crossing threads pass over the weft on the left, and remain above the weft on that side for six picks; they then cross to the right, and appear at that side over six successive picks. Plan K is the ground plan; L is a small part of the plush figure represented in design J by the solid marks; while M is an intersection of the last five threads, the three middle ones only being in view. Although two threads cross three, it will be seen that the ground threads work together in pairs, and may, therefore, be drawn double through the mails; indeed, the practical mounting would be so in order that the warping arrangement may repeat in the short rows of the jacquard.

Fig. 287 shows the same part of the design arranged on 8 by 8 design paper for the card-cutter, and for the 10-row machine with draft as illustrated in Fig. 285. The crossing threads in Fig. 287 are on the 1st and 2nd, and the 5th and 6th vertical lines or cords; when the design is turned through 180°, or upside down, for cutting, these cords will correspond with the 10th, 9th, 6th, and 5th rows of holes, part B, Fig. 285. The diagonal marks (/) in the design Fig. 287 indicate the crossing threads on the left in the open shed, *i.e.* when lifted by the loose slips through the action of the cords in rows 10, 9, 6 and 5, Fig. 285.

The small diamonds ( $\diamond$ ), on the same cords as the diagonals in Fig. 287, show that the crossing threads must be on the right to form the crossed shed; therefore rows 1 and 2, part A, Fig. 285, with easier rows 11 and 12, part C, must be cut for lifting. The card-cutter therefore cuts as follows:—

- 1st and 2nd rows on card, or rows 10 and 9 (Fig. 285) for open shed when represented by diagonals /
- 9th row on card, or row 2 (Fig. 285) for crossed shed when represented by diamonds  $\diamond$
- 5th and 6th rows on card, or rows 6 and 5 (Fig. 285) for open shed when represented by diagonals /
- 10th row on card, or row 1 (Fig. 285) for crossed shed when represented by diamonds  $\diamond$
- 3rd, 4th, 7th and 8th rows on card, or rows 8, 7, 4 and 3 (Fig. 285) for ordinary and plush weaving.

This fabric contains about 144 threads per inch, that is about 28 pile threads per inch.

The groundwork of the better class Madras muslins is formed by gauze, but in this case the crossing is done by means of what is termed a "gauze reed," which performs the same function as the doups, etc. In this particular fabric, however, all the crossing threads move from side to side at the same time, and cross one thread only. The gauze reed consists of ordinary reed wires extending between the two usual ribs of the reed, and between each pair of ordinary reed wires is a second wire which reaches to the middle of the reed. These half length reed wires have smooth pointed tops, and each contains a hole near its point for carrying one of the odd or crossing threads which do not pass through the harness mails. The even or harness threads are taken straight from the harness and passed loosely between the wires of the gauze reed. These threads, however, pass singly through splits of a

plain or "tug reed" situated midway between the harness and the gauze reed. The latter rises and falls every gauze pick in order to raise the crossing thread above the weft, but previous to rising, on odd gauze picks say, the tug reed is positively moved to the left by the action of a cam so

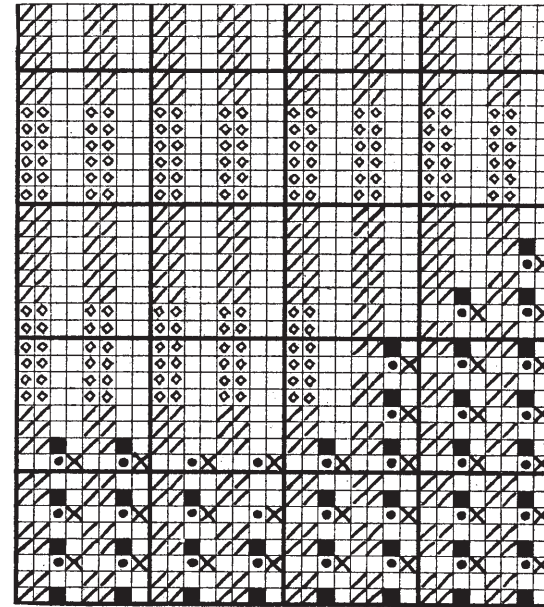


FIG. 287.

that all crossing threads rise on the right of all harness threads; then previous to even gauze picks the tug reed is returned to the right by the action of a spring, thus carrying all harness threads in that direction, hence when the gauze reed rises it lifts all crossing threads to the left of the harness threads. In older forms the tug reed was omitted, and the comber-board containing the harness was

moved bodily to right and to left, but this method has been almost entirely superseded by the above-mentioned tug reed.

The designs for these fabrics are made on the same principle as those for common harness damask designs; no weaves appear on the paper, and when two or more colours of weft are introduced, the newer form of loom is arranged to perform all these functions automatically. A card is laced for each pick—blank for the gauze pick, but cut according to pattern for the one, two, or more coloured figuring picks intervening. Each card controls the box motion for its own particular weft, and the loom picks at will from either end. The figuring weft passes over all odd or crossing threads, and under all harness threads where pattern is being developed, but at other places it passes over all warp threads and floats entirely unbound on the surface of the fabric. After the piece leaves the loom these floating portions are cut off by machinery. For such a fabric, and with these methods of production, little knowledge of the actual cloth structure is required by the designer.

## CHAPTER XXIV

### LAPPET AND SWIVEL FABRICS

LAPPET weaving, or the ornamentation of woven fabrics by means of lappet frames, is executed in the loom simultaneously with the weaving of the foundation texture itself, and produces a type of textile ornament akin to embroidery.

This type of figure development may and does produce some striking and varied effects, but it cannot be relied upon for absolute accuracy or for neatness in the development of the figure. While lappet ornament may be applied to many types of woven texture, its application is almost entirely restricted to plain woven muslin textures, or to fabrics of a gauze nature. The ornament itself may be either continuous or intermittent in character; if of the latter type, the loose or floating threads, which connect succeeding spots or small figures, are shorn off in a subsequent finishing process.

Although mechanical processes are not within the scope of this work, it will be necessary to refer briefly to the chief features of a lappet loom in order that our further remarks concerning lappet designs may be rendered intelligible. In addition to the ordinary parts which are essential for the production of the foundation texture—say a plain cloth—a lappet loom is provided, among other items, with the following accessories:—

1. A pin frame, situated immediately behind the race of the lay; this frame rises as the lay recedes, and presents its pins close against the race board so as to form the back support of the shuttle as the latter passes from box to box; the frame falls again, as the lay advances, until the tops of the pins are beneath the warp and the cloth in order that the reed proper may beat up the weft, and that the needle frame, as well as the whip or ornamenting threads, may be traversed laterally by the lappet wheel through the distance required to form the ornament.

2. One or more needle frames—four being the usual limit—placed between the pin frame and the reed; the latter is supported about three inches behind the race of the lay to provide room for the frames. (The traverse

of the lay of a lappet loom is usually about three inches more than that of a similar loom for plain fabrics.) Each needle frame consists of a wooden bar which is provided with a series of brass or steel needles, each of which is from 3 to  $3\frac{1}{4}$  inches long, pointed at the top for easy entrance between the threads of the warp, and provided with an eye for the passage of the whip or lappet threads. The spacing of the needles in each frame, as well as the number of needles, depends upon the distribution of the pattern and the cloth to be ornamented, but the spacing of the needles, and the traverse of the needle bars, must both be arranged as accurately as possible in multiples of splits or dents of the reed used for the ground texture. Each needle frame may, at will, partake of a rising and falling movement in unison with the pin frame, and also of a short lateral or side to side movement; or if desired any frame may remain inoperative both vertically and laterally as determined by the pattern wheel.

3. Extra warp beams or rolls for the whip or lappet threads, one whip roll being usually required for each needle frame. These rolls are supported either under or over the warp beam proper, and the threads from each roll are passed in a zigzag manner through a special tensioning device, one tensioning arrangement being necessary for each roll. Each whip thread is then led loosely between the heddles of the camb shafts, under the reed, up to and through an eye of the needle frame by which it is controlled. In some special cases the whip threads for the front needle frames pass under the intervening back frames, but in most instances they pass directly from the under side of the groove supporting the reed to the needle eye. As the needle frames rise, they lift their whip threads to or near the top of the shed, *i.e.* above the

weft: after the passage of the shuttle, the frames fall below the warp line to permit the reed to beat up the weft, and to enable them to be moved laterally to their proper position for forming the pattern. On the succeeding pick the whip threads are lifted above the weft in a different part of the cloth. It is thus evident that, when the needle frames are mounted below the warp, the lappet figure will be developed on the under side of the fabric, and invisible, unless by mirror reflection, from the weaver's position. Further, it is also evident that a lappet thread is always stitched or bound round a weft thread, and that there can be no intermediate stitching between the extreme points on the same horizontal whip line.

4. A pattern wheel, unless the lag and peg motion is used, mounted upon and oscillating with the lay, and employed to control the lateral position of the needle frames, or the extent of their movement, and to determine whether they shall operate vertically or remain inoperative. The usual form of pattern wheel, termed the "Scotch" lappet wheel, is made from a solid piece of well seasoned, close grained, wood—plane tree or sycamore. A number of ratchet teeth—a measure or a multiple of the picks in a repeat of the pattern—are cut on its periphery: thus, if the wheel is advanced one tooth every two picks, the number of teeth may be half that of the picks; it may be the same number; or it may be a multiple of half the picks. When the wheel is moved one tooth per pick, it is clear that the number of teeth must be equal to, or some multiple of, the number of picks. One concentric groove for each needle frame is then formed in the face of the wheel in accordance with the pattern to be developed. A projection or peck, attached to a lateral extension of the corresponding needle frame, enters into this groove,

and by it is laterally controlled. On the opposite face of the wheel parts may be fixed to determine when the frame or frames shall be inoperative as regards vertical movement. Accurate cutting and forming of the grooves in the pattern wheel are essential to secure accuracy in the development of the pattern.

Pattern wheels are of two general kinds, termed "common wheels" and "presser wheels"; they are distinguished as follows: In a common wheel each ratchet tooth, and therefore each corresponding radial division of the wheel, serves for two picks; and, since the needle frames for this type of wheel are automatically, but negatively, moved from left to right, and from right to left, on alternate picks, in regular succession, both sides of the groove must be carefully formed. Each side of the groove limits the movement of the frame, and is therefore employed for forming the pattern. In this case the groove in the pattern wheel does not move the needle frame, but simply limits its movement; other parts move the frames negatively to left and to right continuously.

Wheels of this type are necessarily somewhat limited in their application, since they cannot advance a lappet thread in the same direction on successive picks. Notwithstanding this limitation, however, they are used for a wide range of patterns, and are more generally utilised than the presser wheels. In presser wheels, each ratchet tooth and each radial division serves for a single pick only. These wheels press or pull a needle frame positively in one direction by the form of the groove, while a spiral spring returns the frame when permitted to do so by the contour of the groove. Both in advancing and returning the frame, the same side of the groove is in action. One side only, therefore—the outside—requires to be carefully cut; the

other side is just arranged to follow the general contour of the pattern while leaving room for the free movement of the peck. It will be obvious, however, that with the presser wheel there is no restriction as to the direction of movement of the frames, other than that of the pattern wheel and the working limits of movement—say about  $3\frac{1}{2}$  inches—of the frames themselves. In both systems the outer pattern grooves control the needle frames nearest the pin frame, and the inner grooves control the frames further back. When the pattern is suitable, it is possible to combine the leading features of both systems in one wheel.

Each order of interlacing requires a separate needle frame and groove in the pattern wheel, and, in general, each pattern requires its own pattern wheel. It is possible, however, by altering the spacing of the needles in the various frames, to obtain different combinations of the individual orders of working on the cloth, and so produce varied effects from one wheel. Coloured yarns may also be used, with considerable effect, for developing the patterns. The dimensions of the pattern wheels vary between 8 or 10 inches as a minimum to 24 inches maximum outside diameter, and are determined, among other considerations, by the following: The number of picks in a repeat of the lappet figure must be accommodated; the pitch of the ratchet teeth must not be too fine, otherwise the action will not be reliable; the arc, or rather the circular space between two adjacent radial lines near the centre of the wheel must not be too small for the diameter—say  $\frac{1}{4}$ " to  $\frac{3}{8}$ "—of a feeler or peck; space must also be provided for a groove for each frame to be employed. A wheel 12 inches diameter over the points of the teeth would give a circumferential space for practically 38 teeth



( $12'' \times 3.1416 = 37.7$  teeth) of one inch pitch, and at a radius of  $2\frac{1}{4}''$  we should have

$$\frac{2.25'' \times 2 \times 3.1416}{38 \text{ teeth}} = \frac{7}{19}''$$

or practically  $\frac{3}{8}''$  space between each pair of radial lines at this distance.  $38 \text{ teeth} \times 2 \text{ picks per tooth} = 76$  picks in a repeat of the pattern for a common wheel. This number could be doubled by increasing the diameter of the wheel to 24 inches; and it could then be further increased by reducing the pitch of the teeth, say, to  $\frac{3}{4}$  inch. Thus:—

$$\frac{24'' \times 3.1416}{0.75'' \text{ pitch}} \times 2 \text{ picks per tooth} = 201, \text{ say } 200 \text{ picks.}$$

If the pitch of the teeth be further reduced to  $\frac{1}{2}$  inch, giving approximately 150 teeth or 300 picks in a revolution, the arc between two radial lines, at 6 inches from the centre of the wheel, would measure only a quarter of an inch. This would require a peck of not more than  $\frac{1}{4}''$  diameter.

Wheels are marked off or scored concentrically by means of a comb of the same pitch as the loom reed in the case of coarse setts, and of half the pitch in fine setts. In the former case, the actual spacing of the splits of the reed is marked directly upon the wheel; in the fine setts every second split only is marked, and a single split is judged by the eye. As a concrete example of lappet wheel dimensions and construction let us consider the "common wheel" specimen illustrated in Fig. 288. It is a 3-frame example—two frames produce the key stripe by working continuously, while the third frame produces the intermittent spot effect.

The pattern repeats on 33 splits and 26 picks, and there are 28 splits per inch in the reed. Since it is a common

wheel type there would be only 13 teeth in a repeat, but this would be doubled to 26 teeth in order to get a wheel of workable size; there would be, therefore, two repeats of the pattern cut round the wheel. If we assume a peck of  $\frac{1}{4}''$  diameter, the arc between two adjacent radial lines must not be less than  $\frac{1}{4}''$  in length (a shade longer), at a

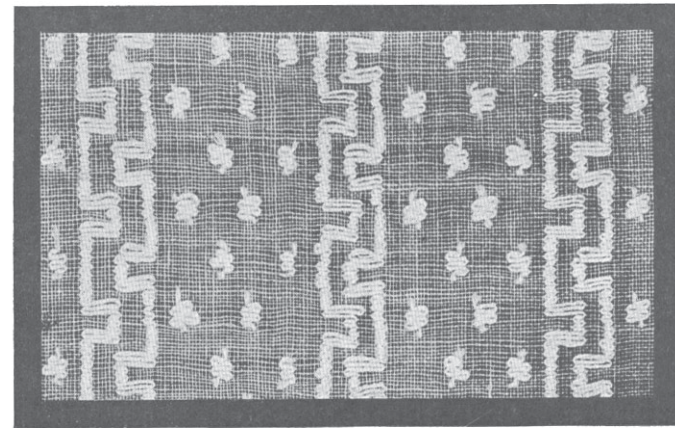


FIG. 288.

distance equal to the radius of the peck from the innermost circle of the groove—

$$\text{radius} = \frac{\text{circumference}}{2\pi} = \frac{26 \text{ teeth} \times 0.25'' \text{ pitch}}{2 \times 3.1416} = 1.035'',$$

and  $1.035'' - 0.125''$ , radius of peck =  $0.91''$  as the distance of the innermost circle of the first groove from the centre of the wheel.

To this distance must be added the space occupied by 6 splits, or  $\frac{6}{8}''$  for the extreme movements of each of the frames 1 and 2; and 9 splits, or  $\frac{9}{8}''$  for the movement of

the third frame—in all,  $\frac{6}{28} + \frac{6}{28} + \frac{9}{28} = \frac{21}{28}$ , or  $\frac{3}{4}$  inch. Further, to each distance of movement should be added the diameter of the peck, and about half an inch of wood should separate the grooves. The total distance from the centre of the wheel to the outer circle of the last groove will therefore be:—

$$0.91'' + (\frac{6}{28}'' + \frac{6}{28}'' + \frac{6}{28}'') + (3 \times \frac{1}{4}'') + (2 \times \frac{1}{2}'') = 3.41 \text{ inches.}$$

Another inch would be necessary on the extreme edge of the wheel for strength, and to permit of sufficient wood for cutting the teeth. The minimum radius for such a wheel would therefore be, —  $3.41 + 1.00 = 4.41$  inches.

It is sometimes possible, on account of the configuration of the grooves, as in the case of the key stripe in Fig. 288, to arrange the grooves closer together than is indicated in the above general statement, but such cases can only be considered as they arise.

Fig. 289 shows in a graphic manner the interlacing of one complete repeat of 66 ground threads and 26 picks of the specimen illustrated in Fig. 288, in addition to the ornament shown in heavy zigzag lines, and developed by the whip threads or the lappet needle frames. A, B, and C, Fig. 289, indicate respectively the effects obtained by the three different needle frames. When the pattern is detached as demonstrated by effect C, the part of the whip thread which joins the figures, and shown in outline only, must be removed after the piece leaves the loom.

A more concise and simpler method of indicating the same pattern would be that of placing on design paper the figuring whip thread only; indeed, there is no necessity whatever for introducing the plain ground weave. The patterns, therefore, are generally marked in solid squares only, as is done for most types of textile design. If the

lappet wheel is moved every pick, there is not much difficulty attached to the preparation of the design, beyond that which arises from the intricacies of the design itself, since the ordinary ruling of design paper may still be taken to represent individual threads and picks. If, on the other hand, the design is intended to be cut on a common wheel, which moves once in two picks, one horizontal line of the design paper may serve for two picks; and, for symmetry, one vertical line may serve for two warp threads, or one split of the reed: in this case some difficulty may be

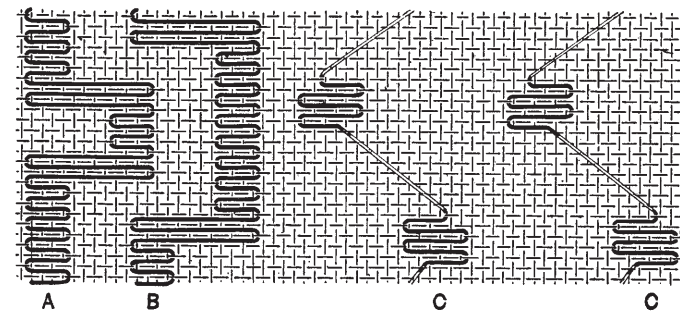


FIG. 289.

experienced. The rotation of the lappet wheel may take place when the needle frames are moving from left to right, or when moving from right to left. To avoid misunderstanding, we shall assume that the wheel is rotated, tooth by tooth, when the frames are moving from right to left, and that the solid marks in Fig. 290, beginning at the top of the figure, represent the odd picks when the lappet frames travel from left to right, while the crosses represent the even picks when the lappet wheel is turned and when the frames travel from right to left. The design paper is ruled in faint lines and heavy lines alternately to indicate

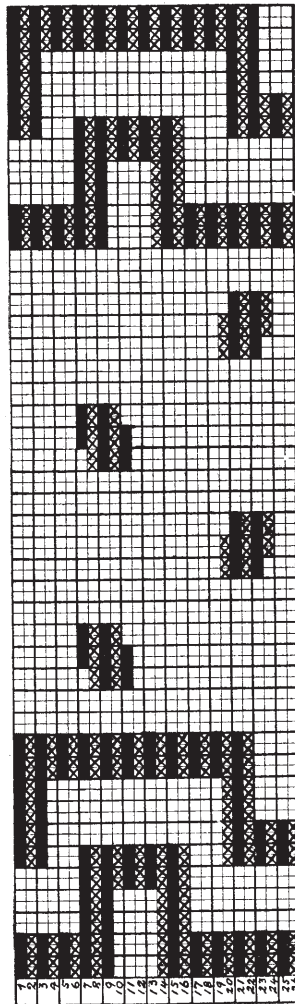


FIG. 290.

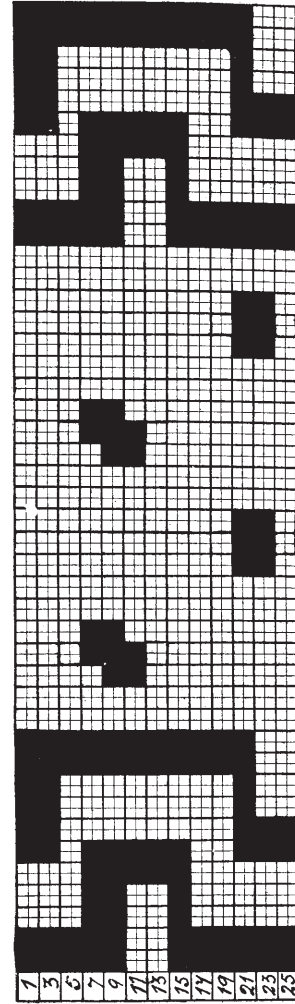


FIG. 291.

more distinctly that two threads, or one split of the reed, and two picks are contained between each pair of heavy lines. If the pattern were painted on single rows of squares, ignoring the faint lines, it would evidently be complete on 33 vertical and 13 horizontal spaces. When the faint line appears between each pair of thick lines, the pattern is identical with that shown in Fig. 289, but if painted on single squares, it would appear as illustrated in Fig. 291, where the solid marks from Fig. 290, *i.e.*, the odd picks only, have been reproduced. The even picks are not shown in Fig. 291, and on comparing this figure with Fig. 290 it will be seen that the three successive long floats in the key portion of Fig. 290 are represented in some parts of Fig. 291 by two picks, and in other parts by only one pick. Similarly, in the spot effect, a difference is found; these apparent irregularities are due entirely to the fact that the even picks are omitted. Since one row of the spot patterns begins on odd picks, and the other on even picks, it is necessary (although we have not done so in the figure) to indicate this in some way on the design paper, if the squares of such paper are not divided by faint lines: for continuous patterns, no such indication is required.

Fig. 292 represents the full wheel necessary for the production of the above pattern. Three grooves are shown—inner, central, and outer—the two former being for the key stripes, and the latter for the spot effect. The numbers 1, 3, 5, etc. up to 25 correspond with the same numbers to the left of Figs. 290 and 291; while the dots within the grooves indicate the extreme positions of the centre of the corresponding peck on the respective odd picks. Short radial lines joining any two dots indicate the travel of that peck from left to right, *i.e.*, while the

wheel is stationary, and diagonal lines joining two peck centres indicate the movement of the peck from right to left, *i.e.*, when the wheel is being advanced one tooth. Peck centres, of course, always move horizontally on one or other of the radial lines when the latter are in the

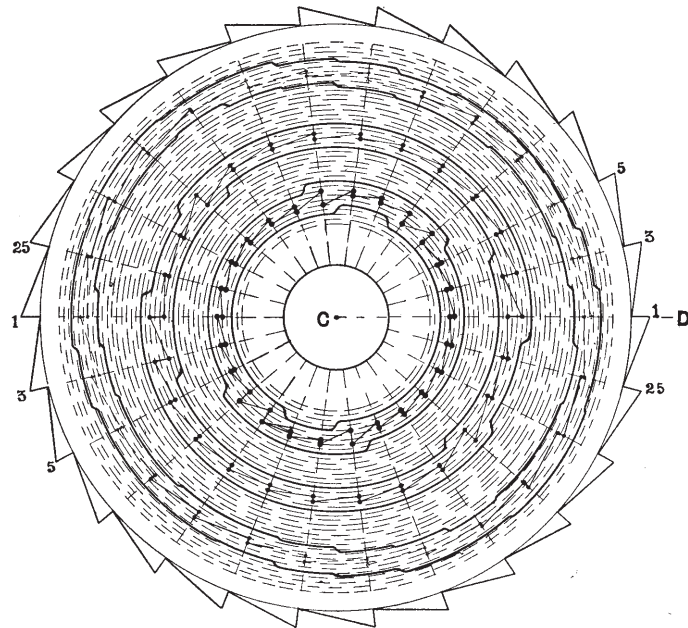


FIG. 292.

position shown by CD—in which position they are to the right of the wheel centre. The wheel in this case is placed at the left hand end of the lay of the loom as viewed from the weaver's position. Dotted concentric circles in the wheel illustrated have been spaced, chiefly for greater clearness, the distance of two splits apart, so that one

concentric space on the wheel represents two splits in the reed (4 threads) and two large vertical spaces in Figs. 290 and 291. Consequently, since 7 splits are required for the diameter of the peck ( $\frac{1}{4}'' = \frac{7}{8}''$ ) and 2 splits for the travel, we have,—9 splits  $\div$  2 =  $4\frac{1}{2}$  spaces of the wheel for the narrow part of the key stripe. (In Fig. 292 we have made this  $4\frac{1}{2}$  into 5 in order to avoid complications in drawing.) All other portions may be calculated in a similar manner. In the outer groove, the peck centres are shown solid where the frame is lifted to form the spot pattern, but dotted where that frame, although traversed, is not lifted at that time. The frame is lifted or not lifted according to the presence or absence of a metal ring which is properly fixed in a circular groove formed in the back of the wheel; we have not attempted to show this in the drawing.

Figs. 293 and 294 are reproductions of two "presser" wheel types of ornament. The former repeats on 68 threads and 80 picks, and is produced by two frames working continuously—two colours of whip thread being used. The pattern of the cloth illustrated in Fig. 294 is complete on 32 threads and 30 picks, and is also produced by two frames which work continuously; at intervals, however, the needles of both frames overlap for a short distance in order to produce the heavy or thick portion of the net work.

Figs. 295 and 296 show special types of lappet ornament. The original of Fig. 295 is a 3-frame presser wheel production, one frame being used for the central zigzag stripe, which is of the usual character of lappet ornament. For the open-work side stripes, however, two frames are necessary, both of which rise for 6 picks in succession without moving to right or to left, and thus place the

whip threads on the face side over the weft; but between the 6th and 7th picks they change positions, crossing their respective whip threads to right and to left, under the same 8 threads, and then rise again for 6 successive picks in the new position. Between the 12th and 13th picks they

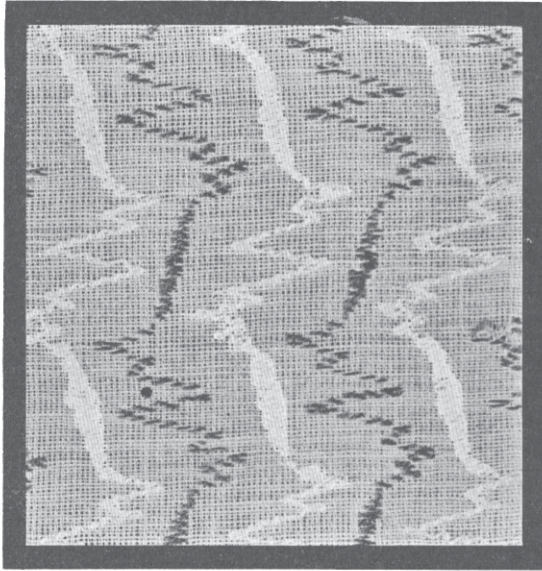


FIG. 293.

again rise, or rather return, to the original lateral position. The general effect is enhanced, and a leno-like effect obtained by the omission of warp threads from several splits of the reed at the proper points. The complete pattern repeats on 48 picks, and the open-work part on 12 picks. Although two frames are necessary for the latter effect, it will be seen that only one whip roll will

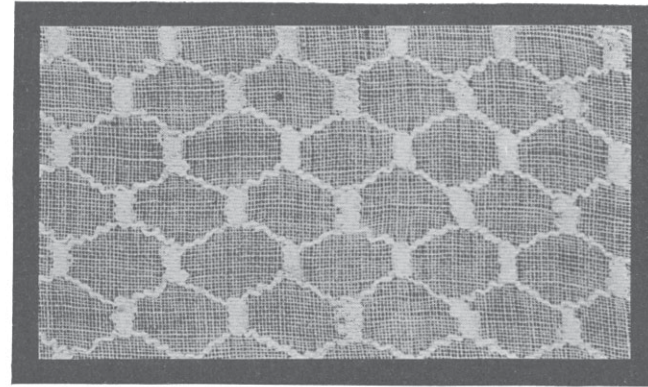


FIG. 294.

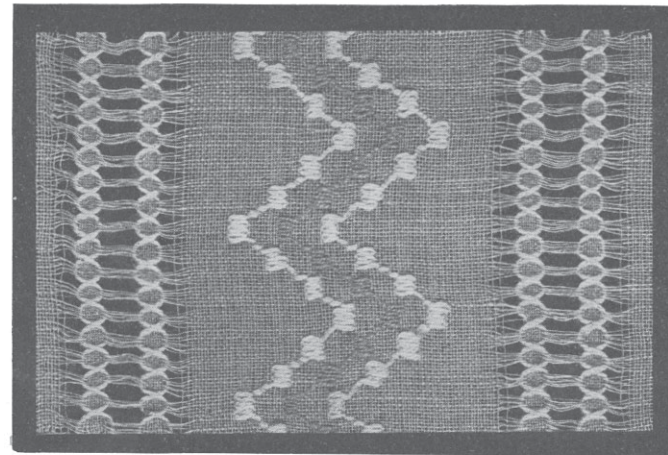


FIG. 295.

be required for both, since the movement of both whip threads is exactly alike in extent, although different in direction.

Fig. 296 illustrates a corded stripe effect, complete on 54 picks, and produced with difficulty, but perhaps most readily, by a common wheel arranged for two frames. One frame with shortened teeth, or else a plate with holes, carries the cord threads—3 strands of 2-fold cotton—close

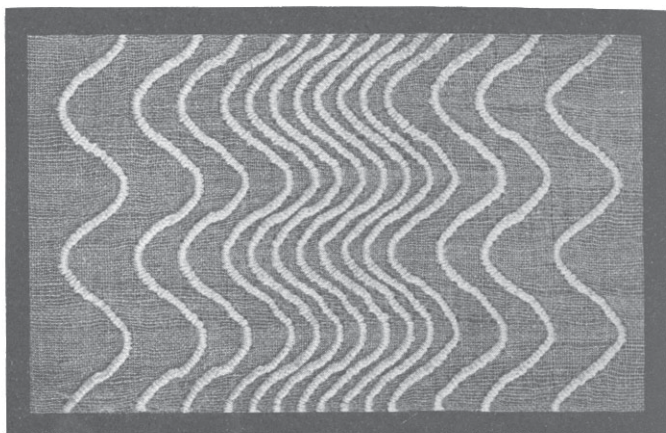


FIG. 296.

up to the under side of the cloth; the other frame carries the real lappet or stitching thread, which is lifted over the weft every pick as usual, but which also passes underneath the cord thread in the interval, and thus binds the latter to the fabric. Two successive stitches are made in the same split of the reed—one on each side of the cord thread—and to enable this to be done, the frame or plate, which controls these threads, is moved alternately to right and to left of this position by the usual common wheel

movement, as well as being moved gradually from position to position in order to form the wave-like line. It will be apparent that very accurate spacing of the needles, and careful adjusting of the positions of the respective frames, are necessary in a case like this if satisfactory work is to be obtained. Indeed, in all cases care is essential, for it will be seen from the photographic reproduction of the cloth in Fig. 288 that the outline of the whip figure is not nearly so accurate as that in Fig. 289.

Presser wheels are constructed on the same general lines as common wheels, with the following differences in detail: radial lines must be drawn and a tooth formed for every pick in the repeat of the weave; concentric lines may again indicate splits or pairs of splits in the reed, according as the sett of the latter is coarse or fine. The full movement of the frame, pick by pick, must be indicated on the outside of the groove to be formed in the wheel—the inside contour being of little importance provided that sufficient space is left for the free movement of the peck.

*Swivel Designs.*—Figure development by means of swivels is simply a particular method of figuring with extra weft. One or more small shuttles, at least one, is used for each spot developed in the width of the fabric. But, since mechanical operations form no part of this treatise, little can be said respecting this type of weaving beyond what has already been said in regard to the ordinary methods of figuring with extra weft. The general methods of designing for swivel fabrics are identical with those illustrated and described in Chapter XIV. pp. 286 to 297, but the size and distribution of the small extra weft figures on this cloth is in a considerable measure restricted and determined by the actual spacing of the extra shuttles in

the loom. Assuming that a swivel shuttle is arranged for every two inches of the width of the fabric, then extra weft spots may occur every two inches of the width in any one line, or every four inches of the width if alternate shuttles only are used. Most swivel looms are so arranged that all shuttles and carriers may be moved laterally to right or to left, so that spots on successive lines for one row of figures may be formed intermediate to those formed for the previous row of figures. By this arrangement any simple system of distribution of the spots or small figures may be obtained. Since each shuttle is independent and may carry its own colour of weft, it is evident that the spots in one horizontal row may be developed in two or more colours at the will of the designer; but when two or more colours are required for the development of any one spot, it is usual to arrange the various shuttles in parallel lines in front of the reed, so that each colour may be inserted in turn in its proper sectional shed, before the insertion of the following ground pick.

Attempts have been made to form a double shed so that an ordinary shuttle may cross the web at the same time as the swivel shuttles are in motion; but in most cases the ordinary picking is suspended during the insertion of the extra weft. This fact, coupled with the reduction of speed which naturally accompanies complicated mechanism, reduces the productive capacity of the loom, and consequently increases the cost of manufacture. The system, however, has the distinct economical advantage of introducing the extra figuring weft only where it is required. In consequence, waste of material is prevented, no dark lines show through the fabric, and the spotting weft is more securely held in position, since it does not cross gaps between the figures, but simply travels from

side to side of the spot. Further, the necessity for binding long floats at the back of the figure does not arise, since no long floats are formed except the single threads which join the spots in successive horizontal rows.

Swivel ornament may be applied to almost any ground texture, although it is mostly used to decorate dress and

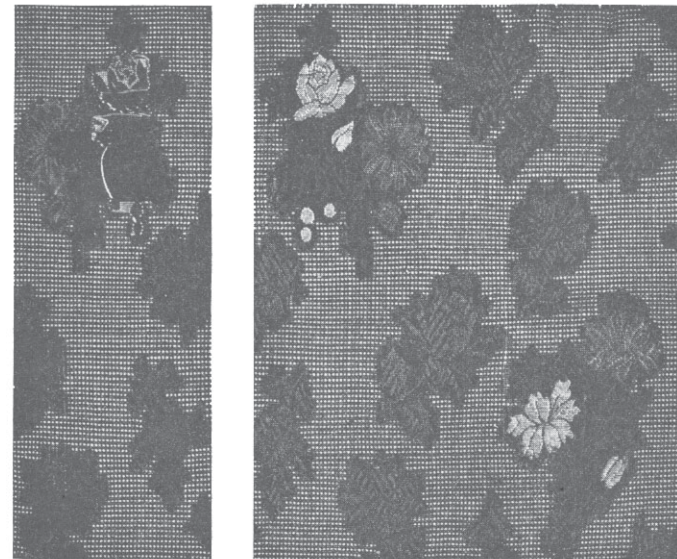


FIG. 297.

simple fabrics, the ground of which is usually plain or other simple weave. In Fig. 297, however, we illustrate a slightly more elaborate swivel effect, in which three swivel shuttles are necessary for the proper development of each spot. The ground texture is a modified gauze or leno effect, two threads crossing two, three picks in a gauze shed. The gauze ground is relieved and embellished at

intervals by jacquard figures developed in warp on a plain  $\perp$  ground. The swivel spot is developed in dark green, pink, and bright gold on a plain black ground, and occupies about 165 threads and 155 picks of the ground texture. The warp is worsted, the ground weft cotton, and the swivel weft soft spun silk. The smaller slip to the left of the illustration shows the appearance of the back of the fabric.

## CHAPTER XXV

### SILK PICTURE DESIGNS AND FABRICS

The principles involved in the development of pictures in silk by weaving are closely associated with those enunciated in connection with figuring with extra weft (see Chapter XIV. pp. 286 to 297). The designs for the latter type of fabrics show clearly that the figures are due, not so much to weave effect as to a simple method of floating the yarns over the desired width of the figure. Some system of interlacing the figuring weft with the warp is naturally employed when the figures assume large proportions. In silk picture weaving, however, every part of the subject is developed by means of weave effects; and the prominence of any particular colour of weft is due, mainly, to its degree of floating, but partly also to the manner in which the floats are arranged.

These pictures are almost invariably developed in solid masses of black and white wefts, intermingled with the various greys which may be obtained by a judicious combination of interweaving of the black and white wefts with

a white warp. The high lights of a picture are displayed by the weaves which allow a maximum amount of white weft or of white warp to float on the surface; the dark patches by a maximum of black weft; and all intermediate greys by a proper blending of the yarns combined with the scheme of interlacing. The extent of the gradation of these grey tones depends in a measure upon the size of the unit weave.

One type of shading has already been demonstrated (see pp. 40 and 41, and Figs. 128, 129, and 130, pp. 206, 208, and 224), and greys may be developed by these designs, or by similar ones made from the 12-thread sateen. Thus, if white warp and black weft be used in conjunction with the 8-thread sateens, there are seven different weaves (1 to 7, Fig. 37, p. 41), which change gradually from a practically solid black effect to an equally practically solid white effect; while with the 12-thread sateen there would be eleven different shades in the gradation from black to white. The available number of shades obviously increases with the increased size of the unit weave, but, on the other hand, the objection to this method of obtaining increased gradation by using larger unit weaves is the fact that the fabric suffers in consequence of the increase in the looseness of the structure. The ordinary silk pictures are rarely, if ever, made with these single or simple weaves; they are made, as already indicated, by a process somewhat analogous to double weft-faced fabrics, and to fabrics figured with extra weft.

Many elegant examples of this type of artistic textures are used for decorative work, and Fig. 298 is a typical example of such a product. Since the original contains at least 2000 threads and 2500 picks, it is clearly impossible to reproduce in the space at our disposal a sectional





FIG. 298.  
498

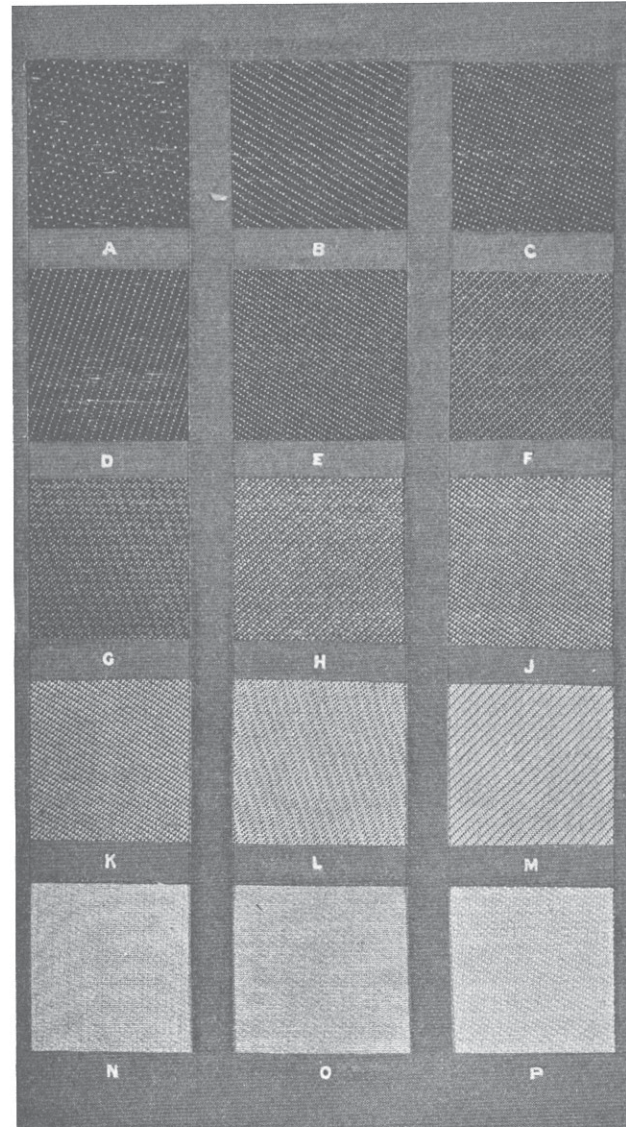


FIG. 299.  
499

2 K 2

design of this example which would contain all the different

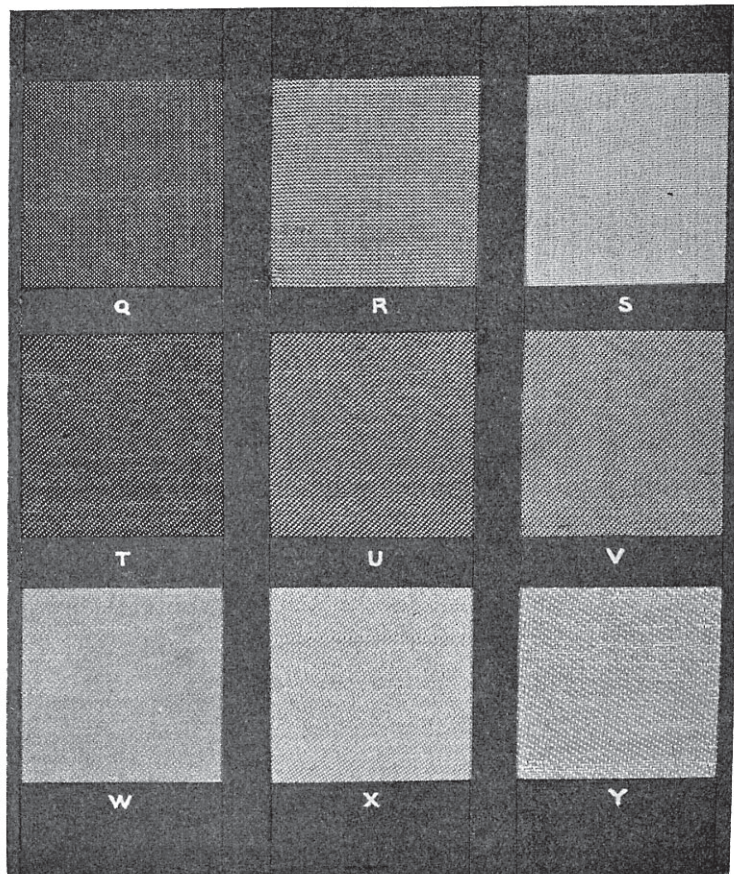


FIG. 300.

weaves employed in the fabric. Instead, therefore, of following the usual process of illustrating any particular

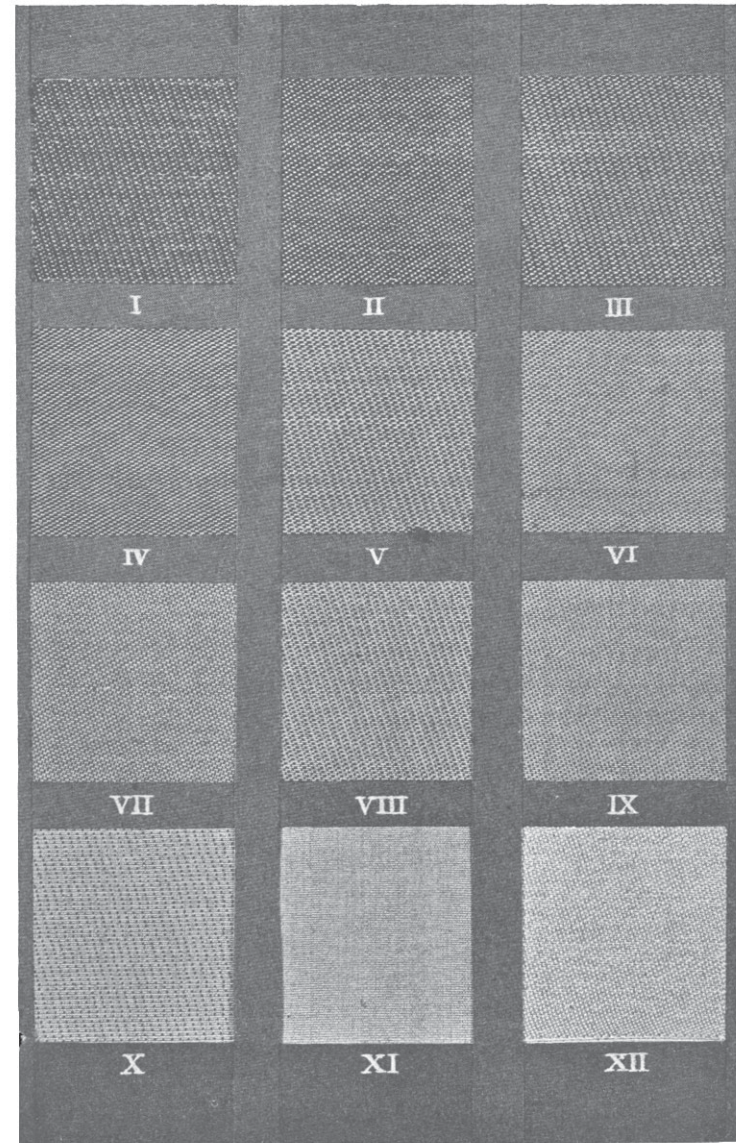


FIG. 301.  
501

part of the structure, we have chosen, what appears to us, the more satisfactory way of showing how the various gradations or shades may be obtained by introducing photographic reproductions of several small pieces of silk fabrics with the corresponding weaves which were used to produce them.

Figs. 299, 300, and 301 are reproductions of thirty-six

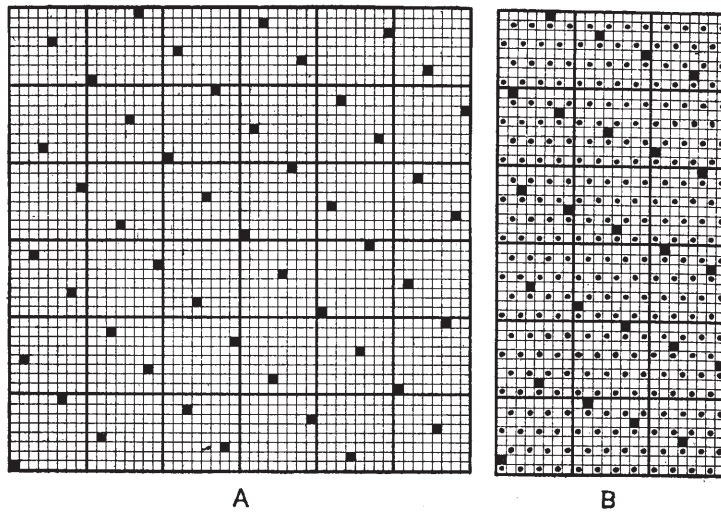


FIG. 302.

different silk fabrics. In Fig. 299, the 15 small samples are graded from almost pure black to pure white, and in the preparation of the point paper design, the designer would introduce into the various parts the weaves which correspond to the depth of shadow required. Fig. 301 shows twelve cloths graded from black to white, while Fig. 300 contains nine patterns which will be explained shortly. Cloths E to P, Fig. 299, are made from 16-thread weaves;

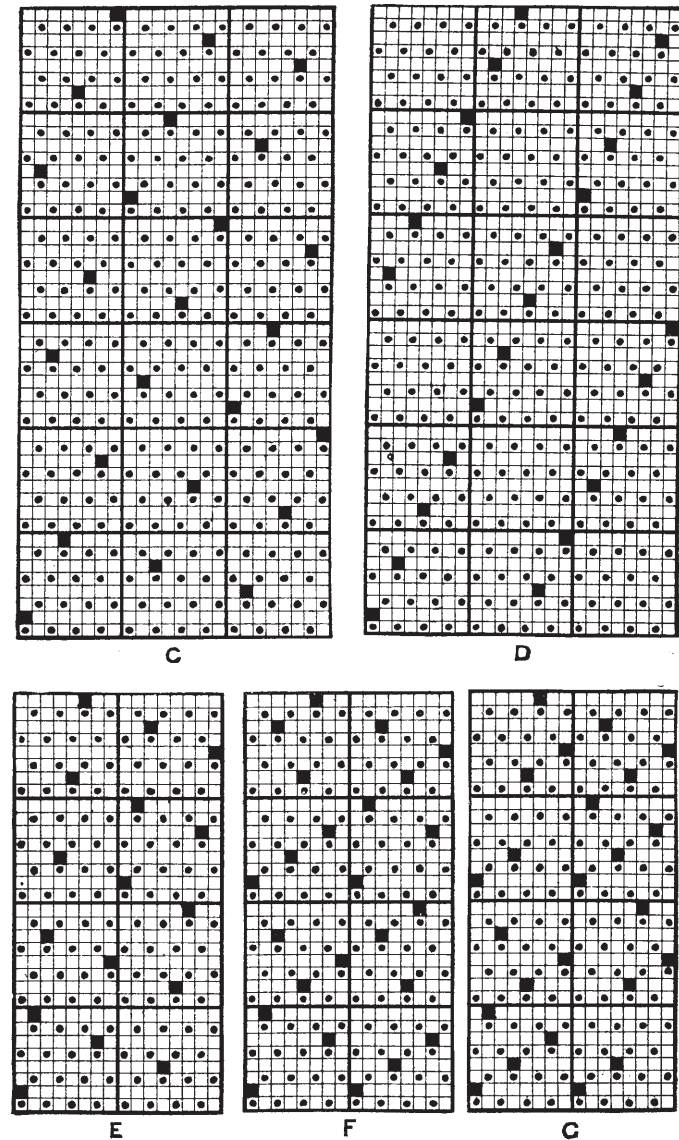


FIG. 303.

B, C, and D from 24-thread weaves; and A from a weave which is complete on 48 threads. The weaves for cloths A and B appear in Fig. 302, and are respectively the 48-thread and the 24-thread sateens. Weave B is complete, and it will be seen that all odd picks of white weft are plain, while the even picks show that the black weft is floating on the surface in 24-thread sateen order. The plain picks are omitted in design A because of the space which they would occupy; they should appear, however, in the corresponding positions, and for the same purpose, as those in design B. All through these designs for silk picture weaving, the dots are placed on white picks and the solid marks on black picks—all marks indicating lifted threads.

Designs C, D, E, F and G, Fig. 303, illustrate the designs for the fabrics bearing the corresponding letters, Fig. 299. The reader will probably see the development of F and G from the sateen unit in E. The prominence of the black picks is gradually reduced in these designs; while in designs H to P in Figs. 304 and 305 the same remark applies, and, in addition, the prominence of the white yarns is increased. The fifteen designs in Figs. 302, 303, 304 and 305 were prepared and used for weaving the cloths in Fig. 299.

The fabrics reproduced in Fig. 301 were woven from the designs which appear in Fig. 306. All the designs in this figure are produced from the 12-thread sateen unit, and the change from dark to light is again more or less gradual. It will be observed that the darkest pattern in this set (Fig. 301) is not very black; the reason for this is easily explained by reference to the designs in Fig. 306, which were used for the construction of these twelve patterns. The solid marks are added in successive designs

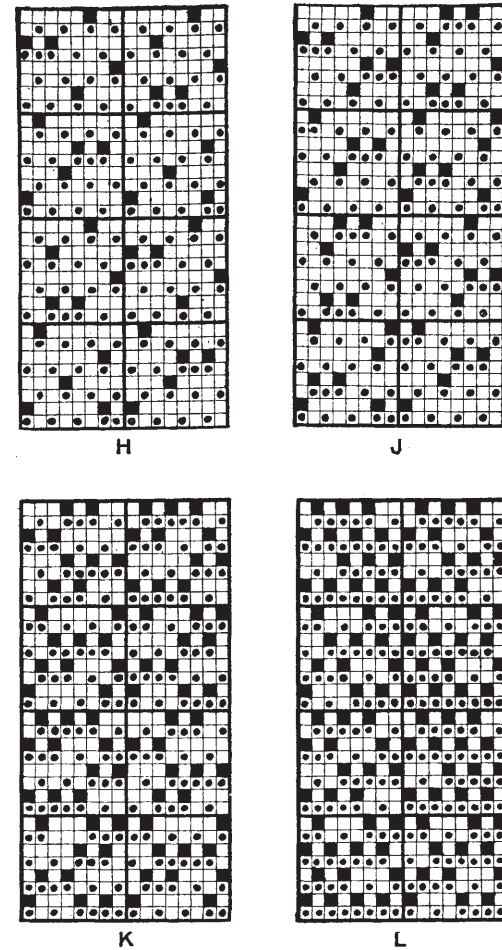
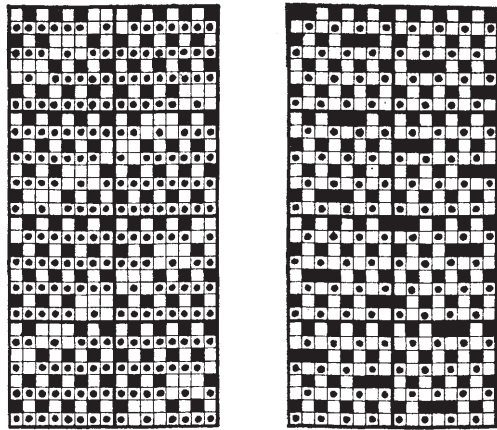
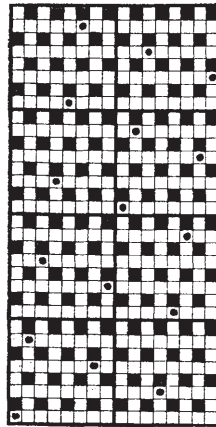


FIG. 304.

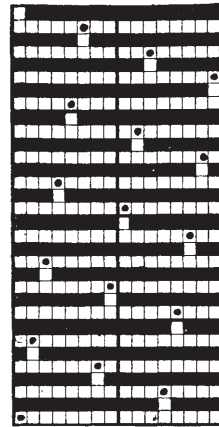


M

N

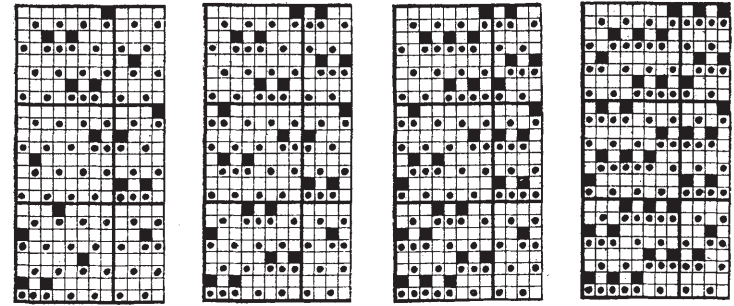


O



P

FIG. 305.

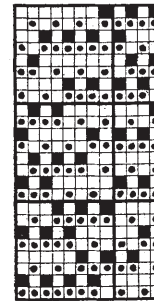


I

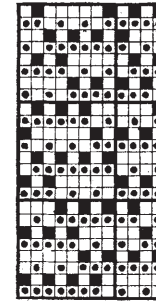
II

III

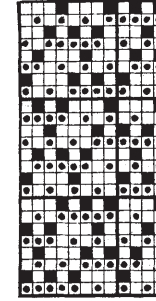
IV



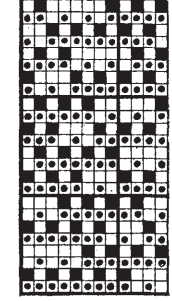
V



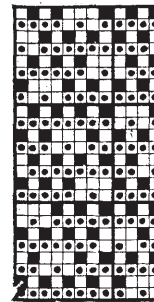
VI



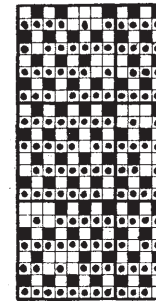
VII



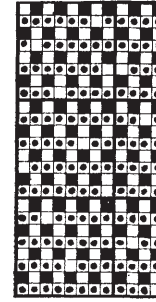
VIII



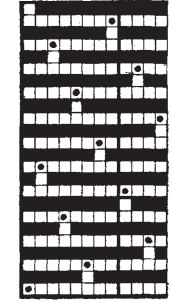
IX



X



XI



XII

FIG. 306.

in systematic order, but the unit weave, which would contain one mark only on each pick, and therefore produce the darkest pattern, has been omitted from the group. It is evident, however, that this unit is the 12-thread sateen, with the marks on the threads in the following order—1, 6, 11, 4, 9, 2, 7, 12, 5, 10, 3, and 8. The white picks used in conjunction with this unit weave would be perfectly plain, but it will be observed from the designs in Fig. 306 that, as the black picks approach more and more towards plain weave, the length of the floats of the white picks is gradually increased, until finally we reproduce the last of the range, design XI, which shows white warp and white weft (rib weave) on the surface. This weave would not be bright enough for the high lights, but for these parts weave XII may be employed.

In preparing a design for a silk picture the weaves in Fig. 306, in addition to the unit weave, would produce practically all the shades required; but if, for any reason, it were necessary to produce some darker effects than it is possible to obtain by the use of the above unit weave, then effects C and A, Fig. 299, may be obtained by using the corresponding weaves from Figs. 303 and 302. Both of these weaves are multiples of the 12-thread unit, and would, consequently, fit in well in the preparation of the design. If still finer gradation be required when using the 12-thread unit, the designs Q, R, and S from Fig. 307 may be employed. Designs Q and S—the woven examples of which appear in Fig. 300—are very useful weaves, and may be used along with those weave effects illustrated in Fig. 301, when additional gradation is required.

The last six patterns in Fig. 300 are made from the designs bearing corresponding letters in Fig. 307. Designs

T to X are made, as shown, from an 8-thread sateen unit, while design Y is a 16-thread weave, and differs only from

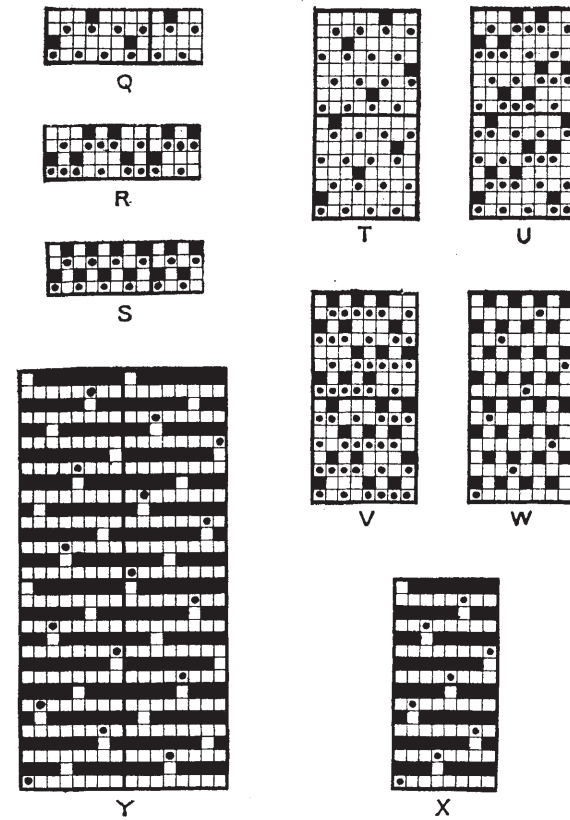


FIG. 307.

design P, Fig. 305, in regard to the black picks, which are, in both cases, at the back of the fabric.

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