usually constructed so that the intermittent release of the reed may be governed optionally by means of a tappet or cam, a dobby, or a Jacquard machine, according to the equipment of the loom. One of the simplest examples of this type of terry motion is that illustrated in Fig. 407, which represents Dugdale and Talbot's device, in which either a cam or else a crank-pin A raises a "frog-" lever B intermittently for two out of every three or more picks of weft, uniformly, according to the particular variety of terry fabric required. The function of the "frog-" lever is to

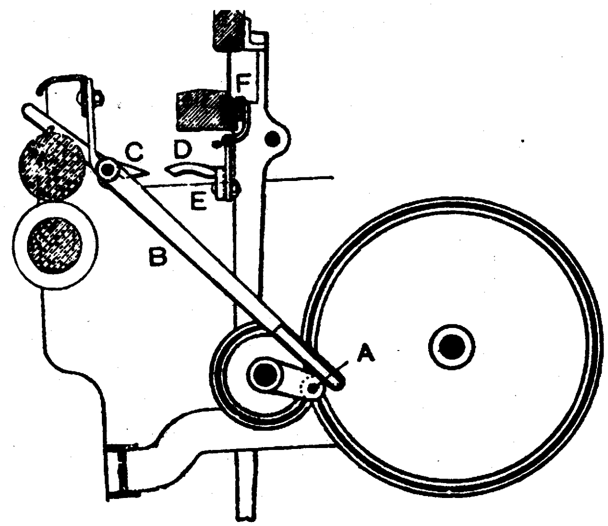


FIG. 407.—Dugdale's terry motion.

raise and depress a tapered "frog-blade" C, which is secured to that lever near the point on which this is fulcrumed, and thus cause a "duck-bill" blade D, projecting from a bracket E depending from the reed-case F, either to pass above the "frog-blade" C in order to release the reed for the two "loose" picks of weft, or else cause the "duck-bill" D to pass underneath the "frog," and thereby lock the reed securely in position when beating-up the "fast" pick or picks of weft, to form the loops of terry pile, in the manner described in §§ 80 and 82.

If at any time it becomes necessary to stop the formation of

the terry pile for the purpose of inserting "fancy headings," as in Turkish towels, or for other purpose, the terry motion is put out of operation simply by depressing the forward end of the "frog"-lever B and retaining it by means of a hook or catch fixed for that purpose. By this means the "frog"-lever B is held clear away from the lifting cam or crank-pin A whereby the "frog" remains constantly in the locking position until it is required to produce terry pile, when the "frog"-lever is again released from its retaining catch. Also, if the loom is equipped either with a dobby or a Jacquard machine, these may be employed to govern the terry motion in any manner according to the variety of terry fabric required. Or again, by an alternative method, the "frog"-lever B may be dispensed with, in which case the "frog" is fixed permanently in position on the loom framing, and the "duck-bill" D is then governed so as to control the action of the reed in the manner desired.

Smith's Terry Motion.

§ 87. Another modification of the loose reed type of terry motion is that illustrated in Fig. 408, which represents Hobson and Smith's device in conjunction with a simple method of controlling the delivery of pile warp threads from the beam. The action of the reed may be controlled either by a spare hook of the Jacquard machine, or else by a "jack"-lever A of the dobby as indicated in the diagram. Thus, through the medium of a chain B the "jack"-lever either raises or depresses an elbow "frog"-lever C in a prescribed manner, in order either to release or else lock the reed when this is beating up the "loose" and "fast" picks of weft respectively. This object is effected by securing the lower reed-case to two or more bracket arms D that are set-screwed to a rod E which extends across the loom and is supported freely in brackets that are bolted to the sley swords F. On one end of this rod E there is set-screwed an arm G formed with a slotted end in which there is fixed an adjustable stud carrying a small bowl or runner H. Thus, as the sley advances, the bowl passes either above or else below the horizontal tapered and curved arm of the "frog"-lever C and thereby either locks

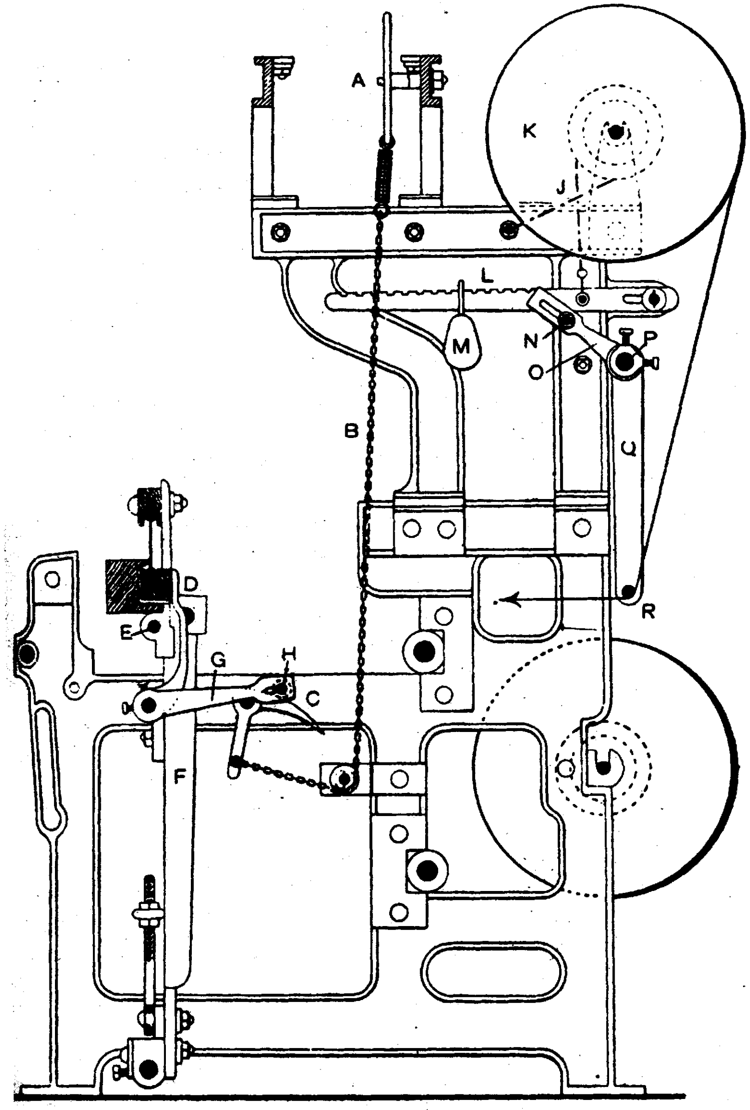


FIG. 408.—Smith's terry motion.

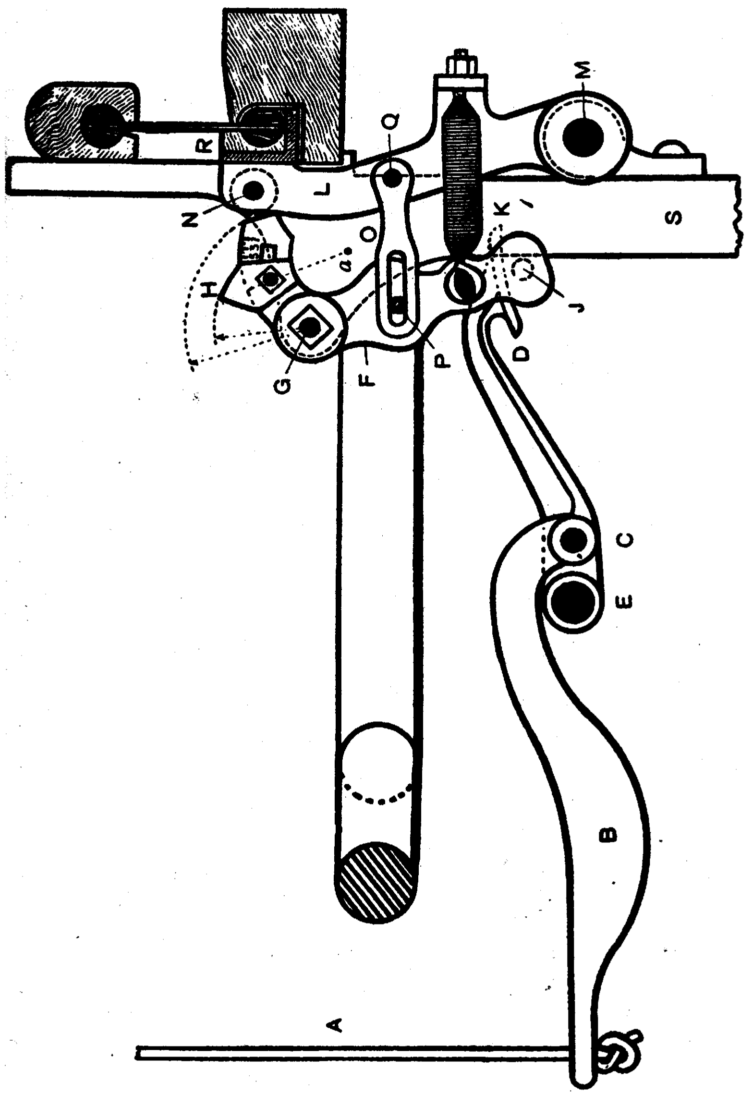
the reed securely in its normal forward position, when beating-up the "fast" pick or picks of weft, or else the reed moves backward, at the bottom, when beating-up the two "loose" picks of weft respectively.

The length or depth of the loops of terry pile may be regulated by adjusting the position of the runner H in the slot at the end of the arm G, and also by adjusting the position of the stud on which the "frog"-lever C is pivoted, in order to vary the angular movement of the arm G, and thereby cause the reed to swing backward for a shorter or a longer distance and so produce a narrower or a wider gap or "fret" at the "fell" of the cloth, according to the depth of loops required.

The delivery of pile warp threads is controlled by passing a band-brake J around a large iron "ruffle" or pulley fixed on one end of the pile warp-beam K, and attaching one end of the band-brake to a lever L containing an adjustable weight M for the purpose of regulating the degree of tension upon the pile warp threads during weaving. Bearing constantly against the lower edge of the weighted lever L there is preferably a small bowl, mounted on a short stud N, fixed adjustably in the slotted end of a short arm O, secured on one end of a strong iron bar P extending across the entire width of the loom. To this cross-bar there are also secured two similar long pendant arms Q, of which the lower extremities support a yarn tension-bar R, under which the pile warp threads are deflected in their progress from the beam towards the front of the loom. Hence, the vibration of the tension-bar R, caused by the varying tension to which the pile warp threads are subjected during weaving, releases the band-brake J, and thereby liberates the warp beam automatically in order to deliver the pile warp threads more freely when the two "loose" picks and the first "fast" pick of weft are being beaten up to produce the loops of terry pile in the manner described previously.

Hacking's Terry Motion.

§ 88. A third modification of the "loose-reed" type of terry pile motion is that illustrated in Figs. 409, 410 and 411, representing Hacking and Hilton's device which may be controlled



either by means of a dobby "jack"-lever or a hook of a Jacquard machine, as indicated in Fig. 409; or else by means of a simple cam or tappet, as indicated in Figs. 410 and 411, which represent the reed in the act of beating-up a "fast" and a "loose" pick of weft respectively. The cardinal features of this ingenious

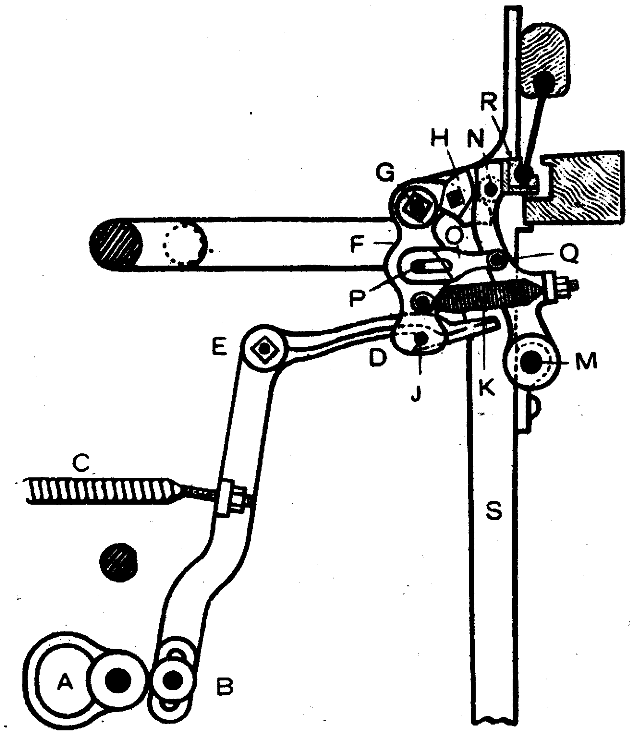


Fig. 410

device consist essentially of an elbow cam-lever F fulcrumed on a stud G secured to the ear of one of the sley swords S, and of which the short horizontal curved arm is furnished with an adjustable stop-piece H. This elbow-lever, which is operated in a prescribed manner to govern the action of the reed according to the number of picks to be inserted for each horizontal row of loops in the terry fabric produced, is controlled in reverse directions from two independent sources, namely, (*a*) by causing the hooked end of an arm D, which is fulcrumed on a fixed stud E, to descend and thereby engage with a stud J projecting on one side at the lower end of the vertical arm of the elbow-lever F which, as the sley advances, is retained by that

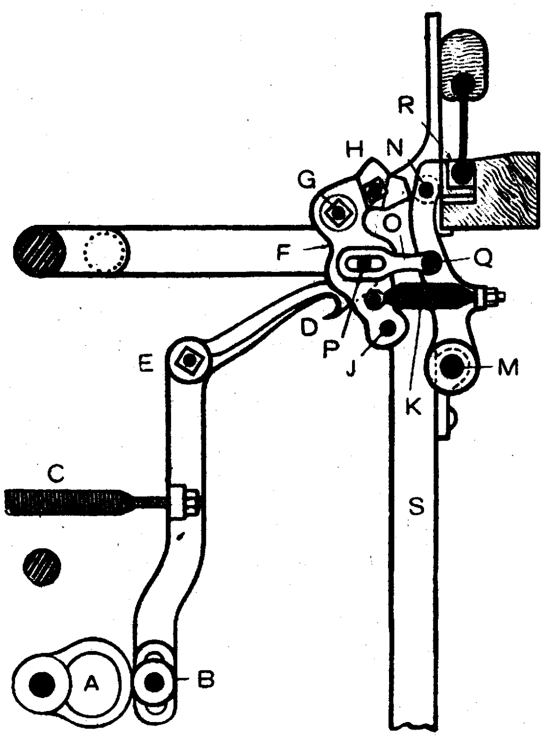


FIG. 411.

hook, thereby deflecting the horizontal curved arm of that lever in order to liberate the reed, and, at the same time, exerting, through the medium of a spiral spring K, sufficient effort upon one of the arms L, supporting the reed-case R, to pull the lower edge of the reed backward, in the manner indicated in Fig. 411; and (*b*) by the reflex action of the spiral spring K which, as the sley recedes, reacts upon the vertical arm of the elbow-lever F

and thereby causes the upper surface of the horizontal arm of that lever to bear against a small anti-frictional bowl N mounted on a stud secured to the lower reed-case R, which is thereby forced forward until the reed is in its normal position in which it becomes securely locked by reason of the end of the curved arm of the elbow-lever F impinging firmly against the small bowl N as indicated in Figs. 409 and 410.

If the operation of this terry motion is governed either by means of a dobby or a Jacquard machine, as represented in Fig. 409, the hooked arm D constitutes one of two members of a double-jointed lever of which the other member is a weighted arm B hinged freely on a stud C passing through both arms at a point immediately in front of the stud E on which the hooked arm D is fulcrumed; whilst the free end of the weighted arm B is connected either to a dobby "jack"-lever, or a hook of a Jacquard machine. By hinging the two arms of the compound lever B, D on separate studs C, E, in the manner indicated, instead of casting both arms of that lever as one member, it affords greater latitude in the setting and timing of the shedding and terry motions, in relation to each other, with less risk of failure or breakage. If, however, this device is governed by means of a special tappet for that purpose, as represented in Figs. 410 and 411, the entire device is, therefore, self-contained and quite independent of the shedding motion, in which case the hooked arm D forms the horizontal arm of an elbow-lever fulcrumed on a stud E, and of which the vertical arm is furnished with an anti-frictional bowl B that bears constantly, under the influence of a spring C, against the rim of a tappet A which performs one revolution during such number of picks as are inserted for each horizontal row of loops of terry pile in the fabric produced.

The free movement of the reed, and therefore the length or depth of the terry loops, is determined by the position in which the adjustable stop-piece H is fixed on the horizontal curved arm of the elbow-lever F which is graduated with the object of enabling the stopper to be adjusted with greater precision, according to the length of pile required, and which will either be longer or shorter by fixing the stopper H nearer to, or further from, the fulcrum G of that lever respectively. Thus, on the deflection of the curved arm of the elbow-lever F to release the reed, the latter, under the influence exerted by the spring K, immediately recedes until the small bowl N comes in contact with the stop-piece H when its further movement is arrested. The inclined surface of the stop-piece H against which the small bowl N abuts, forms a small arc of a circle which is concentric with the centre of the stud G on which the elbow-lever F is fulcrumed; whilst the curved arm of that lever forms the arc of a circle described from a point marked *a*, as indicated by dotted lines in the diagram, Fig. 409.

By producing the curvature of the stop-piece H so that it is concentric with the stud G it thereby ensures the line of maximum resistance offered by that stopper against the small bowl N, passing through the centres of that bowl and the stud G respectively. Also, as a precaution against the tendency of the bowl N, owing to the impulsive momentum exerted by the sley when beating-up the two loose picks of weft, to move forward out of contact with the stop-piece H and thereby involve the risk of producing loops of terry pile of irregular length, in different horizontal rows, there is provided a slotted link O which is hinged freely on a short stud Q projecting on one side of the arm L supporting the reed-case, whilst the slotted end of that link is penetrated by an adjustable stop-pin P fixed in the vertical arm of the elbow-lever F as indicated in the diagrams. Thus, by adjusting the stop-pin P to cause it to bear lightly against the extreme rear end of the slotted link when the small bowl N is in contact with the stopper H, as indicated in Fig. 411, the stop-pin P will thereby prevent the reed from advancing until it is forced forward by the curved arm of the elbow-lever F only when this is released by raising the retaining hook D, in order to lock the reed in its normal position, when beating-up the "fast" pick or picks, as described previously.

Varieties of Terry Pile Fabrics.

§ 89. Fig. 412 is the design for a plain "three-pick" terry fabric with the pile formed on both sides, and in which the warp

threads are arranged in the order of one pile and one ground warp thread alternately, as represented in the design. In the production of terry piece-goods, such as roller towelling, not more than four healds are necessary, namely, two for each series of warp threads; but in the production of separate towels, with "headings" or borders, it is usual to employ five healds, namely, two (at the front) for pile warp threads, and three (in the rear) for ground warp threads, drafted in the manner indicated above the design. When pile and ground warp threads are disposed alternately, one thread from each series is passed between each successive dent of the reed; but when the warp

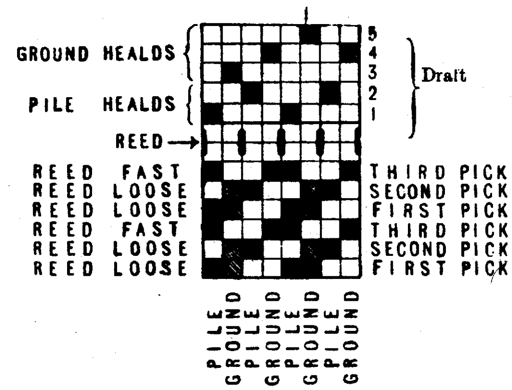


FIG. 412.—Design for three-pick terry pile fabric

threads from both series are drafted in pairs, they are also passed through the reed in pairs, whereby two warp threads of the same series are contained in the same dent of the reed. The relative merits of each system of drafting, and other practical considerations, are stated in § 94. On examining the design, Fig. 412, it will be seen that consecutive ground warp threads interweave in a contrary manner to each other, as do also consecutive pile warp threads. Pile warp threads that are *over two picks* and under one pick form pile on the face, whilst those that are *under two picks* and over one pick will form pile at the back of cloth when in the loom.

§ 90. In the production of terry fabrics, without the aid of wires, it is absolutely essential to observe a specific order of shedding in relation to the action of the reed as governed by the terry motion, otherwise the loops of pile will either be imperfectly developed, or they may not appear at all. This order is clearly indicated in the design (Fig. 412) and also in the graphic

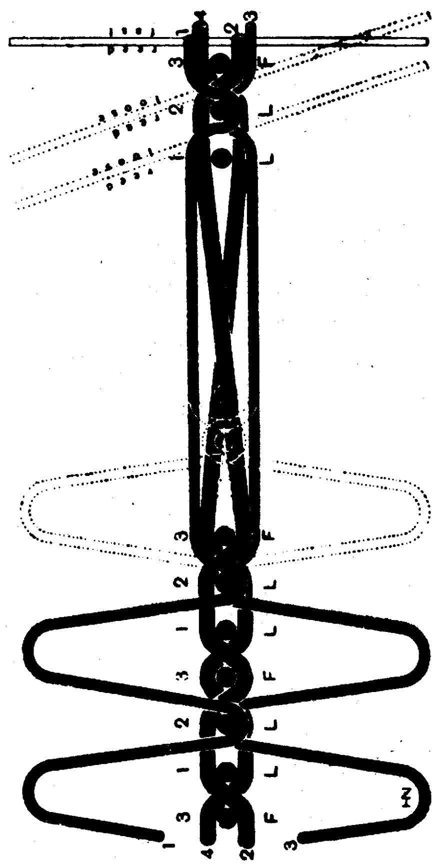


Fig. 413.—Graphic diagram of a three-pick terry fabric, demonstrating the action of the reed, and the formation of loops of terry pile, during weaving.

diagram (Fig. 413) which represents a longitudinal section of a three-pick terry fabric. On examining these figures it will be seen that the reed is "loose" for the first and second picks, termed "loose" picks, and "fast" for the third pick, termed

the "fast" pick. It will also be observed that the "loose" picks are always inserted in *reverse pile warp sheds*, but in the *same ground warp sheds.* With this order of shedding in relation to the reed motion, pile warp threads make two intersections, and ground warp threads only one intersection with the picks, before the latter are beaten up to the "fell" of cloth; hence, the picks easily slide along ground warp threads which are held taut, whereas their better grip of pile warp threads, which are slack, thereby causes the latter to be drawn forward and thus form loops of pile.

§ 91. As stated in § 81, the number of picks inserted for each horizontal row of loops, in terry pile fabrics produced by

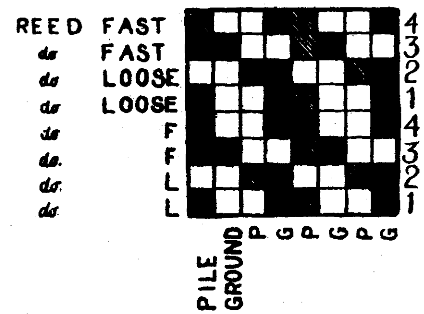


Fig. 414.—Design for a four-pick terry pile fabric.

the aid of terry motions, varies in different fabrics from three to six picks. The number of picks selected, however, does not, in the very least degree, affect the essential factor governing the construction of these fabrics, as regards the order of shedding in relation to the timing of the reed motion, as described in § 90. This fact is specially emphasised because it constitutes the cardinal and most essential condition in the production of terry pile fabrics, and the lack of such information sometimes proves a hindrance to their successful manufacture. It should also be observed that the relative density of loops of pile is either greater or less in a measure which is inversely proportional to the number of picks inserted for each horizontal row of loops.

The design for a four-pick terry fabric in which the loops of

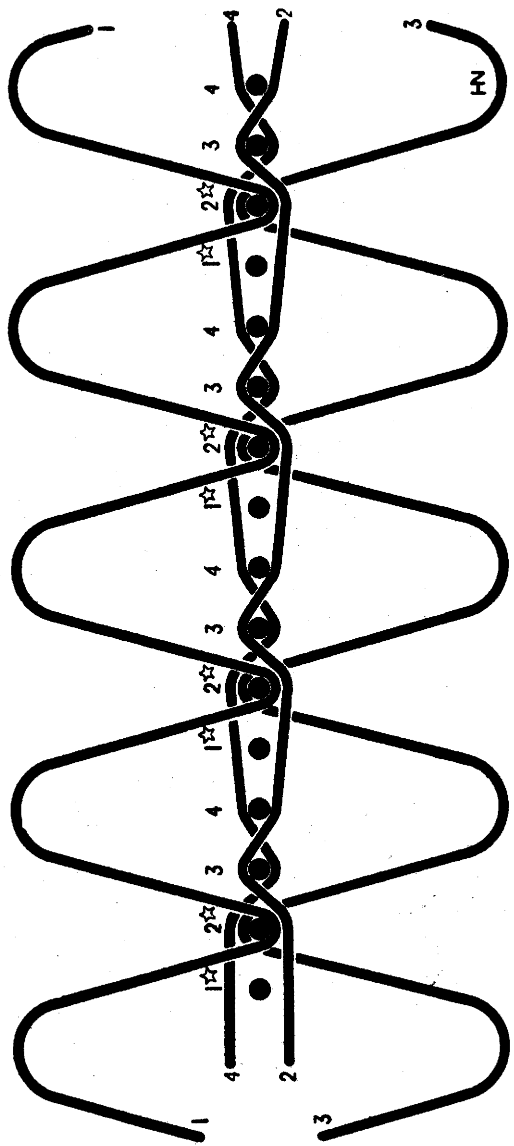


FIG. 415.—Longitudinal section, showing the construction of a four-pick terry pile fabric, from design Fig. 414.

pile are distributed equally on both surfaces, is indicated in Fig. 414, whilst a longitudinal section of the cloth produced from that design is represented graphically in Fig. 415. This variety differs from a three-pick terry fabric by having two picks, namely, the first and fourth picks, which are contiguous, inserted in the same warp shed, a circumstance which necessitates the use of a "catch-cord" for one of the selvedges. (A "catch-cord" is a device to govern extreme outer selvedge warp threads, so that the weft will be caught by those threads and thereby prevented from being pulled backward into the warp shed in the event of a shuttle passing through the same shed for two or more picks in succession.) By inserting four instead

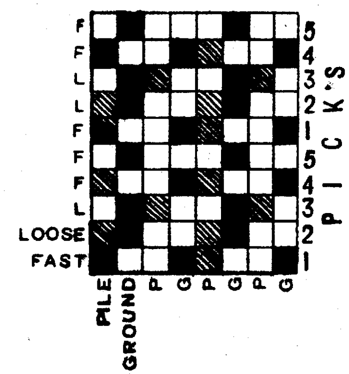


FIG. 416.—Design for a five-pick terry pile fabric.

of three picks for each horizontal row of loops, a firmer and heavier texture is produced. Also in the manufacture of those fabrics in which differently coloured threads are employed to produce simple counterchange effects (as exemplified in many terry towels and bath mats), that course enables a sharper and more perfect definition to be made at the horizontal edges of figure, where pile warp threads pass from face to back, and *vice versâ*. The starred numbers 1 and 2 in Fig. 415 and the subsequent diagrams of terry fabrics signify that the reed is *loose* for the picks indicated, and *fast* for the intermediate picks during weaving.

The construction of a "five-pick" plain terry fabric is

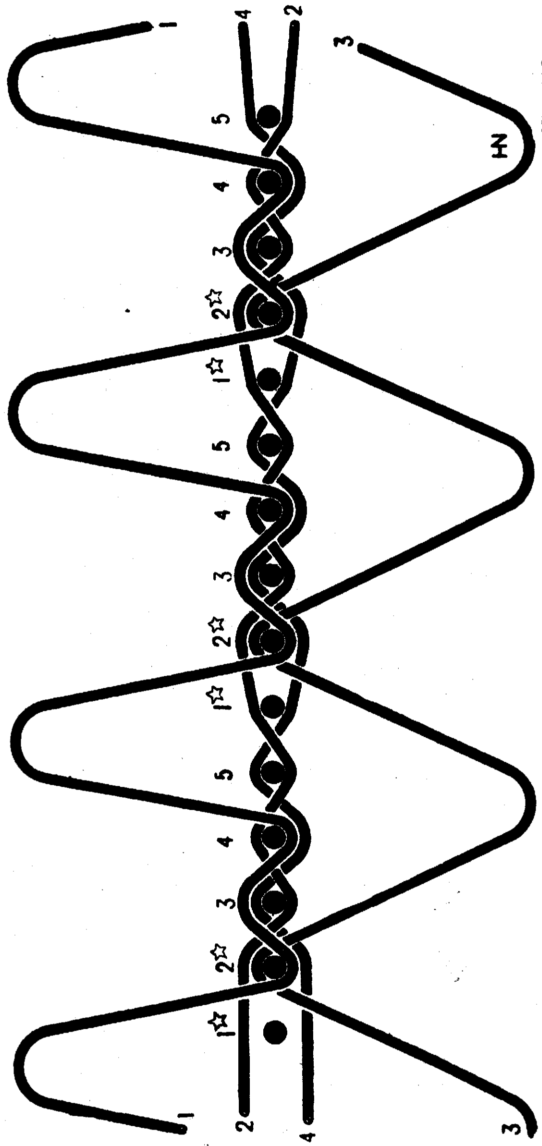


Fig. 417.—Longitudinal section, showing the construction of a five-pick terry pile fabric, from design Fig. 416.

indicated in Figs. 416 and 417 which represent the design and sectional diagram, respectively, of that variety, in which it will be observed that the pile warp threads do not interweave in an exactly contrary manner on the face and back of the cloth, as in the three-pick and four-pick varieties. Thus, whereas face pile warp threads loop over two consecutive picks of weft and intersect with three picks, the back pile threads loop under four consecutive picks of weft and pass over only one pick, as indicated in the sectional diagram. By adopting this course, it permits of a relatively greater density of picks of weft than would be possible if the back pile warp threads also intersected

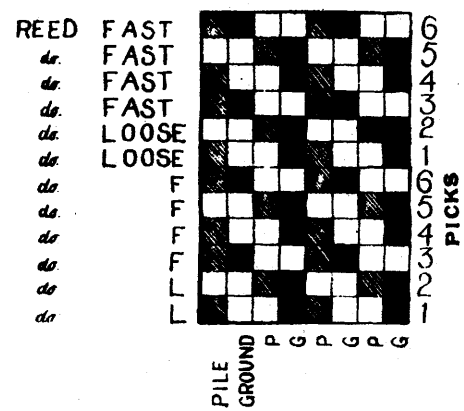


Fig. 418.—Design for a six-pick terry pile fabric.

with the same three picks of weft. Five-pick terry pile weaving, however, is usually restricted to the production of Jacquard figured terry pile fabrics, as described in §§ 93 to 96.

§ 92. Another modification in the construction of terry pile fabrics is exemplified in the six-pick structure of Turkish towels, of which the design and longitudinal section are given in Figs. 418 and 419 respectively. So far as the structural design of this fabric is concerned, it is identical with that of an ordinary three-pick terry pile fabric (Fig. 412), repeating on three picks, excepting that in weaving this six-pick terry structure the reed is governed so as to be loose for two out of six picks (instead of

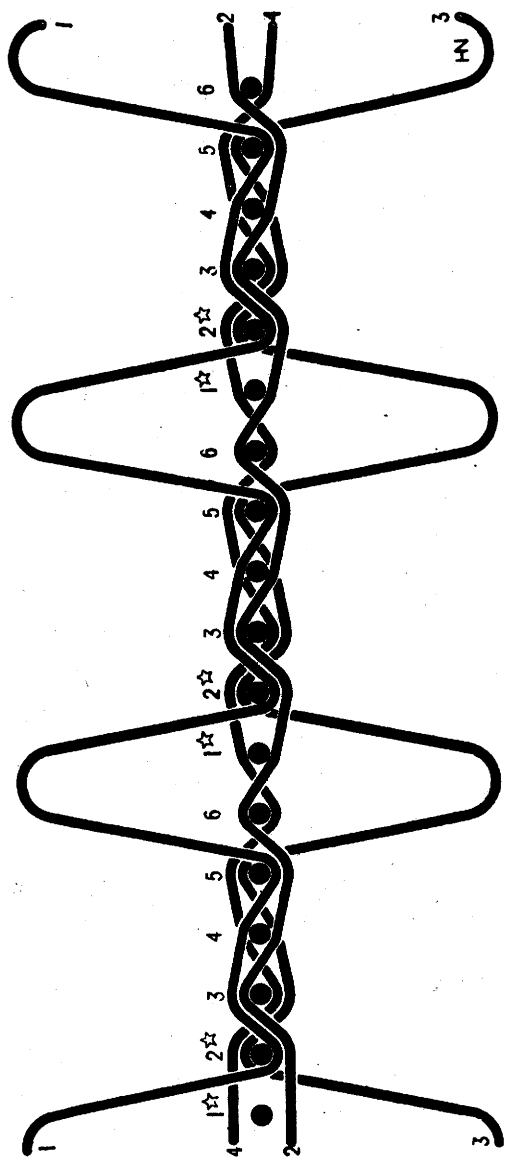


FIG. 419.—Longitudinal section, showing the construction of a six-pick terry pile fabric, from design Fig. 418.

two out of three picks, as in a three-pick terry fabric), thereby causing six picks to be inserted for each horizontal row of loops, as shown in diagram, Fig. 419. Terry pile fabrics constructed on this principle are relatively stronger and of much firmer texture than either of the previous examples; also pile warp threads are more firmly interwoven with the foundation texture, and therefore less liable to be accidentally or otherwise withdrawn when the fabric is in use. In the production of six-pick terry fabrics, the reed is loose for the first and second picks only, and fast for the four remaining picks.

Figured Terry Pile Fabrics.

§ 93. The principle of terry weaving is not restricted to fabrics that are usually produced with an entire surface of terry pile, as exemplified in Turkish towels, bath mats and similar articles in which coloured threads are sometimes introduced simply for decorative effect; but this principle of weaving is also employed as a means of embellishment by Jacquard figuring of a more or less elaborate character, as exemplified in bed counterpanes, dressing-table covers, toilet covers and mats, curtains or hangings, furniture antimacassars and many other articles both of utility and adornment. Figured terry fabrics are usually constructed on the principle of the "three-pick" variety of terry weaving, as described in § 89, and of which the design and longitudinal section of that variety are represented in Figs. 412 and 413 respectively; whereas the "five-pick" variety, which yields a firmer and more durable texture and also affords greater security to pile warp threads, is usually restricted to fabrics of superior quality and heavier textures, for use as bed counterpanes.

The structure of a "three-pick" and a "five-pick" figured terry pile fabric is indicated graphically by sectional diagrams, Figs. 420 and 421 respectively. As a general rule these fabrics are produced with terry pile figuring on a simple foundation texture, which is quite bare or plain in consequence of the pile warp threads developing the loops of terry pile on the reverse side of cloth when they are not required on the obverse side for figuring purposes, as represented in the sectional diagrams.

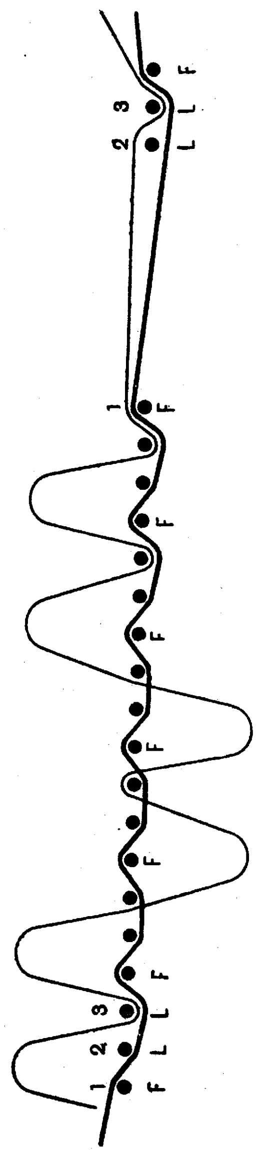


FIG. 420.—Longitudinal section, showing the construction of a three-pick figured terry pile fabric.

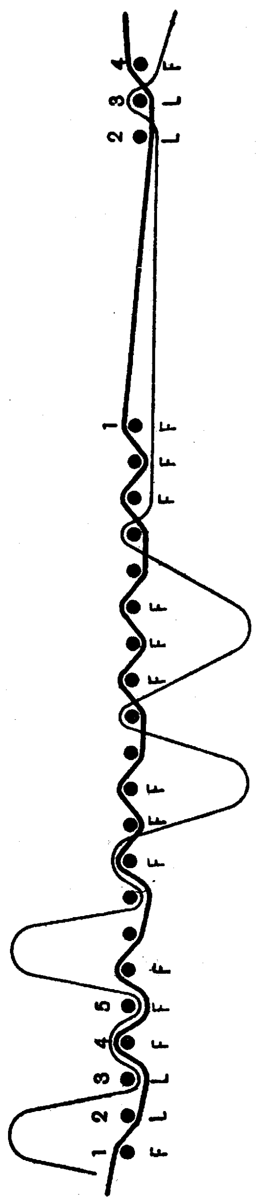


FIG. 421.—Longitudinal section, showing the construction of a five-pick figured terry pile fabric.

It will be observed in Figs. 413, 415 and 419 that in the three, four and six-pick terry fabrics consecutive pile warp threads always intersect with weft in an entirely reverse manner to each other; whereas, in the present example of a five-pick terry fabric, when pile warp threads are forming pile on the face they interweave in a different manner from that when forming pile at the back. Thus, when forming pile on the face, pile warp threads interweave over two picks, under one, over one, and under one pick; whereas, when forming pile at the back, they interweave under four picks and over one pick. The object of this arrangement is to cause pile warp threads to intersect less frequently with picks of weft, and so permit of a greater number of picks per inch to be inserted in cloth. Such a course, however, involves a less secure interlacement of the pile warp threads with the foundation texture, from which they are more liable to be withdrawn accidentally.

Terry or Twin Jacquard Machines.

§ 94. In the production of figured terry fabrics, as in that of the plain varieties, the ground warp threads are controlled by means of healds, whereas the pile or figuring warp threads are controlled by a Jacquard harness which, from considerations of economy, is usually operated by means of a special type of terry or "twin" machine whereby each pattern card serves for three or five picks of weft in succession, according to the number of picks inserted for each horizontal row of loops in the fabric; also, the preparation of applied terry designs and the operation of card-cutting is thereby greatly facilitated and simplified.

A special terry machine of this type, as represented in Fig. 422, is designed to control the same pile warp thread or threads either by means of two contiguous reversed hooks C, C[1] (or else by a "twin" or double hook, as represented at F, detached) that are connected by their "tail" or "neck" cords D, and which are contained in two contiguous rows (as the first and second, third and fourth, and so on) as indicated in the diagram. The two hooks constituting either a pair or a "twin" hook are both controlled by the same needle B, but they are raised independently by two distinct sets of griffe-blades E, E[1] that are

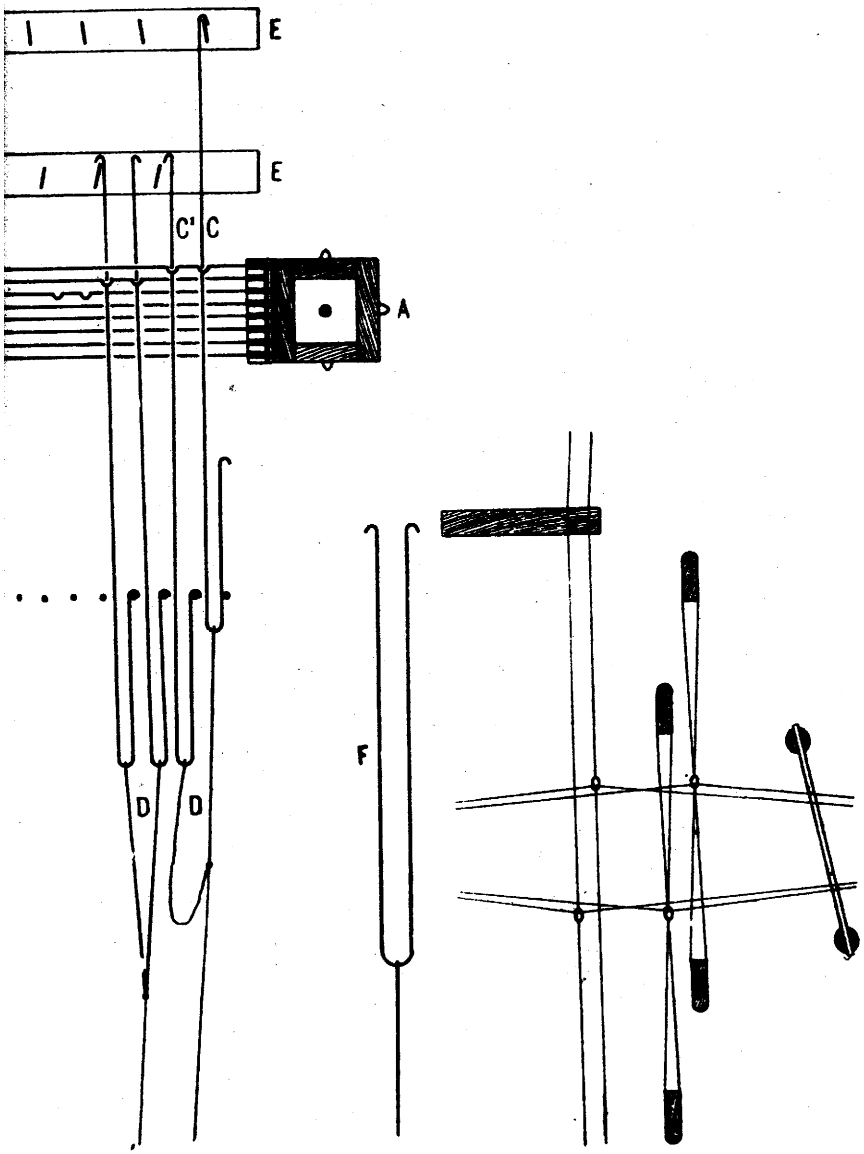


FIG. 422.—Compound Jacquard figuring and heald binding harness for figured terry pile fabrics.

operated independently of each other and also of the card cylinder A, and in a prescribed manner, according to the particular variety of terry fabric to be produced, to be described presently. All hooks in the first and alternate rows face the card cylinder and, in their normal position, remain *over* their respective griffe-blades E, by which they are raised whenever a *hole* in a pattern card is presented to the needle controlling that pair of hooks; whereas all hooks in the second and intermediate rows are reversed and therefore point *away* from the card cylinder and, in their normal position, remain *off* their respective griffe-blades E^1, by which they are raised only when they are pushed over those griffe-blades by presenting to the corresponding needles B a blank place in the pattern cards.

§ 95. The drafting chart and shedding plans, of which the latter also indicate the operation of the card cylinder, griffe-blades, healds and reed, for the production of three-pick and five-pick figured terry fabrics, as represented by the sectional diagrams, Figs. 420 and 421, are indicated in Fig. 423, A, B and D respectively, whilst the shedding plan for a four-pick variety is indicated at C. Thus, when producing a three-pick figured terry fabric, the card cylinder retains each pattern card against the needle-board for three picks in succession, during which the leading set of griffe-blades, 1, *ascends* and remains up for the first two picks of weft, to develop terry pile figuring on the face of the fabric; whilst the second set of griffe-blades remains *down*, in order to develop the loops of pile on the reverse side of the cloth with all the pile warp threads that are, in respect of that same horizontal row of loops, not required on the obverse for figuring purposes. Then after the first two picks are inserted, the two sets of griffe-blades reverse their relative positions for the insertion of the third pick of weft, during which the card cylinder moves outward to change the pattern cards for the next following series of three picks, and so on for each pattern card in succession, corresponding to one horizontal row of loops. At the same time, the first heald is raised for the first pick and depressed for the second and third picks of weft, whilst the second heald operates in an exactly contrary manner to that of the first heald, and the reed is "fast" for the first

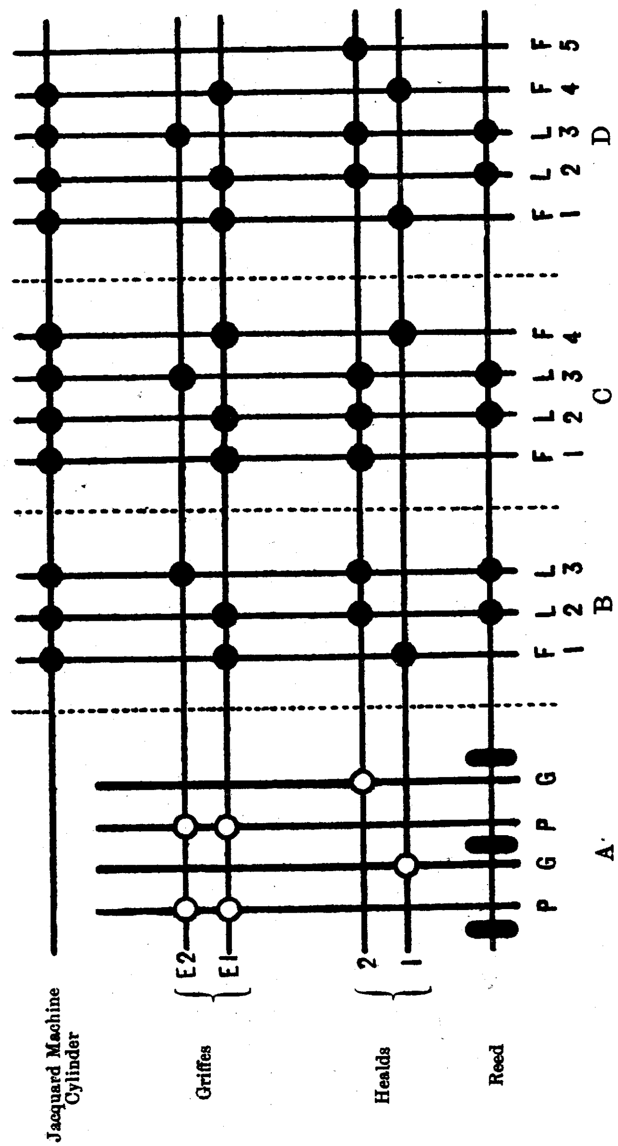


FIG. 423.—Draft (A) and shedding plans (B, C, and D) for 3-, 4-, and 5-pick figured terry fabrics.

pick and "loose" for the second and third picks, as indicated in the shedding plan, Fig. 423, B.

The shedding plan for a four-pick figured terry fabric, which is of rare occurrence, is virtually the same as that for the three-pick variety, in respect of the first three picks of weft; whilst the third and fourth picks are inserted in reverse warp sheds, as indicated in Fig. 423, C.

Also the shedding plan for a five-pick figured terry fabric is identical with that of the four-pick variety in all respects, excepting for the fifth pick when both sets of griffe-blades remain down, and thereby leave down *all* pile warp threads for that pick and the card cylinder moves outward, in order to change the pattern cards, after the fourth pick, and remains out during the fifth pick, thereby allowing a longer period for changing the pattern cards. Also the second heald is raised, and the reed remains "fast" for that pick, as indicated in the shedding plan for this variety, Fig. 423, D.

Method of Preparing Applied Designs for Figured Terry Pile Fabrics.

§ 96. The preparation of an applied design for a figured terry fabric, of any variety to be produced by means of a special terry machine of the type described in the previous sections, is a comparatively simple procedure, as also is the operation of cutting the pattern cards from such a design. This is due to the fact that a design of this character is developed *en bloc*, with the figure portion painted up solidly, and the ground portion left blank on the design or point paper, of which the small vertical and horizontal divisions represent rows of loops of terry pile in each direction respectively, and in which each small filled square represents one loop of pile on the face side, and a blank square a loop of pile on the reverse side of the cloth, quite irrespective of the number of picks to be inserted for each pattern card of which the entire set may, therefore, be employed optionally for any variety of these fabrics, since the particular character they assume is determined mechanically by the shedding plan. The counts of design paper required, therefore, is determined by the ratio of loops of pile contained in an equal space horizontally and vertically, and not by the number or ratio of warp threads and picks of weft contained in the fabric.

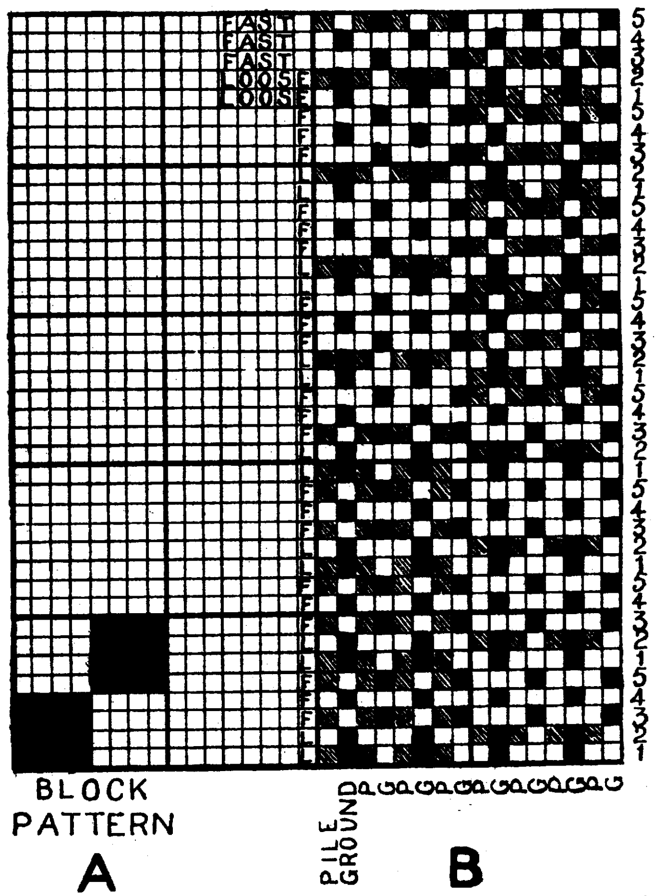


FIG. 424.—Applied design (B) for a 5 pick figured terry pile fabric embellished with pattern indicated *en bloc* at A.

The method of indicating, on point paper, a figured terry design, on a small scale, is represented at A, Fig. 424, consisting of, a simple four by four dice pattern of which the actual

interlacement of the pile and ground warp threads with the picks of weft, in a five-pick variety of terry fabric, is indicated at B of the same figure.

Fast-Reed Terry Pile Weaving.

§ 97. As stated in § 80, terry pile fabrics may be produced in an ordinary fast-reed loom which is not equipped with a special terry motion for that purpose, and in which each pick of weft is beaten up immediately to the full extent, close to its predecessors, and without the necessity of creating temporary gaps or "frets," without weft, as is usual in ordinary terry pile weaving. The method here indicated, however, is quite distinct from the improvised methods that are sometimes employed for the purpose of developing a series of loops that are usually disposed at moderately wide intervals apart, and as briefly described in § 100 under the sub-heading "Loop Pile Fabrics"

By conforming to certain conditions which constitute the essential features of a method of terry weaving, patented by Taylor and Dawson, terry pile fabrics which, in their general outward appearance, bear a very close resemblance to those of the usual type, may be produced in an ordinary "fast-reed" loom that beats up every pick of weft in the usual manner, and without the aid of a special terry motion. By this means, the patentees claim that terry pile fabrics are thereby not only produced both more expeditiously and economically, but also that the distribution of the loops of pile is more perfect than that obtained by the usual methods of terry weaving.

The method under present consideration consists essentially of conforming to the conditions specified as follows, and as indicated in the accompanying Figs. 425 to 431 :—

1. By drawing-in the ground and pile warp threads through the shedding harness and reed with a "two-and-two" disposition in the specific order of one ground thread, two pile threads and one ground thread drawn through each dent of the reed, in regular succession, and with a reed wire separating the two adjacent ground threads, as indicated in the "drawing-in" chart, or "draft," Fig. 425.

2. By interlacing pile warp threads, with the picks of weft, in a specified manner so that pile threads in *alternate* dents

only will form pile (either on the face or back of the cloth), simultaneously, on the same pile pick or picks of weft; and pile threads in *intermediate* dents only will form pile, simultaneously, on the next pile pick or picks of weft, and so on in alternate succession, and as indicated in the designs, Figs. 426, 428 and 430, and also in the graphic diagrams, Figs. 427, 429 and 431, which represent longitudinal sections of the fabrics produced from those designs respectively.

3. By regulating the delivery of pile warp threads in a manner that will permit of these being drawn forward either by each successive pick of weft, or at any other prescribed interval, in order to form loops of pile of the required depth; and

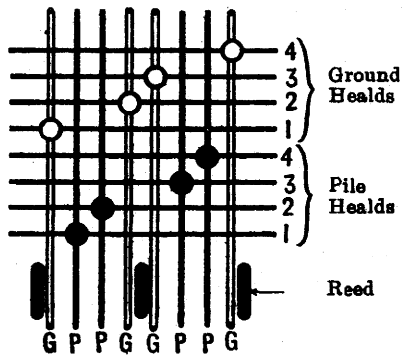


FIG. 425.—Draft of warp threads for "fast-reed" terry pile fabrics.

4. By beating-up each successive pick of weft, *immediately*, to its final position in the cloth, instead of leaving a short gap or "fret" for three picks and then beating them up together, as when a special "terry motion" is employed.

§ 98. [Although it is not absolutely essential for the development of a terry pile surface, by this method, that object is facilitated by delivering the pile warp threads in a positive and prescribed manner either by passing those threads between a pair of nip or tension rollers to which there is imparted an intermittent movement at regular intervals of one or more than one pick of weft, as required, and as actually recommended by the patentees of this method.]

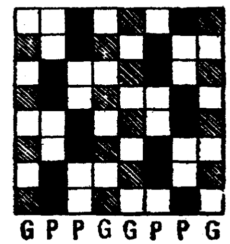


FIG. 426.

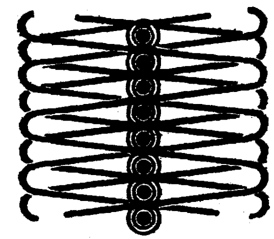


FIG. 427.

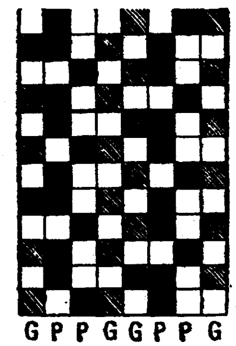


FIG. 428.

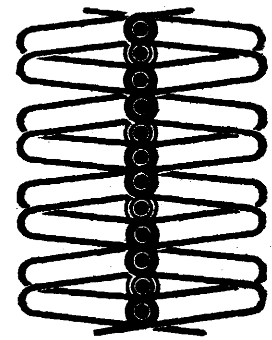


FIG. 429.

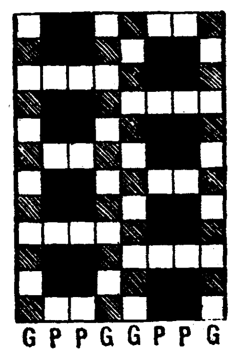


FIG. 430.

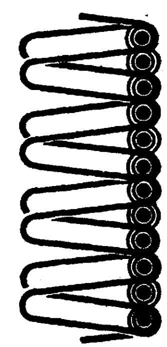


FIG. 431.

The design indicated in Fig. 426 repeats on four picks, and is adapted for a reversible terry fabric in which pile threads are raised for two and depressed for two picks in alternate succession, and in a reverse manner (in respect of contiguous pile threads), without interlacing those threads, with any intermediate pick or picks of weft for the purpose of binding them more securely to the foundation texture. These threads, therefore, are liable to be accidentally withdrawn very easily in fabrics constructed in accordance with this design. A preferable method of interweaving pile threads is that indicated in the design, Fig. 429, which repeats on six picks, and is also for a reversible pile fabric in which pile threads are raised for two picks and depressed for one pick, or *vice versâ*, thereby securing those threads more firmly to the foundation texture, as indicated in the diagram, Fig. 429. The third design, Fig. 430, also repeating on six picks, is for a fabric in which pile threads are raised for two picks and depressed for one pick uniformly, thereby producing a terry pile surface on one side of the cloth only, as indicated in the diagram, Fig. 431.

The draft, Fig. 425, indicates pile warp threads drawn through four healds, at the front, and ground warp threads through four healds, in the rear, although only two healds are necessary to govern ground threads. Also, both the number and proportion of ground and pile threads in each dent of the reed and also the number of picks inserted between horizontal rows of loops may be varied according to the relative density of pile required, as well as to give additional firmness both to the pile threads and to the foundation texture. Further, decorative effects in the form of check patterns, stripes, and many other simple figured effects may be developed by the use of "fancy" drafts and spaced healds; or more elaborately figured designs may be produced by employing a Jacquard machine and figuring harness.

Practical Details of Terry Pile Weaving.

§ 99. In § 89, reference was made to different optional systems of drafting warp threads through the harness and reed for the production of terry fabrics. In that section, it was also stated

that pile and ground warp threads were sometimes disposed in the harness and reed alternately, and sometimes in alternate pairs, with practically similar results. Theoretically, it would appear that an alternate disposition would ensure a more uniform distribution of each series of warp threads; but on this point there is little, if any, appreciable difference between the two arrangements. In practice, however, an advantage is afforded by the two-and-two over the alternate disposition of warp threads. This arises from the fact that, with such a disposition of the two series of threads, either consecutive pile warp threads or consecutive ground warp threads always interweave in an opposite manner to each other (excepting in the example of five-pick terry fabric just described). Therefore, by placing two warp threads of the same series in the same dent of the reed, they are never either up or down together for the same picks of weft, but always occupy opposite positions; whilst a reed wire separates a pile and ground warp thread that are contiguous, and that are sometimes up or down together at the same time. Hence, these two circumstances conduce to the formation of a clearer warp shed for the passage of a shuttle during weaving.

In the production of terry pile fabrics of strong and heavy textures, such as linen Turkish towels, it is a common practice to employ what is termed a double reed. Such a reed virtually consists of two reeds placed one behind the other, with a space of about $\frac{1}{8}$ in. between them, and constructed in such manner that the wires of one reed are placed exactly midway between those of the other, thereby constituting a compound reed of which the practical counts or sett is equal to twice that of the single reeds. The objects of such a reed are to obtain greater resistance when beating-up weft, and also to gain a little more space for yarn and thereby diminish the abrasive frictional action of the reed upon the warp threads during weaving.

Another practical point in terry weaving relates to the manufacture of those fabrics in which coloured threads are employed for the production of striped counterchange effects, as seen in roller towelling and bordered towels. It is well known to all practical men that however near to the reed the temples are placed, there is a greater or lesser degree of contraction in width at the fell of the cloth. It follows, therefore, that the inward pull of cloth will cause the warp threads to bear on the outer sides of the reed wires around which they bend. For this reason it is found advantageous (when pile and ground warp threads are alternated with each other) to place pile warp threads on the *left*, and ground warp threads on the *right*, between the dents towards the *left-hand* selvedge, and in the reverse order between the dents towards the *right-hand* selvedge, when facing the loom. The object of this arrangement (which is particularly desirable where figured counterchange stripes occur) is to cause ground warp threads, which are taut, to bear against the reed wires, and to allow pile warp threads, which are slack, to lie on that side of ground warp threads nearest the selvedges, and so avoid the risk of pile warp threads being impeded in their passage between the reed wires and ground warp threads.

Loop Pile Fabrics.

§ 100. A variety of looped pile fabrics that are in vogue as ladies' dress materials are formed with a series of loops either sparsely distributed, or arranged in stripes, on the obverse side of the cloth only. These loops are developed by means of extra warp threads, upon a foundation texture of simple construction. The extra warp threads require to be wound upon a separate warp beam, which is very lightly weighted, to permit those threads being freely withdrawn when required to form loops. Fabrics of this class are but very remotely, if at all, related to the more typical varieties of terry pile fabrics described in the previous sections of this chapter, as they neither embody the same principles of construction, nor is it essential to employ a terry pile motion to produce the loops—although loops are sometimes formed in these fabrics by causing the reed to recede for certain picks, and to be held fast in its normal position for others, in a manner similar to that which obtains in terry pile weaving, and as described in § 82, excepting that the liberation of the reed is effected by means of the dobby (if such is employed), or by other improvised contrivance, to save the expense of a loom equipped with a special terry pile motion. The prevailing method, however, of forming loops in this variety of fabrics is

to pass the required warp threads between two cloth-covered tension or delivery rollers which are moved intermittently, in order to deliver uniform lengths of warp according to the size of loops required and to weave without allowing the reed to swing backward at the bottom, from its normal position, as the sley advances to beat up picks of weft, as in ordinary terry weaving by means of a special terry pile motion. In some respects, therefore, this method of producing terry or loop pile in a "fast-reed" loom by the beating-up of each pick of weft in immediate succession, to the "fell" of cloth, possesses certain features in common with Taylor and Dawson's method of producing ordinary terry pile fabrics in "fast-reed" looms, as described in the previous sections, §§ 97 and 98, of this chapter.

CHAPTER IX.

GAUZE AND NET LENO FABRICS.

§ 101. "Gauze" and "leno" are terms which designate different varieties of one of the most interesting types of woven fabrics comprised under the generic term of "cross-weaving". The distinctive characteristic feature of this type of fabrics is the peculiar *crossing of warp threads with each other*, caused by pulling them out of their normal straight and parallel course, first to one side and then to the other side, of other warp threads, which cross and re-cross in some definite order.

Cross-weaving is a useful principle of fabric structure which is adopted extensively in the production of silk, cotton, worsted and linen textures, for almost every variety of purpose, such as garments that are employed as underclothing, curtains, antimacassars, and many other domestic articles. It is also frequently employed in combination with tissue, lappet and swivel figuring (described in Chapter XI.) piqués, and many other types of fabrics. When it is applied to fabrics of an extremely light, open and flimsy texture, and especially if produced from silk, they are usually described as "gauze" fabrics; but if applied decoratively to heavier textures of cotton and linen, they are usually termed "leno" fabrics, of which there are two distinct classes, namely, (1) "net leno," and (2) "leno brocade" fabrics, each comprising several different varieties of texture.

In the weaving trade, however, the terms "gauze," "leno" and "net leno" each denote a distinctive woven effect produced by the application of the principle of cross-weaving. For example, a "gauze" effect is developed by causing one series of warp threads, termed "doup" threads, to form more or less zigzag or wavy lines, whilst another series of warp threads, termed

"regular" or "standard" threads, remain comparatively straight, thereby requiring a separate warp beam for each series of threads

A "leno" effect, however, is developed by causing both "standard" and "doup" warp threads to bend equally, as in "leno brocade" fabrics, therefore requiring only one warp beam to contain both series of threads. Also, in some instances, both "gauze" and "leno" effects are developed in the same fabric, in which case the warp threads require to be wound on at least two separate warp beams to allow for the different rates of contraction during weaving.

"Net leno" fabrics are chiefly produced by means of healds, and are usually characterised by a more or less pronounced striped formation, developed by the introduction of comparatively coarse warp threads, termed "net" warp threads, which usually assume a more or less wavy or zigzag course, and produce a series of "net" leno stripes. Sometimes the vertical stripes are crossed by a series of horizontal stripes to produce "check" patterns. Net leno weaving offers unlimited scope to a capable designer in the production of decorative leno effects, which are frequently of a most interesting and sometimes of a very beautiful and attractive character. And it is, perhaps, not too much to say that no other principle of weaving is capable of yielding such variety of exquisite decorative effects for so small an expenditure of artistic or technical effort.

"Leno brocade" fabrics are those in which the cross or leno principle of weaving is employed as an additional means of embellishment, as described in Chapter X. They are produced by means of Jacquard machines, and generally consist either of a gauze or leno figure surrounded by a ground of the plain or calico weave, or *vice versâ;* and sometimes either the warp, weft, or both are allowed to float where required for the purpose of developing ordinary brocade figuring. An interesting variety of leno brocade fabrics are those in which both leno brocade and also net leno figuring are employed in combination for the development of stripes of each kind arranged either alternately or otherwise. In the production of this variety of fabrics it is usual to employ a compound harness consisting of a Jacquard mounting for the leno brocade stripes, and a heald harness for the net leno stripes.

Plain Gauze.

§ 102. The simplest example of gauze or cross-weaving is that in which one or two warp threads cross each other on successive picks, or pairs of picks, in regular succession so as to produce an open net-like structure of uniform texture, as represented graphically at C, Fig. 432. This diagram indicates the method of drafting warp threads through the healds and reed at A, and the order of shedding at B, to produce the gauze structure represented at C. By studying that diagram in conjunction with those given in Figs. 433, 434 and 435, the principles of cross-weaving, which are generally so puzzling to students, will be easily understood. A shedding harness for cross-weaving, whether it consists of healds or Jacquard mountings, may be constructed optionally on either of two alternative schemes known as a "bottom-doup" or a "top-doup" harness, according to whether the "doup slips" or healds are situated *below* or *above* the warp threads respectively, to be explained presently. A heald harness constructed with a "bottom-doup" arrangement, and also the formation of the sheds for the production of plain gauze, are represented graphically in diagrams Figs. 433, 434 and 435. In those diagrams the healds are shown perspectively, and with the object of making their functions clear and distinct only one heald eye is shown on each heald. Fig. 433 shows all parts in their normal or inoperative position. Warp threads, all of which come from the same warp beam, are separated into two divisions of alternate threads, respectively termed "standard" or "regular" warp threads S, and doup warp threads D.

The essential features of this harness are—a heald G, termed the "front standard," situated immediately in front of all other healds, and a half-heald, termed the "doup heald" H, placed in front of the front standard, and consisting of a number of loops or slips J, termed "doups," of which the upper parts pass *over* the eyes of the "front standard," and return

through them, to prevent their withdrawal. The doups are attached to a single heald-stave H, situated *below* warp

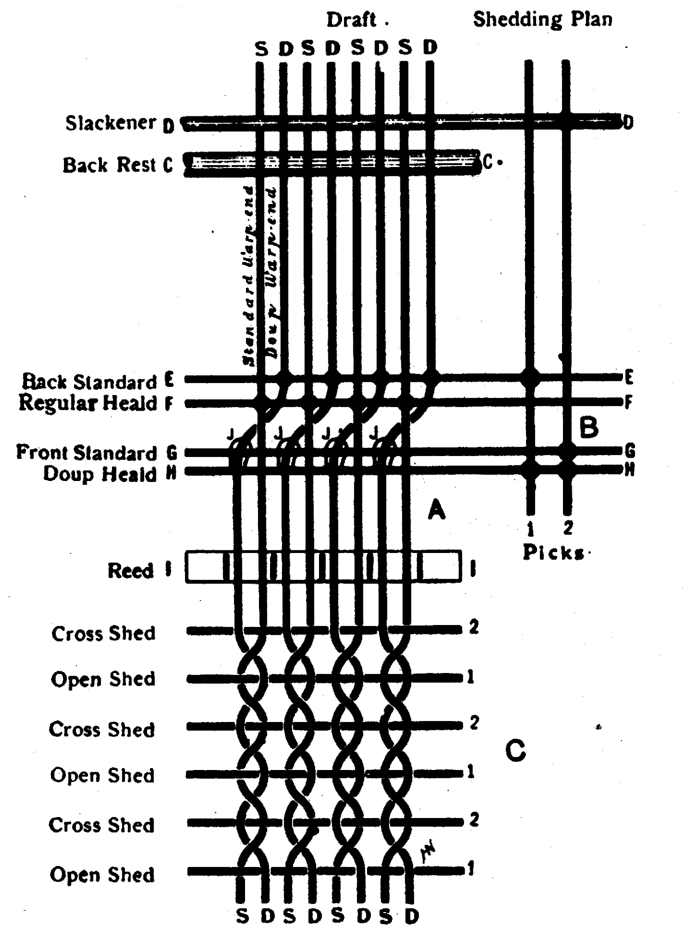


FIG. 432.—Draft (A) and shedding plan (B) for simple gauze (leno) fabric of which a plan is shown at A.

threads; hence the term "bottom-doup" as distinguished from a "top-doup" harness, in which the doups are attached to a stave situated *above* warp threads.

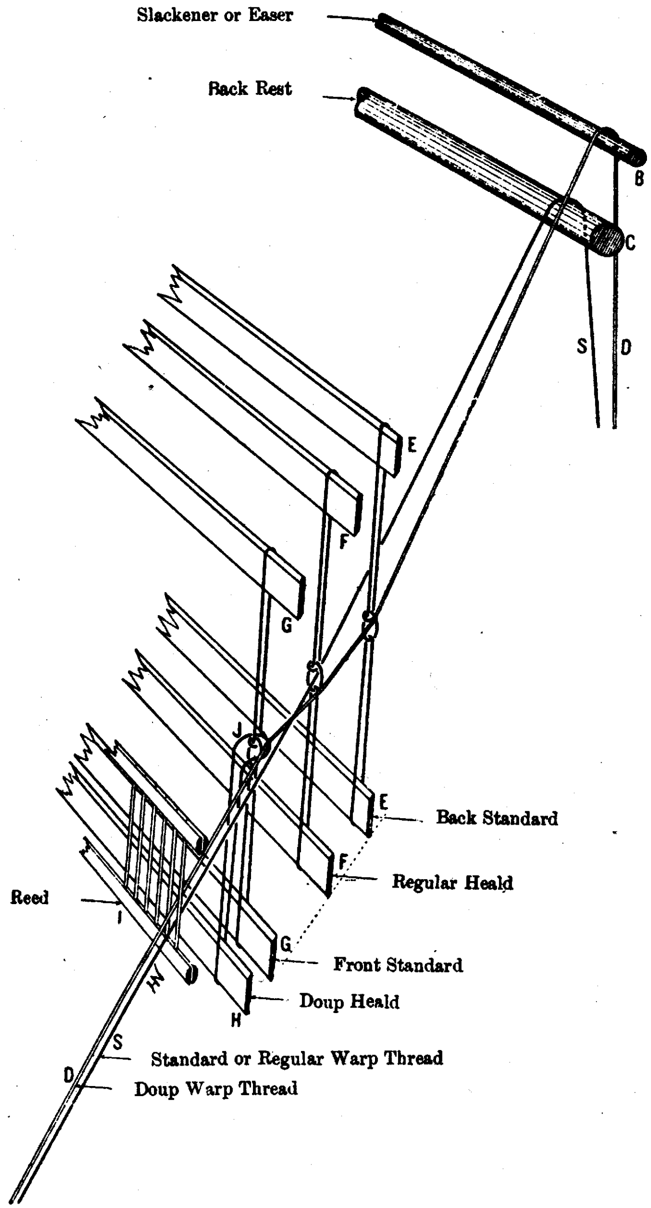


FIG. 433.—Warp shed closed.

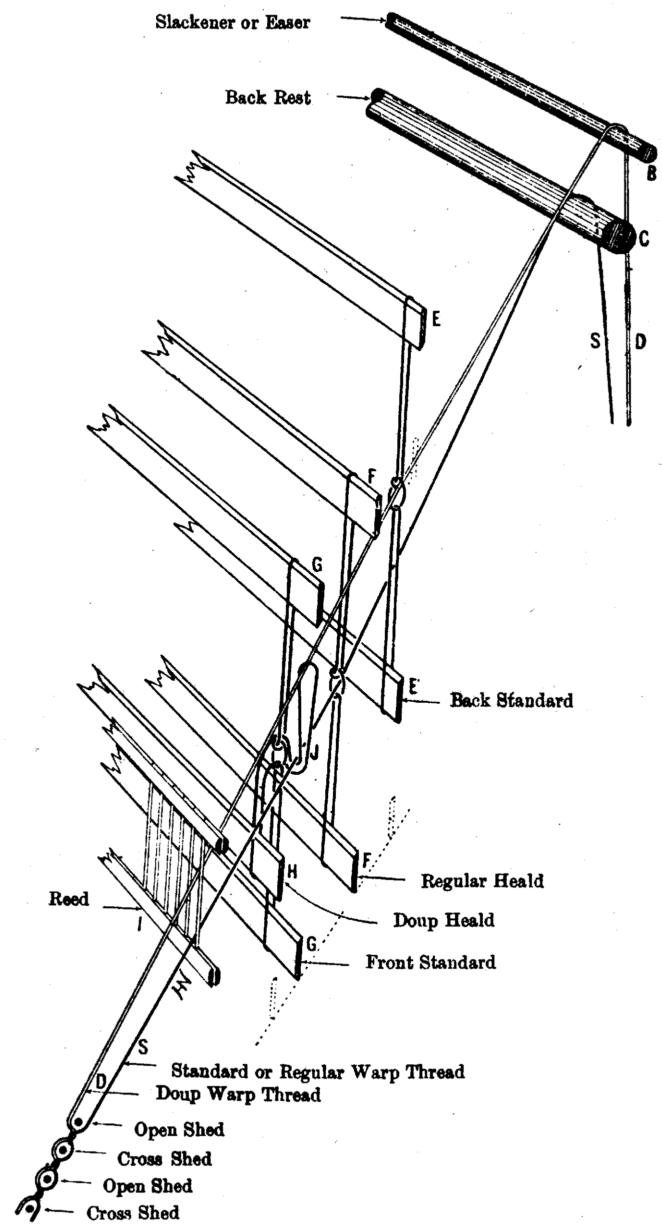


FIG. 434.—Formation of "open" warp shed.

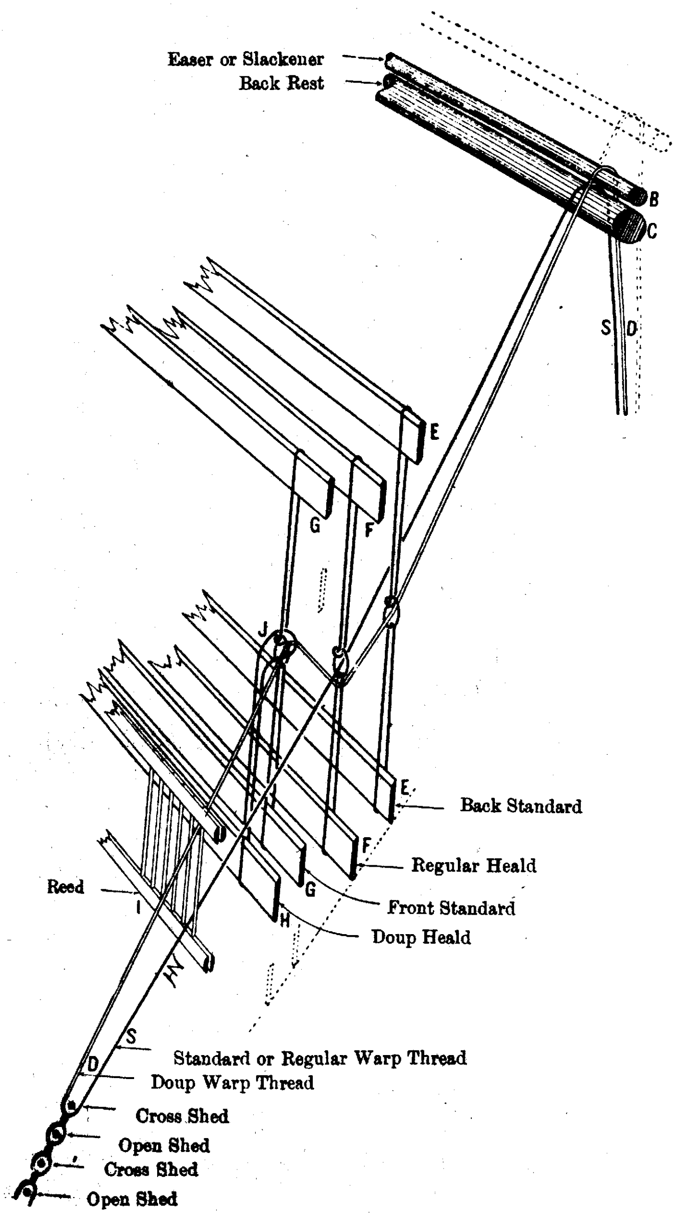


FIG. 435.—Formation of "cross" warp shed.

Standard warp threads pass from the warp beam to cloth in a perfectly straight course, first over the back rest C, thence through the respective eyes of a regular heald F, and through a dent of the reed I. Doup warp threads pass over a bar variously termed the "easer," "vibrator" or "slackener" B, situated a little to the rear of, and in a little higher plane than, the back rest C; thence through eyes of a heald E termed the "back standard". From here they pass *in front* of heald eyes governing standard warp threads, and then cross *underneath* the latter from right to left, after which they pass through a loop J attached to a single heald-stave H (situated *below* warp threads), and finally they pass between the *same dents* of the reed (1) as their fellow standard warp threads.

(NOTE.—In order to prevent confusion of terms, the attention of students is specially directed to the apparent inconsistency in the use of the term "back standard" to describe those healds E which govern doup warp threads when the latter are raised on the normal side of their respective standard warp threads (to form "open" sheds), instead of that term being used to describe the regular healds F which govern standard or regular warp threads. The term "*back* standard," however, is that established by custom to distinguish the healds that are complementary to, and which govern doup threads in conjunction with, "*front* standard" healds.)

§ 103. In the production of a simple gauze texture entirely devoid of figuring, two distinct forms of shedding are required, namely, a straight or "open" shed, and a "cross" shed. A straight or open shed is one in which warp threads are separated without deviating from their normal parallel course. Its formation with a bottom-doup harness (as illustrated in Fig. 434 and indicated in the shedding plan of Fig. 432) is effected by raising both the back standard heald E (which controls "doup" warp threads) and the "doup" heald stave H. By raising the half-heald stave, "doups" J become slackened, and thereby release their control of "doup" warp threads, which are quite free to return from their crossed position on the *left*, to their open or parallel position on the *right* of standard warp threads. Thus by raising the "back standard" E, "doup" warp threads are raised on that side of "standard" warp threads which they occupy before being crossed underneath those threads, without being impeded by the "doup" slips, which, being slack, are taken up by their respective "doup" warp threads.

A "cross" shed is one in which "doup" warp threads are raised on the *opposite* side of "standard" warp threads to that which they occupy in the healds *before* being crossed—that is, on their *crossed* side. Its formation, as illustrated in Fig. 435, is accomplished by raising both the "front standard" heald G and the "doup" heald H together. Unless means were adopted for its prevention, the formation of a "cross" shed would impart abnormal tension to "doup" warp threads, in consequence of the short interval or "stretch" of warp between the "fell" of the cloth and the eyes of heald F, around which "doup" warp threads bend on being raised. Such undue strain is prevented by passing "doup" warp threads over an easing bar or "slackener" B, situated in the rear of the back rest C. By that means "doup" warp threads are allowed a little longer course or "stretch" between the warp beam and "fell" of the cloth. Thus, when a "cross" shed is formed the "easer" or "slackener" is brought forward from its normal position (indicated by dotted lines) to slacken the "doup" warp threads, and thereby prevent undue tension being imparted to those threads. This function is variously described as "easing," "slackening" and "vibrating".

An examination of the gauze structure represented in Fig. 432, and also of Figs. 434 and 435, will show that "standard" warp threads are *never* raised, and that "doup" warp threads are raised for *every pick* of weft inserted—first on the right and then on the left of "standard" warp threads alternately. That peculiarity, however, is characteristic of plain gauze-weaving only, and not of cross-weaving generally; otherwise the development of figuring (as exemplified in "net leno" and "leno brocade" fabrics) could not be accomplished. In those fabrics all warp threads, whether "standard" or "doup" threads, may be raised as desired to produce any ordinary woven effect in combination with cross-weaving, and their construction is governed by the same general principles as those underlying the construction of simple gauze.

"Cellular" Gauze Fabrics.

§ 104. An example of gauze cloth, which is sold under the trade name of "cellular" cloth and employed extensively in the production of light summer garments for underclothing, is that represented in Fig. 436, and of which the plan of cloth drafting chart and shedding plan are indicated at A, B and C respectively, Fig. 437. The distinctive feature of fabrics of this class, of which there are several modifications, consists essentially of a more or less pronounced cellular diamond formation which

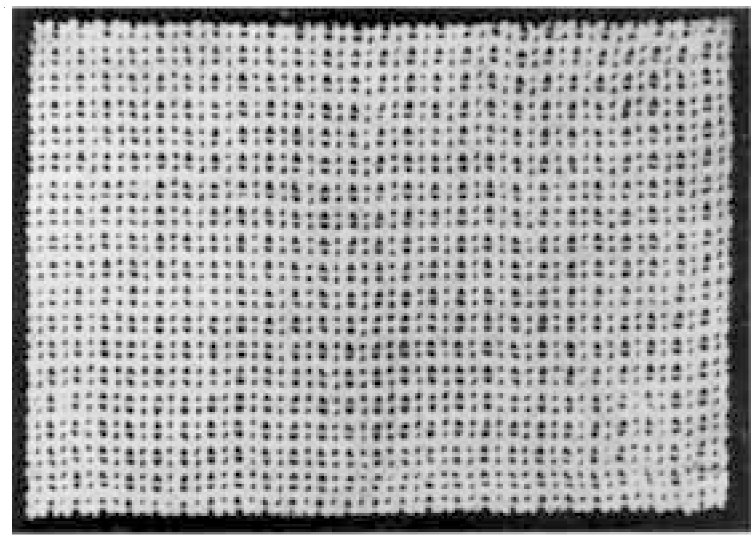


FIG. 436.—"Cellular" gauze or leno fabric.

results chiefly from the difference of tension between the "standard" and "doup" series of warp threads during weaving in conjunction with the principle of cross-weaving, thereby necessitating the employment of a separate warp beam for each series of threads. Thus, standard warp threads are taut and therefore lie in comparatively straight and parallel lines, whereas doup warp threads are slack and assume more or less zigzag or wavy and opposing lines, thereby producing in the fabric the characteristic cellular formation as described.

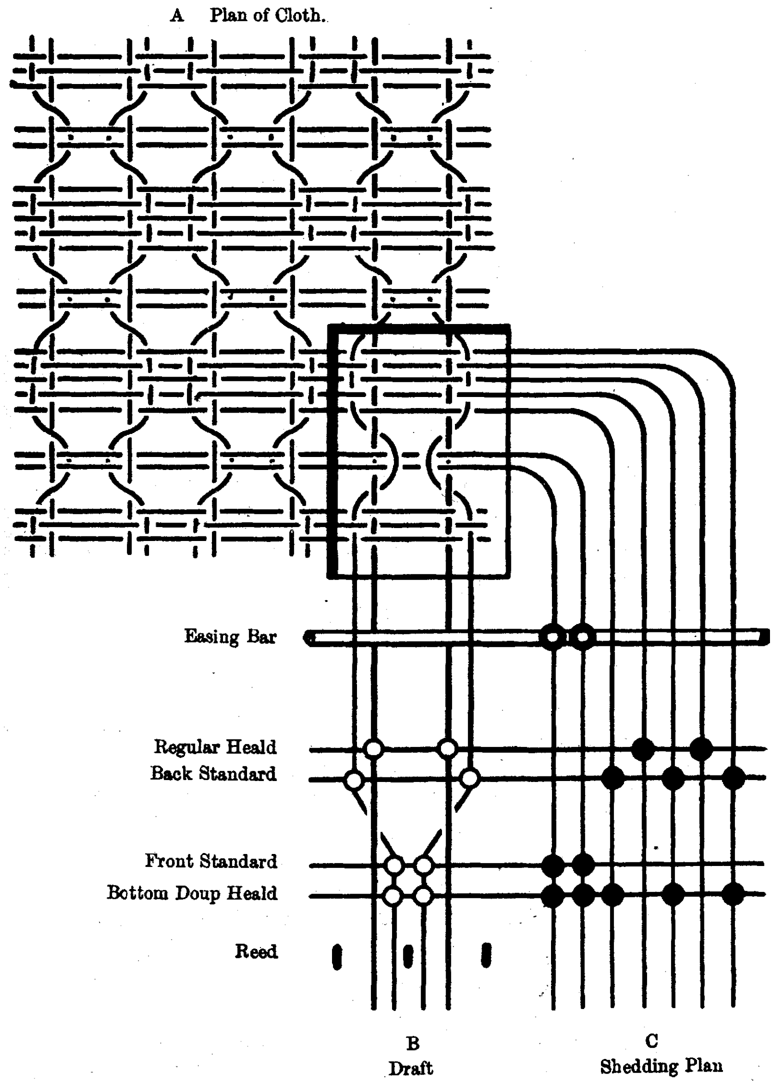


FIG. 437.—Plan, Draft and Shedding Plan of "Cellular" Cloth, Fig 436.

For practical considerations, it is more expedient to weave fabrics of this character with the face side downward, in order to minimise the effort of shedding during weaving. This course involves the use of a *bottom-doup* harness, as indicated in drafting chart B and shedding plan C, Fig. 437, which has the disadvantage of presenting the reverse side of the cloth to the weaver, whereby faults are more liable to escape observation during weaving.

The example of cellular gauze cloth illustrated in Fig. 436, and also the plan of that cloth, A, Fig. 437, are both represented obversely, but with the lower right-hand corner of the plan reversed, as seen in the loom. This sample, which is of a fairly good quality of texture, contains fifteen of each series of warp threads, per inch, of 2/16's and 2/18's counts of yarn for standard and doup threads respectively; and fifty picks, per inch, of 2/24's weft. The rate of contraction, during weaving, by standard and doup warp threads, is, in the present example, equal to fifteen and thirty-three per cent respectively of the original warp length on the beam.

Net Leno Fabrics.

§ 105. In the production of typical net leno fabrics (as exemplified in the accompanying photographic reproductions), the number of doup healds, front standard healds, back standard healds, easers or slackeners, and extra warp beams containing the net doup threads, must severally correspond with the number of different schemes of douping in the same fabric. Thus, if all doup warp threads in a piece of cloth cross their standard threads either in the same direction or in reverse directions simultaneously, only one doup heald and one each of the other several parts just enumerated would be required for its production. The direction in which doup threads cross is quite optional. They may cross uniformly either in the same direction, or in reverse directions simultaneously, as predetermined by the manner in which they are crossed in the shedding harness before being passed through their respective doup slips. If they are crossed over (in the harness) in the same direction uniformly, they will all cross in the same direction simultaneously, in cloth, as exemplified in the second net leno stripe B, Fig. 442; but if some doup threads are crossed over to the right, and others to the left, of their respective standard warp threads, they will always cross in reverse directions in cloth. Thus, by drafting alternate doup threads in one direction, and intermediate threads in the opposite direction, a neat diamond formation may be produced, as exemplified in the net leno stripe A, Fig. 438, which illustrates an example of net leno

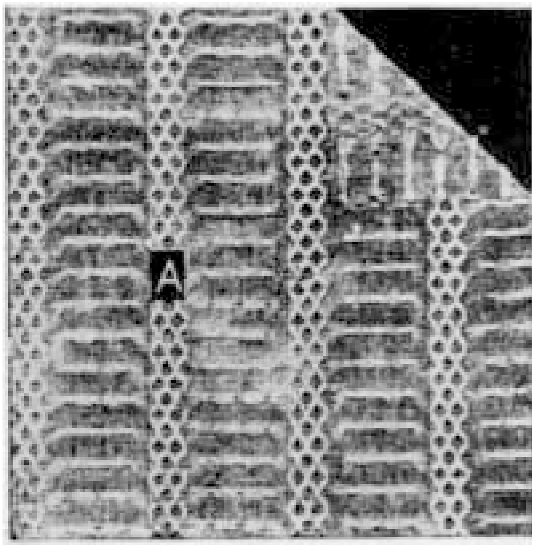


FIG. 438.—One-doup net leno fabric, for which the design, draft and shedding plan are given in Fig. 439.

weaving produced by means of only one set of doups operating in conjunction with one back standard heald.

For reasons stated subsequently in § 120 (in which the relative merits of a *top* and a *bottom*-doup harness are compared), it is usual to weave net leno fabrics with a *top*-doup harness. For this reason, the "drafts" and shedding plans, for the samples of leno fabrics represented in the accompanying illustrations, are adapted for top-doup harnesses. With such a harness, the conditions of shedding which obtain in respect of a bottom-doup harness, as

explained in § 103, are simply reversed, just as if a bottom-doup harness were inverted. By inverting the diagrams representing a bottom-doup harness, given in Figs. 433, 434 and 435, and also by reversing the shedding plan given in Fig. 432 (except that representing the easer), the conditions of a top-doup harness will be faithfully represented (excepting that, being ink lines drawn on paper, and not actual threads, the relative positions of standard and doup warp threads remain the same, whereas doup warp threads should cross over the *top* of standard warp threads). Thus, an open shed is formed with

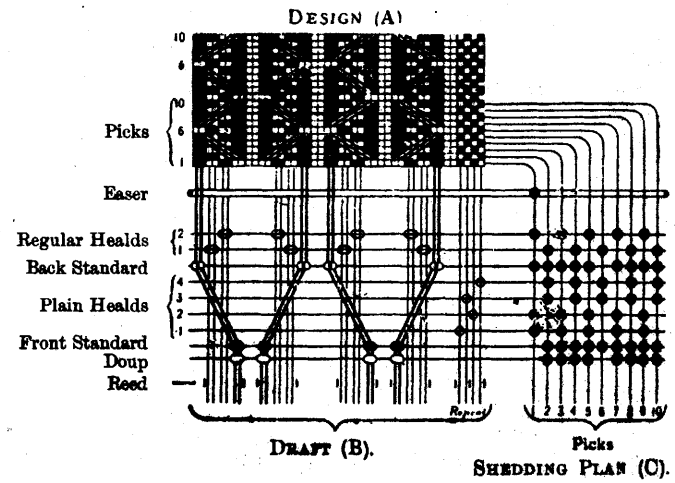


FIG. 439.—Design, draft and shedding plan for net leno fabric, Fig. 438.

a top-doup harness by raising the heald governing standard warp threads, and also the front standard; and a cross shed is formed by raising the back standard controlling doup warp threads, and also the heald governing standard warp threads, and, at the same time, slackening doup warp threads to prevent excessive strain upon them.

§ 106. Fig. 438 represents an example of net leno weaving by means of only one set of doups. In this example, a net leno stripe is developed at regular intervals, from four pairs of white doup warp threads drafted to the right and left alternately, of their respective standard warp threads, which latter consist of fine threads taped in pairs. The intervening stripes consist of the plain or calico weave, on which a spotted effect is developed by means of extra picks of coarse white weft. These float loosely underneath the leno stripes, whence they are subsequently cut away, as seen in the corner turned down. The design, with the draft and shedding plan for that cloth, are respectively indicated at A, B and C, in Fig. 439. (Horizontal lines in the drafts and

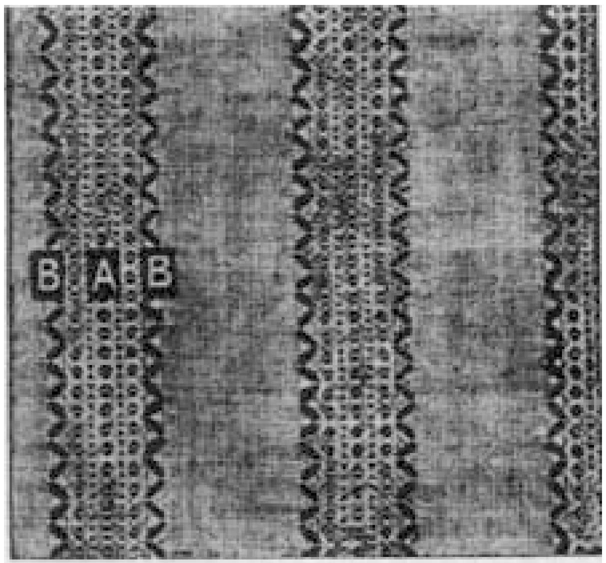


FIG. 440.—Two-doup net leno fabric, for which the design, draft and shedding plan are given in Fig. 441.

shedding plans represent healds; vertical lines in the drafts represent warp threads; and a circle placed on an intersection of a warp thread and heald indicates that such warp thread is drawn through such heald. Vertical lines in the shedding plan represent picks of weft; and a black spot placed on an intersection of a heald and pick signifies that such heald is raised for such pick.) For simplification of the shedding plan, the spotting with extra weft, in the present example, is left out of consideration. By carefully studying the design, draft and

shedding plan of each of the accompanying examples of leno fabrics their construction will not be very difficult to under-

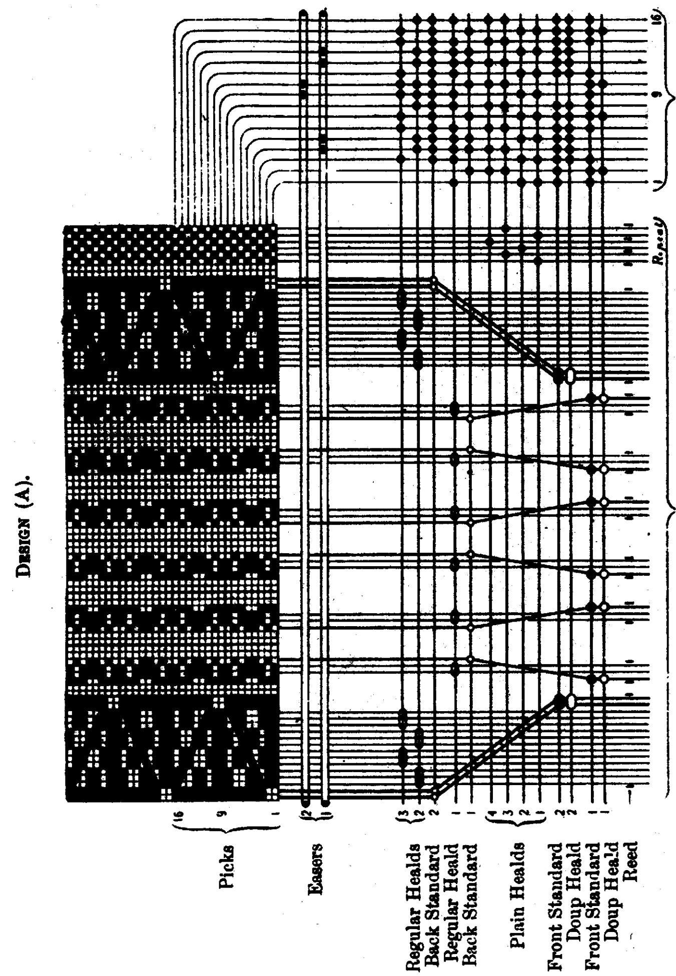


FIG. 441.—Design, draft and shedding plan for net leno fabric, Fig. 440.

stand. The operation of the healds for each pick of weft may be seen by tracing them individually from the design to the shedding plan.

For the general guidance of students it may be stated that with a top-doup heald harness, a cross shed is formed (in respect of any one series of doup threads) by raising standard and doup warp threads together, by means of their respective regular healds and back standards, whilst the same doup threads are held down in front by means of their front standard and doup healds; at the same time, doup warp threads are slackened by

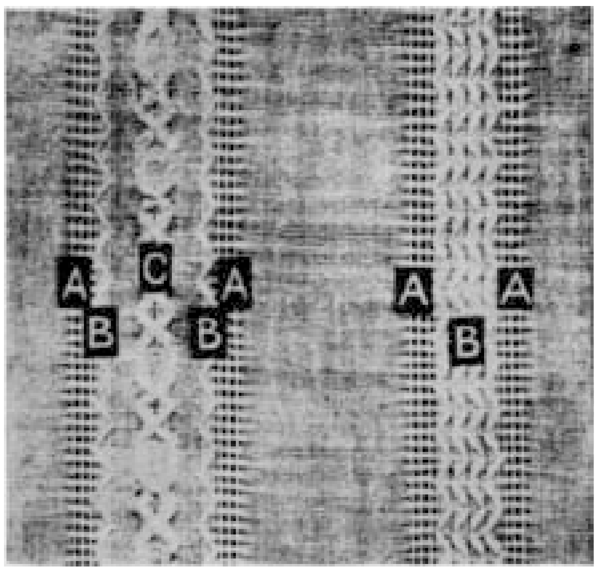
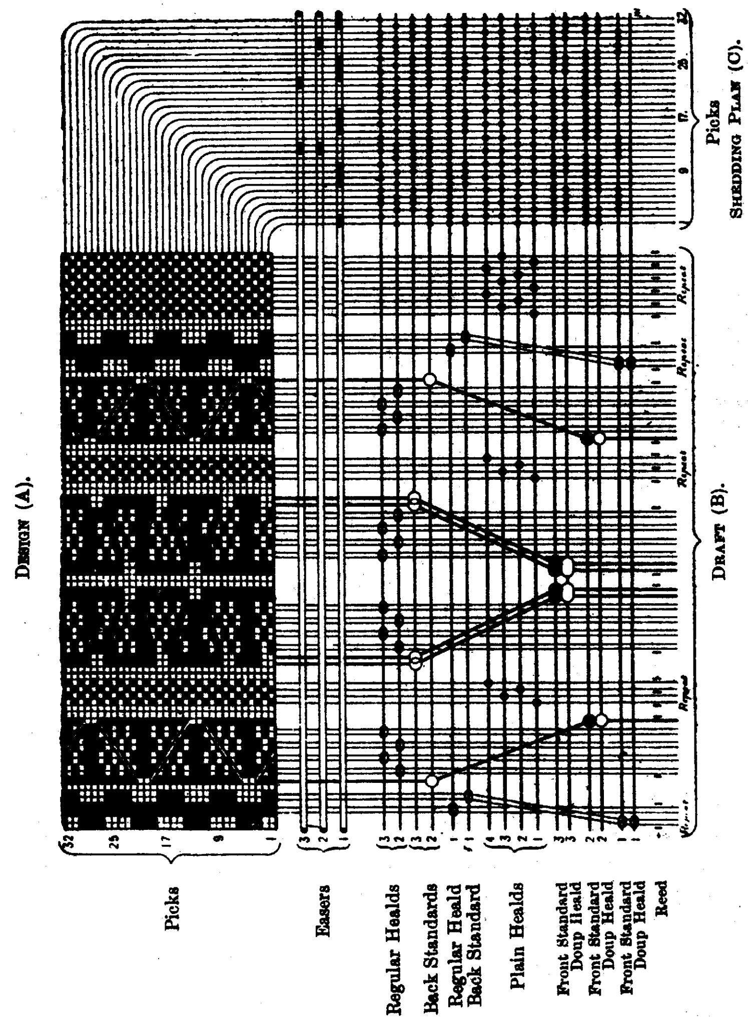


FIG. 442.—Three-doup net leno fabric, for which the design, draft and shedding plan are given in Fig. 443.

means of their easers, to prevent undue strain upon them whilst making a cross shed. An open shed is formed by raising front standards (as indicated by shaded squares in the designs), with such standard warp threads as are required, and, at the same time, leaving doup healds down. (The object of raising a front standard heald without its corresponding doup heald is to liberate doup warp threads so that they may return to the normal side of their respective standard warp threads.) When a doup thread is required at any time to pass over one or more than one pick

of weft, it must be raised for such pick or picks by means of the front standard and doup healds, as well as by the back standard heald, *both at the same time*.



§ 107. On examining the accompanying drafts it will be observed that the dents of the reed are not of uniform width, and also that some dents are left empty. It frequently becomes necessary to remove reed wires in order to obtain wider dents to receive doup and standard warp threads—when these are in such quantity as to prevent their free movement or passage (during shedding) within a dent of normal width, which would chafe and break them as the sley oscillates to and fro. Also,

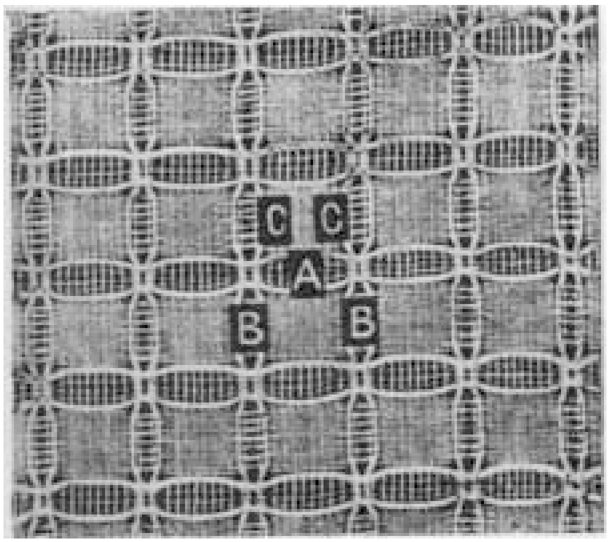


Fig. 444.—Three-doup compound net leno fabric, for which the design, draft and shedding plan are given in Fig. 445.

dents of the reed are sometimes left empty to permit of net doup threads spreading in cloth, and also to accentuate the perforations characteristic of many leno effects, as exemplified in stripes A, Fig. 440, and stripes B, Fig. 444.

Fig. 440 illustrates an example of a two-doup net leno fabric, of which the design, draft and shedding plan are given in Fig. 441. One set of doups are required to produce stripes A, and another set to produce stripes B. Stripes A consist of a neat open network, caused by the reverse drafting of six doup threads,

each of which crosses to taped standard warp threads. Stripes B consist of a pair of doup threads, which cross over twelve standard threads (taped in threes) to produce a continuous wave line.

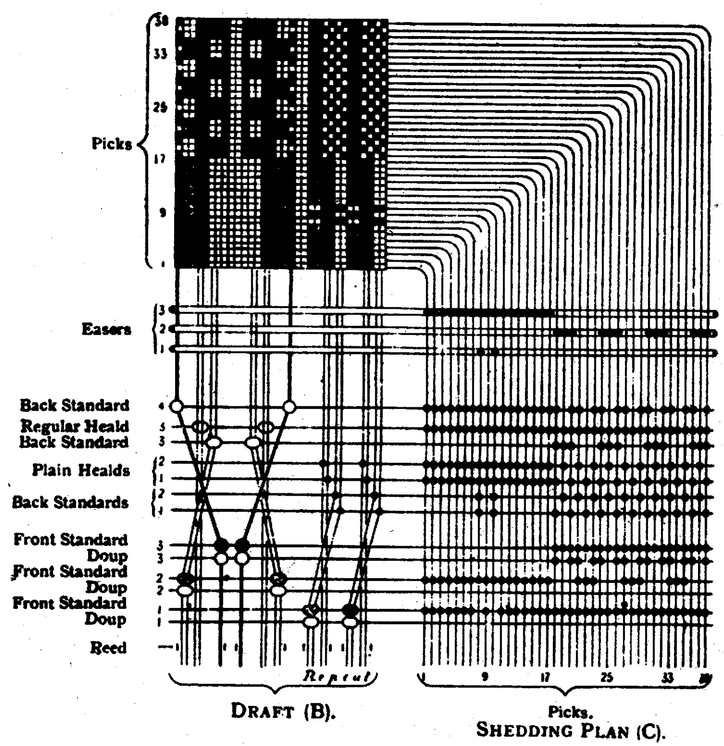


Fig. 445.—Design, draft and shedding plan for compound net leno fabric, Fig. 444.

Figs. 442 and 444 illustrate examples of leno fabrics, each requiring the use of three sets of doups to produce net stripes A, B and C respectively. That number of doups is rarely exceeded in one loom, owing to the complications to which they give rise by the addition of numerous accessories, and the difficulty of obtaining good and clear warp sheds during weaving. The construction of the fabric represented in Fig. 442 is clearly indicated in the accompanying design, draft and shedding plan (Fig. 443), which it will well repay a student to carefully investigate.

Fig. 444 is a check leno fabric of special interest, inasmuch as it embodies an uncommon feature in leno weaving. This consists of a compound leno effect produced by causing a thick net doup thread to cross from side to side of other doup and standard threads, which, combined, constitute the standard threads for that net doup thread. By carefully examining the design, draft and shedding plan (Fig. 445) for that cloth, and following the operation of the healds for each pick of weft, its construction will be easily understood. The same course should be pursued with each of the preceding examples, paying special attention to the method of drafting, and the operation of doup healds, front and back standard healds, and easers.

Gauze and Net Leno Figuring by Means of Several Back Standard Healds to each Doup Heald.

§ 108. In § 105 it was stated that, for the production of *typical* net leno fabrics, as represented by the foregoing examples, the number of doup healds, front standards and certain other essential equipments of a leno loom, must necessarily correspond with the number of different schemes of interweaving the respective doup threads in the same fabric; and, also, that the number of doup healds in one loom rarely, if ever, exceeds three. Under certain conditions, however, it is possible to develop gauze and leno effects of a more or less ornate character by means of only *one* doup heald, and *one* front standard that operate in conjunction with any practicable number of back standard healds to govern doup warp threads, and with a corresponding number of regular healds to govern standard or regular warp threads. Or, the scope of this type of leno harness may be increased by employing more than one doup heald, each to operate in conjunction with a distinct set of back standard healds of any practicable number. It is doubtful, however, if more than two doup healds could be satisfactorily

employed with this arrangement of doup harness. Patterns developed by this system are frequently so elaborate as to give the impression that they have been produced either by a Jacquard machine, or else by quite an impracticable number of doup healds.

Of course this system of leno weaving imposes certain limitations in respect of the style or character of "douping" that are not existent with the use of independent doup healds. For example, *all doup warp threads* must necessarily cross from the normal or open side to the crossed side of their respective standard warp threads *simultaneously, since they are all controlled by the same doup heald*; but they may be raised either on the normal or open side of standard threads, or left down (on certain picks only) in practically any pre-determined manner. The system also virtually demands the crossing of warp threads in some definite and uniform manner at regular intervals of picks. Indeed, in one variety of this class, in which single threads cross each other to form a true gauze figure on a ground of the plain weave, or *vice versâ*, such conditions are inevitable; but in another variety, in which comparatively thick net doup threads are introduced solely as a means of embellishment, the restrictions are not quite so limited.

Leno fabrics of the class under present notice are of three distinct varieties, namely: (1) those in which a gauze figure is surrounded by the plain or tabby weave (or *vice versâ*), and in which warp threads cross each other as single threads, with one pick in each shed, as illustrated at C, Fig. 446; (2) those in which either warp or weft is allowed to float freely (for the development of brocade figuring), but which in all other respects are like (1); and (3) those in which *net leno* figuring is developed by means of thick net doup threads upon a comparatively light ground texture, preferably of the plain calico weave.

Although it is for many reasons (as explained subsequently in § 120) more expedient to weave *net leno* fabrics of the ordinary type by means of a *top-doup* harness, that arrangement is perhaps not so well suited as a bottom-doup harness to the production of the class of leno fabrics under present consideration,

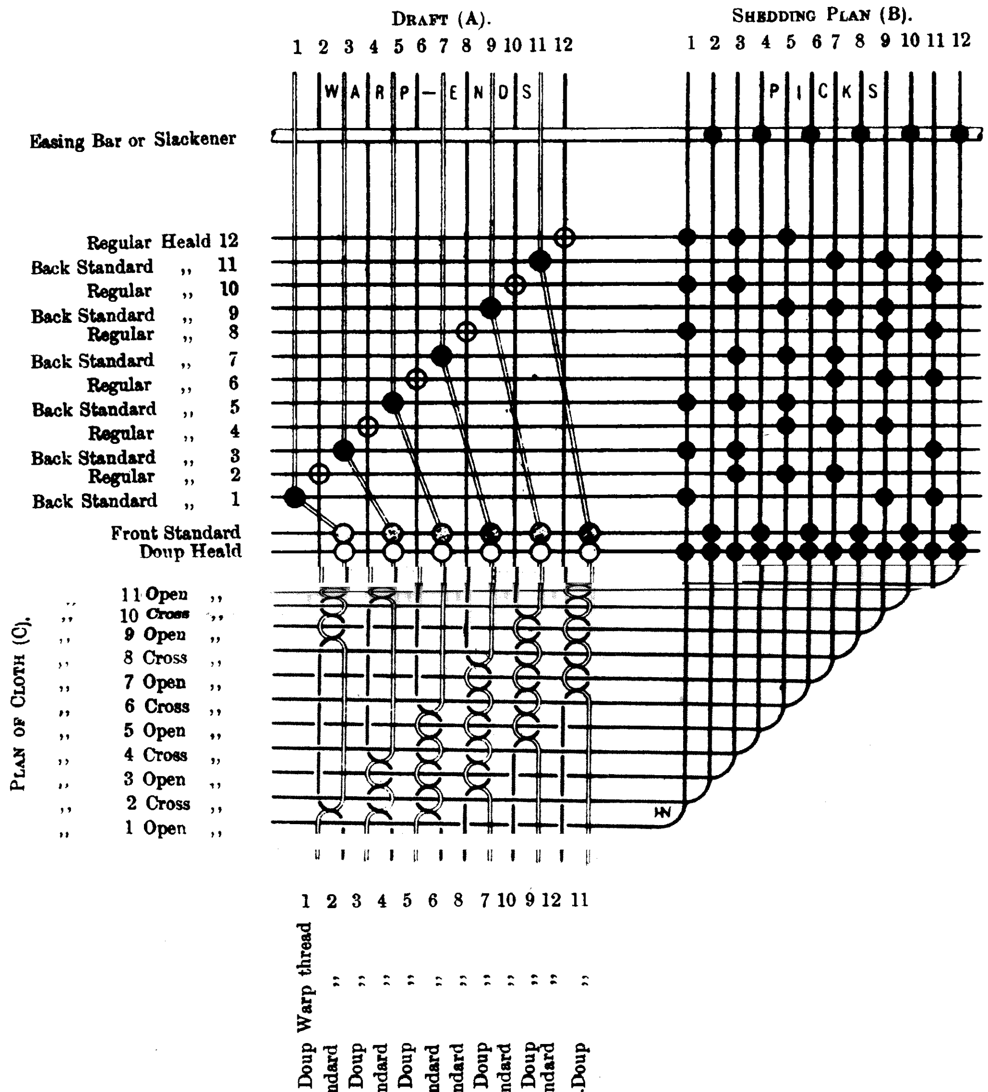


FIG. 446.—Graphic diagram demonstrating the production of figured gauze and leno fabrics by means of one doup and one front standard heald operating in conjunction with more than one back standard heald. The shedding plan (B), with the draft (A) would develop the pattern represented in the plan of cloth (C), and of which the design is indicated in Fig. 447.

chiefly because the formation of a cross shed with a harness of this type would require *all healds* (excepting the front standard and doup healds) to be raised. Still, when that course would not involve excessive straining and risk of breakage of mechanical parts, nor absorb an abnormal degree of motive power, it would be advisable (if other circumstances were favourable) to employ a top-doup harness in preference to a bottom-doup harness. It should be carefully observed, however, that the accompanying drafts and shedding plans for this variety of leno fabrics are all arranged for *bottom-doup* harnesses.

§ 109. The construction of the first-named variety of this class of fabrics is illustrated in Fig. 446, where A and B respectively show the method of drafting and shedding to produce cloth represented at C, in accordance with the design given in Fig. 447. This is a simple pattern, repeating on twelve warp threads and picks, developed by alternating diagonal bands of the gauze and calico weaves, and will serve to demonstrate the principles on which they are designed and woven.

As indicated in the draft at A (Fig. 446) warp threads are drawn through twelve healds with a straight-over draft. After passing through those healds in regular succession, alternate warp threads, that are passed over an easer, are taken as doup threads (represented by white lines), which, after crossing *underneath* from left to right of the intermediate warp threads (which become standard threads, represented by black lines), are passed through the loose slips of the doup or half-heald which hang underneath warp threads, as previously described and illustrated in § 102. Thus: healds Nos. 1, 3, 5, 7, 9, 11 become back standards to govern doup threads; whilst healds Nos. 2, 4, 6, 8, 10, 12 are regular healds to govern standard warp threads.

§ 110. It is characteristic of this particular variety (1) of leno fabrics that *all* doup threads, and those only, are invariably raised by the front standard and doup healds for alternate (say even-numbered) picks to form cross sheds; but both doup *and* standard threads may be raised for intermediate (or odd-numbered) picks to form open sheds, according to the pattern required; care being taken not to raise, *at the same time*, fellow doup and standard threads that cross each other, and pass through the

same dent of the reed. Thus, where it is required to form gauze, doup threads are raised by their respective back standards; whilst in the calico portion standard threads are raised by their respective healds *for odd numbered picks only*. The operation of healds in this manner gives rise to a peculiar phenomenon in cloth which is, at first, very puzzling to those who are more or less intimately acquainted with leno fabrics constructed in the usual manner. An examination of the plan of cloth will show that doup threads *appear to form an open shed* when raised on the *right* of their respective standard threads, whereas they are actually forming a cross shed, and *vice versâ*. This apparent anomaly arises in consequence of employing only one doup heald *which must rise for alternate picks* to develop the plain weave in observance of the principles governing the construction of these fabrics. It should also be observed (*a*) that the easer must slacken doup threads whenever both front standard and doup healds are raised together to form a cross shed —that is, on alternate picks; and (*b*) that the doup healds must lift *without* the front standard on intermediate picks. The reason for raising the doup heald without the front standard, when an open shed is formed, is to liberate *all* doup threads, and permit of the required doup threads being raised on the normal side of their respective standard threads by means of their back standard healds. The reason will now be manifest why a bottom-doup harness is preferable to a top-doup harness for weaving these fabrics. If the latter were employed to weave the design indicated in Fig. 447, the shedding plan B (Fig. 446) would require to be entirely reversed in all parts excepting the easer, and such a course would involve much greater power for shedding.

The chief considerations affecting the construction of these fabrics are clearly indicated in the plan of cloth at C, which should be carefully studied in conjunction with the design (Fig. 447), draft at A, and shedding plan at B. This may best be accomplished by comparing each pick of weft, in the design, with the corresponding picks in the shedding plan; and by tracing the lines (representing picks) from the shedding plan to the corresponding picks of weft, in cloth, and thereby trace the cause to the effect. The preparation of designs for these fabrics will be greatly facilitated by using design or point paper on which the narrow divisions, in one direction, are ruled off in pairs, with lines of medium thickness, as seen in Fig. 447. The two narrow divisions between two medium lines correspond to a doup warp thread and its fellow standard warp thread that cross with each other and pass through the same dent of the reed. Such a course will reduce the risk of a designer inadvertently raising

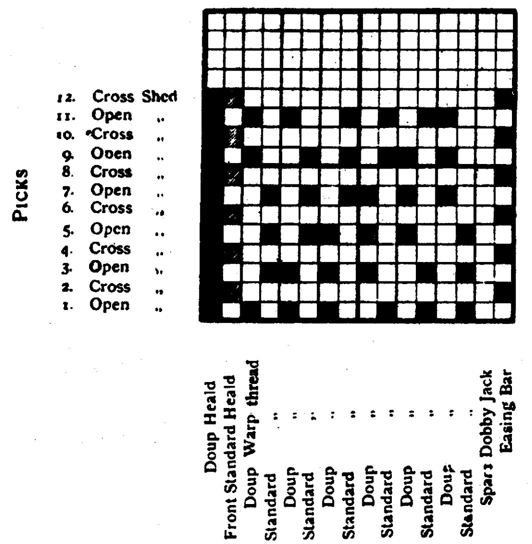


FIG. 447.—Design for pattern represented in graphic plan of cloth (C), Fig. 446.

two fellow warp threads at the same time, which would not be in strict accordance with the principles governing this particular variety (1) of the class of fabrics under present consideration.

§ 111. In §§ 108 and 109 it was described how the simple gauze and plain calico weaves could be combined to develop simple figured effects by means of only one doup heald and a front standard heald, operating in conjunction with several back standard and regular healds, to produce the first-named variety (1)

of this class of leno fabrics, as illustrated in Fig. 446. The second variety (2) of this class is characterised by *warp-float* figures on the obverse side, and *weft-float* figures on the reverse side of cloth (when in the loom), either in combination with the simple gauze weave only, or with both that and the plain calico weave. It should be noted, however, that in observance of the principles governing the construction of these fabrics, *doup* warp threads may only be allowed to float on that side of their fellow standard warp threads to which they have been crossed in the shedding harness, and *not* on the normal or open side of those threads. The reason for this will be understood when it is remembered that all doup warp threads must necessarily be raised on their crossed side of standard warp threads by means of the front standard and doup healds, for alternate picks of weft, as required for the development of the gauze and plain weaves; but where warp figure is required, standard warp threads also may be raised in those parts for the same picks. For the intermediate picks, therefore, *doup* warp threads must be *raised* in the float or brocade figure and gauze portions only, by means of their respective back standard healds; but they must be *left down* in the *plain weave;* also, *standard* warp threads must be *raised* in the brocade figure and plain weave portions only, but *left down* in the *gauze* portion, for the same picks. When those picks are inserted the doup heald is raised, in order to liberate *all* doup warp threads, and permit such as are required up to be raised by their respective back standard healds. It should be explained that, although doup warp threads may be raised (for the intermediate picks) on the normal side of standard warp threads by means of their back standard healds, in order to develop brocade figuring, they will not remain on that side in the cloth, but will be pulled to the crossed side (when raised for the alternate picks) by means of the front standard and doup healds, and permanently remain there, as described in § 110. Doup threads are enabled to return to their crossed side in the brocade figure portions, in consequence of both standard and doup warp threads being *raised together* in those portions, and not intersecting with weft. When preparing designs for this variety of leno fabrics, it is advisable, in order to obtain the best results, to always separate warp figure from gauze by a margin of the plain or calico weave, as illustrated in the design, Fig. 448, in which shaded squares represent the gauze weave. The shedding plan for that design, given in Fig. 449, is adapted for a bottom-doup harness similar to that represented in diagram, Fig. 446, but consisting of eight back standard and eight regular healds. with a front standard and a doup heald, and an easing bar. By studying Figs. 448 and 449 in conjunction with that diagram, the foregoing description will be more easily comprehended. It should be observed that these two varieties of leno fabrics impose certain restrictions with regard to the method of drafting warp

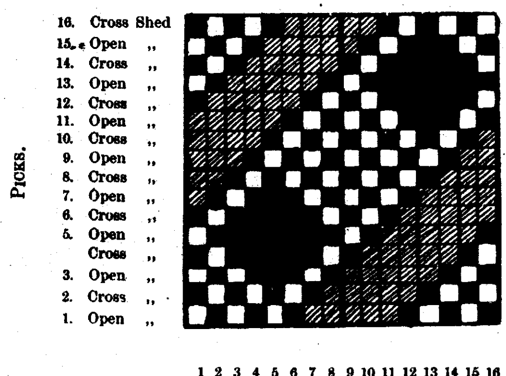


FIG. 448.—Design for figured gauze fabric for which the shedding plan is given in Fig. 449.

threads through the healds, namely: Doup and standard threads must be arranged in the harness *alternately* with each other, and with doup threads crossing their fellow standard threads uniformly in the same direction, when passing from their respective eyes in the back standard healds to their appointed doup slips in the doup heald. These conditions are necessary in order to effect the combination of true gauze with the plain or tabby weave, which characterises these fabrics. Also, their construction does not permit of the employment of "pointed" or "centred" drafts that are obtained by simply reversing in the usual manner. This arises in consequence of warp threads being in *pairs*, each of which consists of a doup and a standard

thread that are complementary to each other and operate in conjunction in the gauze and calico portions of the fabric, and not as independent threads.

§ 112. By far the most useful and interesting variety of this type of figured leno fabrics is that constituting the variety (3), in which "net leno" figuring is developed upon a comparatively light muslin texture, as exemplified in the accompanying reproductions of cloth (Figs. 450, 452, 454). This variety (3) of leno fabrics is of a distinctly different character from any

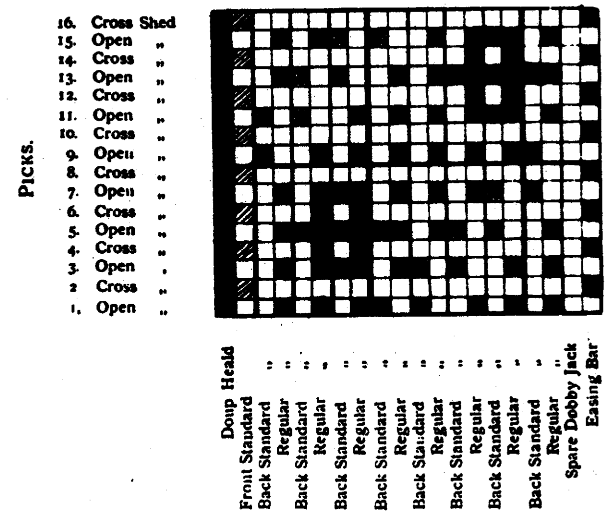


FIG. 449.—Shedding plan for design Fig. 448.

that have been previously described, and affords much greater scope to a designer in the production of decorative effects. Also, it imposes fewer restrictions in the construction of designs than are imposed by the varieties of one-doup leno fabrics (1 and 2). This arises from the employment of comparatively thick "net" doup warp threads for figuring purposes only. These work quite independently from the fine ground warp threads, and play no part whatever in the construction of the foundation texture. They may, therefore, be employed in greater or lesser numbers in relation to ground warp threads, and may be disposed either in groups to produce stripes (as in Fig. 450), or at regular intervals and short distances apart, for the development of all-over patterns. All doup warp threads are controlled by one doup heald and a front standard heald (for the formation of cross sheds) and such number of back standard healds (to form open sheds) as corresponds with the different orders of interweaving doup threads with the ground texture. It is imperative, therefore, that doup warp threads must "doup," *i.e.*, be raised

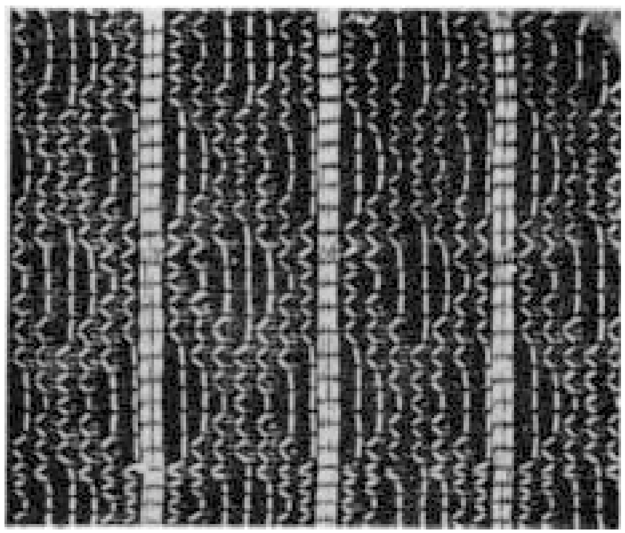


FIG. 450.—Net leno fabric woven by means of one doup and one front standard heald, and four back standard healds, for which the design, draft and shedding plan are given in Fig. 451.

on their crossed side to form cross sheds *simultaneously*, although they may be either raised or left down by their respective back standards, for the open sheds; hence, only one easing bar is required to slacken all doup warp threads simultaneously during the formation of cross sheds. Provided designs are constructed to ensure a uniform rate of contraction by all doup threads, the latter may be contained on one warp beam; but if their rate of contraction varies, they will require to be wound upon separate beams, according to the different rates of

contraction. Ground warp threads are governed by healds placed in the rear of back standard healds, and are contained upon a separate warp beam.

Doup threads may be crossed under their respective standard or ground warp threads (in the shedding harness) in almost any desired manner, either in the same direction, uniformly, or in reverse directions, as required. In the example of cloth represented in Fig. 450, white mercerised doup threads of twofold yarns are arranged in groups to form stripes. Each group consists of seven pairs of threads, all of which cross their standard warp threads in the same direction in the harness, with each pair of doup threads crossing three pairs of black ground warp threads that are intersected with black weft to produce a light muslin foundation texture. The leno stripes are separated by a white stripe composed of four pairs of white mercerised threads of the same material as doup threads.

The method of designing and drafting for this variety of leno fabrics is demonstrated in Fig. 451, which shows the design, draft and shedding plan at A, B and C respectively, for the production of the example of cloth represented in Fig. 450. The pattern repeats on sixty-three warp threads (counting each pair of white mercerised threads as one) and sixty picks of weft. Warp threads would require to be wound upon three warp beams, namely, one for ground threads, one for doup threads and one for the white threads to form the narrow stripes. The shedding harness comprises a doup and a front standard heald, four back standard healds, two healds to govern ground warp threads, two healds to govern black warp threads to weave plain cloth in the narrow stripes, and one heald to control the threads forming the narrow white stripes.

§ 113. It is important at this particular stage to inform readers that if net leno fabrics are produced by means of a *bottom-doup* harness, they will be woven face downward. This warning is necessary to prevent confusion by the apparent inconsistency between the specimens of cloths, as here represented, and their respective designs, which latter, being prepared for bottom-doup harnesses, represent the reverse side of those cloths. The dotted lines on the design (Fig. 451) are not essential to its construction, but are merely introduced to indicate doup warp threads as they will appear on the *face* side of cloth, so that their working may be easily followed. On examining that design and shedding plan, it will be seen that a cross shed is formed for two consecutive picks out of every six, by raising

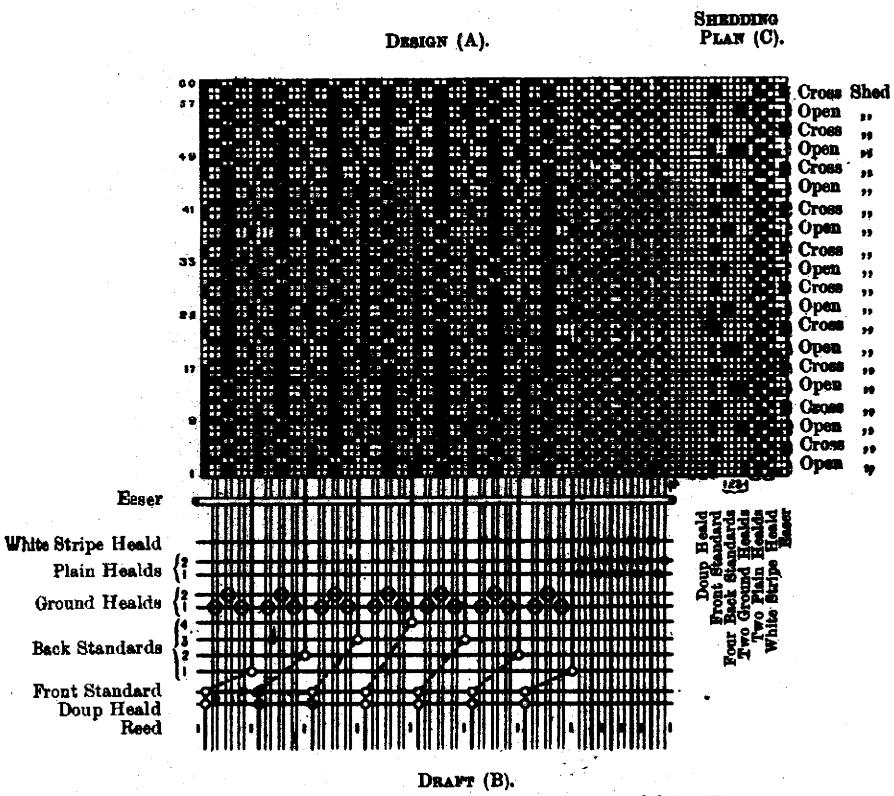


FIG. 451.—Design, draft and shedding plan for net leno fabric, Fig. 450.

the front standard and doup healds, and slackening the easer; whilst the ground healds operate as indicated. The two consecutive picks midway between those in the cross sheds are inserted in *open sheds*, for which doup warp threads may be either raised or left down by their respective back standard healds, as required. When, however, the single picks of weft,

that intervene between those in the cross and open sheds, are inserted, *all doup warp threads must remain down*. The peculiarity of these fabrics (that was referred to in §§ 110 and 111) of doup threads appearing to be on the normal side of standard warp threads, when they are actually on the crossed side of those threads, and *vice versâ*, is also observable in this variety of leno fabrics.

§ 114. Figs. 453 and 455 are reproductions of other examples of figured "net leno" fabrics in which the figuring is developed by means of only one doup and one front standard heald,

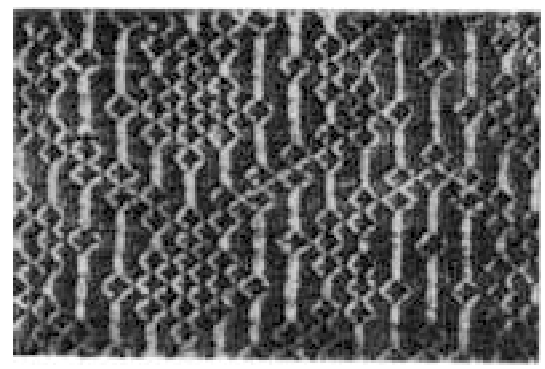


FIG. 452.—Net leno fabric, woven by means of one doup and one front standard and five back standards for which the design, draft and shedding plan are given in Fig. 453.

operating in conjunction with several back standard healds, and two or more healds to govern ground warp threads to produce the foundation texture. In these examples doup warp threads are arranged in pairs disposed at regular intervals apart, for the production of all-over designs. The threads of each pair cross their respective standard ground warp threads in reverse directions, so as to develop a neat diamond formation, excepting where doup threads lie straight and parallel on their *crossed* side of standard warp threads. The present examples will serve to indicate the general character of designs suitable for these fabrics, and also the fair scope they offer to a designer in the creation of effective patterns. The example of cloth

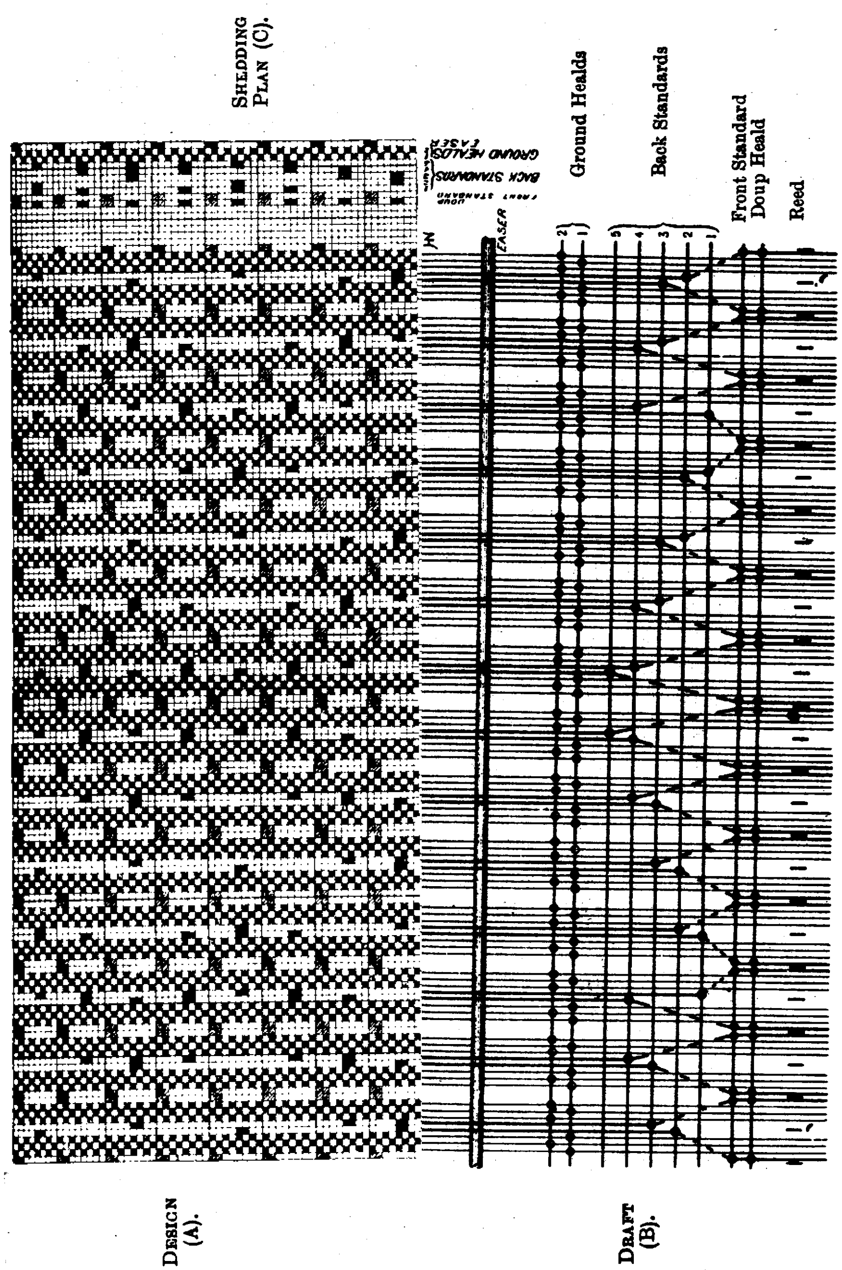


FIG. 453.—Design, draft andshedding plan for net leno fabric, Fig. 452.

represented in Fig. 452 has a foundation texture of the plain weave, consisting of fine ground warp threads (taped in pairs) picked with fine weft. Doup warp threads, of two-fold yarn, each cross three pairs of standard threads, and are governed by five back standard healds, in addition to a front standard and a doup heald. It has required a different drafting of doup threads through the back standards, but not of ground warp threads, which are governed by two healds that rise and fall alternately for consecutive picks throughout.

The design, draft and shedding plan (arranged for a bottom-doup harness) required to weave the example of cloth (Fig. 452) are given at A, B and C respectively (Fig 453). The pattern repeats on eighty-four pairs of ground warp threads (represented in the design and draft as single threads) and twenty-eight doup warp threads and sixty-four picks of weft. Doup warp threads are drawn through the back standards so as to form a reversed pointed draft. The method of drafting doup warp threads for these examples of cloth marks a distinctive and important feature of interest in their construction. As will be seen, on consulting the draft (B, Fig. 453), doup warp threads are disposed in pairs, with the two threads constituting a pair crossing from their normal to their crossed side in reverse directions simultaneously, and drawn through heald eyes in the same back standard. For example, the central pair of doup threads are drawn through the fifth back standard heald, and constitute one extreme point of the draft; whilst the first and last doup threads in the pattern, which cross in reverse directions, both pass through the second back standard, and constitute a pair forming another point in the draft.

This arrangement of the draft causes the threads of each pair to converge and lie side by side, quite straight and parallel with each other, *when on their crossed side*, but to diverge when raised by their back standard healds. Thus, by forming cross and open sheds at regular intervals (of picks) apart, the neat net leno diamond formation, characteristic of the present examples, is produced. On examining the design and shedding plan, it will be observed that an *open shed* is formed for two contiguous picks (the third and fourth) out of every eight picks, and a *cross shed* for the intermediate pairs of picks (the seventh and eighth), whilst the ground healds rise alternately for consecutive picks throughout, to produce the foundation texture. Owing to the different rates of contraction of doup warp threads with this design, those threads will require to be contained upon three separate warp beams, in addition to one containing ground warp threads.

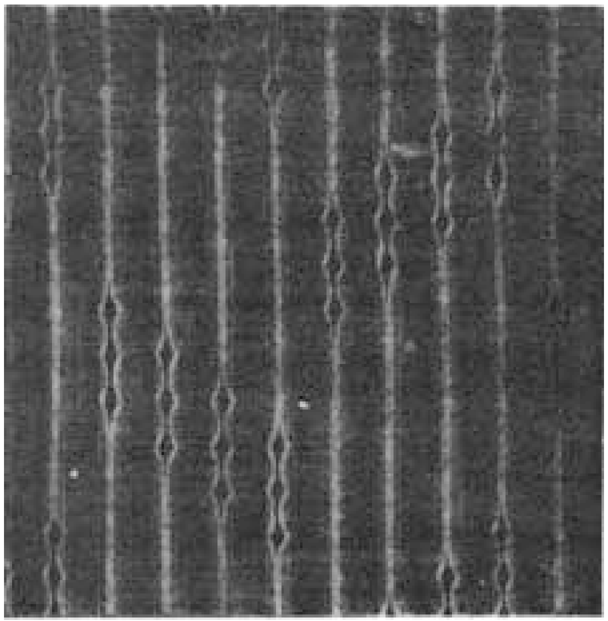


FIG. 454.—Net leno fabric, woven by means of one doup and one front standard, and eight back standards.

§ 115. The cloth represented in Fig. 454 shows a slight variation from the previous examples in having doup warp threads more widely dispersed upon a muslin ground texture of plain cloth. In this example, each set of doup warp threads consists of two pairs of threads of two-fold yarn, crossing their respective standard warp threads in reverse directions. The ground warp threads, which serve as standard threads for each doup

warp thread, consist of four threads taped in pairs, whilst the intervening stripes of plain cloth consist of eleven single warp threads. This example has required eight back standard healds to produce the pattern which it contains, with consecutive pairs of doup threads drawn through them in regular succession to form a straight-through draft. The leno effect is developed by forming two cross sheds in succession, for single picks, at intervals of six picks, and by forming an open shed, where re-

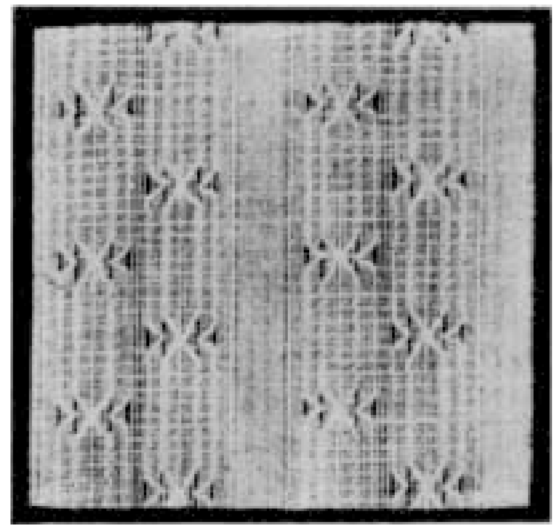


FIG. 455.—Net leno fabric, woven by means of two doups and two front standards, with two back standards operating in conjunction with each doup heald, and its front standard.

quired, also for single picks, midway between two cross sheds, but only at intervals of twelve picks; thus: **1** (*cross shed*), 2, 3, 4, 5, 6, **7** (*cross shed*), 8, 9, **10** (*open shed*), 11, 12, and so on. It is imperative, in order to create harmonious leno effects in fabrics of this variety, that cross and open sheds should be formed in a rhythmical order, and not at irregular intervals of picks apart. It may also be observed that if doup warp threads cross their standard threads in the same direction uniformly (as in Fig. 451), it is advisable to draw them consecutively through successive back standard healds; but if they cross in reverse directions (as in Fig. 453), they should be drawn through the back standards in pairs, as indicated in the draft B.

§ 116. It is stated in § 108 that more than one doup heald, each to operate in conjunction with several back standard healds, may be employed to increase the scope of the type of leno harness under present notice. The example of cloth represented by Fig. 455 has required two doup healds, each operating with two back standards. In this example doup threads lie straight when on the *normal* side of their standard threads, as in ordinary net leno fabrics.

Leno Specialities.

§ 117. In the production of gauze and leno fabrics by the methods previously described in this chapter, it is impossible to effect a crossing of any two or more warp threads with each other, unless the crossing threads are severally contained in the same dent of the reed: hence, a crossing may not be made with warp threads that are separated by a reed wire. This restriction, however, may be avoided by the use of specially adapted leno weaving devices, whereby the crossing of warp threads is accomplished by means of doup healds situated *between* a disappearing beating-up half-reed, or comb, and an ordinary deep stationary reed, situated *between* the doup healds and regular healds, as clearly represented in Fig. 463. Such arrangement of healds and reeds enables warp threads to be crossed either separately, or in groups, in almost any conceivable manner, irrespective of the order in which they pass through the dents of the stationary reed, during weaving. Thus, it is possible to effect a crossing of threads, *en masse*, that extend over several dents, without those threads *crossing or douping with* the intermediate warp threads which they simply pass over. The doup harness may be either a top or bottom-doup harness, or it may be a combination of both these arrangements. Also, warp threads may be passed through and governed by two separate and distinct doup slips of the same or different lengths, to effect a crossing to the right or left over

a smaller or a greater number of threads, as required. This system of leno weaving affords almost illimitable opportunities to a capable designer in the creation of decorative effects of a very ingenious and pleasing character, as exemplified in Figs. 456 to 462, which are full-size photographic reproductions from actual pieces of cloth representing a few typical examples of this particular variety of leno fabrics.

§ 118. The construction of these fabrics will be better understood if the reader is informed of the mechanical devices employed in their manufacture, of which there are several modifications that differ chiefly in details of construction and operation. With the object of conveying that information to students, a diagram representing a part sectional elevation of a loom equipped with Whitehead and Wood's modification of a special leno weaving device is given in Fig. 463. With a view to better demonstrating the operation of this device, the sley and its appurtenances are represented both at the backward

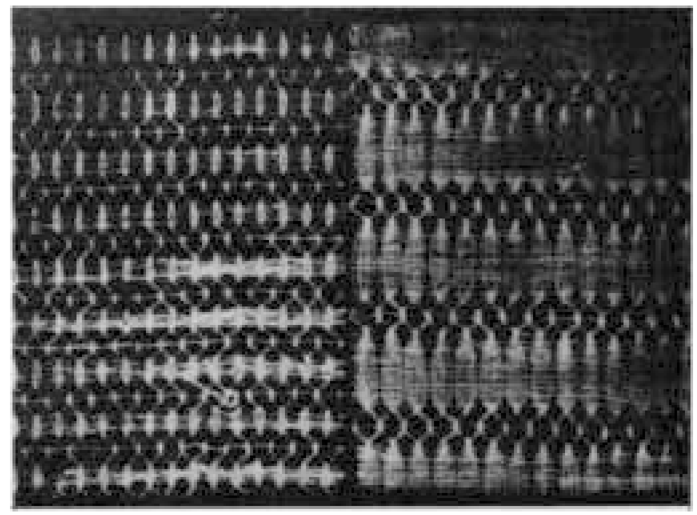


FIG. 456. FIG. 457.
Special leno effects produced by a system of crossing warp threads in front of the reed.

and forward extremities of their movement by full lines and dotted lines respectively. As indicated in the diagram, instead of fixing a reed in its usual place in the sley, a reed O, of unusual depth, is placed between the regular healds N, and the doup healds P, and permanently fixed to brackets secured to the loom framing. The function of the stationary reed is simply to effect an even distribution of warp ends over the required

FIG. 458.

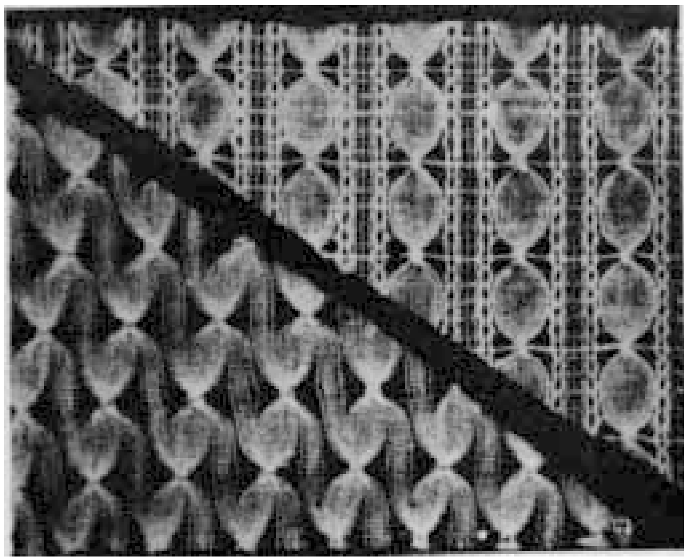


FIG. 459.

FIGS. 458 and 459.—Special leno effects produced by a system of crossing warp threads in front of the reed.

width of cloth, and to retain them at that width. Fixed at each end, and in the rear of the sley, are two iron brackets, each formed with three vertical slots to freely receive the ends of three staves extending from end to end of the sley. The foremost slot in each bracket contains a coarsely-pitched half-reed or pin-stave G, situated immediately behind the shuttle raceboard, in place of the usual reed, for the purpose of guiding a

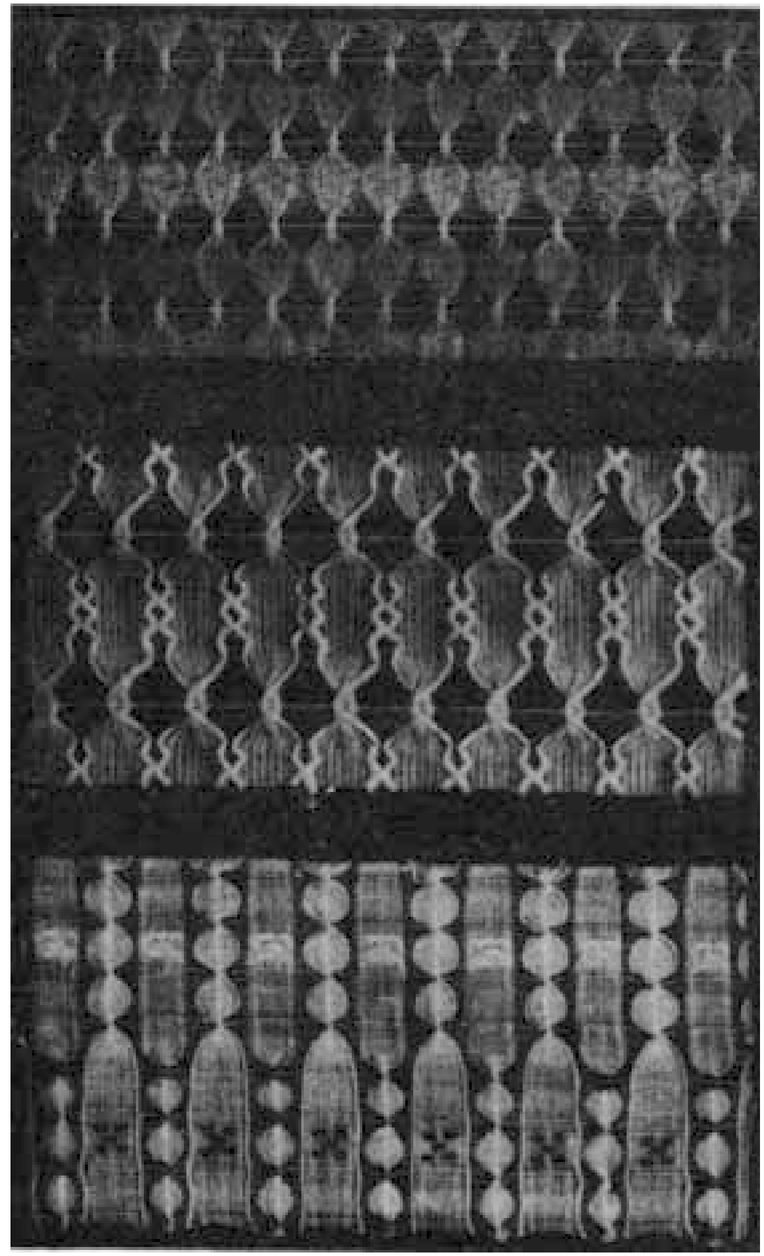


FIG. 460.

FIG. 461.

FIG. 462.

FIGS. 460 to 462.—Special leno effects produced by a system of crossing warp threads in front of the reed.

shuttle in its transit through the warp sheds. To the rear of the pin-stave is a half-reed or comb F, for the purpose of beating up the picks of weft; whilst above the half-reed is an iron locking bar J, to securely lock the half-reed, and make it rigid whilst beating up. All these parts alternately rise and fall in unison with the movement of the sley, and in the following manner, namely: As the sley advances, the half-reed rises to beat up weft and the locking bar falls, thereby passing immediately behind the upper ends of the reed wires, to give them firmness whilst beating up. As the sley recedes, the half-reed falls, and the locking bar rises, so that both move clear of warp threads during the formation of a shed, and warp threads are thereby free to be crossed as required between the stationary reed and the "fell" of cloth. The base of the half-reed is connected by rods E, to the ends of levers C, and its upward and downward motion is effected by means of two cams B, fixed one near each end of the crank shaft A, of the loom. The cams act upon the levers C, which are each fulcrumed upon studs D fixed in the ends of arms that project from the sley swords, and, therefore, oscillate with the sley. The motion of the pin-stave G is contrary to that of the half-reed F. Thus, as the sley recedes, the pin-stave rises, to act as a guide for the shuttle as it passes through the warp sheds, but falls clear of the warp threads, cloth and loom temples as the sley advances to beat up weft. The contrary action of the pin-stave and half-reed enables the first to be actuated by the second, by attaching them to opposite ends of cords H, which pass over pulleys I. The upward and downward motion of the locking bar J is obtained by means of cords K, which pass over pulleys L, and have each one end attached to fixed points M, on the loom framing. Thus, as the sley advances, the cords diminish in length between the pulleys L and the fixed ends M, thereby allowing the bar to fall by gravitation; but as the sley recedes, the cords increase in length between the fixed points and pulleys, thereby raising the locking bar clear of warp threads. A similarity exists between the sley of this type of loom and that of a lappet loom, as represented in Fig. 501 (§ 136). Both are provided with pin-staves for the guidance of a shuttle during

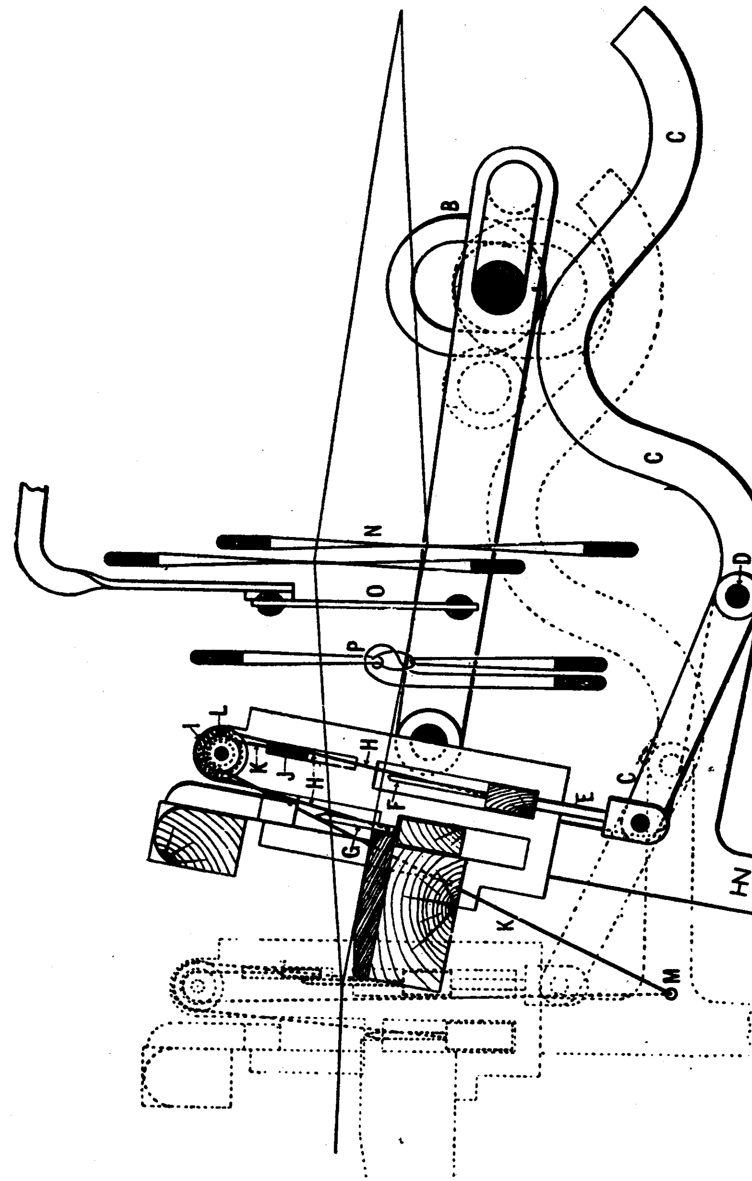
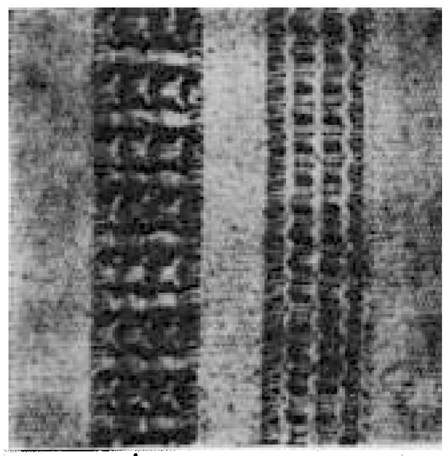


FIG. 463.—Whitehead and Wood's device for the production of special leno effects by crossing warp threads in front of the reed

picking; but, instead of a half-reed, a lappet loom is furnished with one or more needle-bars to control figuring or "whip" threads, and these bars are moved laterally for figuring purposes, as well as vertically, to insert figuring threads into the warp sheds.

Full-cross Leno Fabrics.

§ 119. In all the examples of leno fabrics herein described, doup threads make only a partial or half turn around their respective standard threads: that is, they pass from one side to



A

FIG. 464.—Full-cross net leno fabric in which doup warp threads are twisted completely around standard warp threads, first to the right and then to the left alternately at intervals of four picks.

the other side of those threads, and then return to the same side, on different picks of weft, but do not completely twist around them. Sometimes, however, leno fabrics are produced in which doup threads are caused to completely encircle their standard threads, and thereby produce a full crossing or twist with them, as exemplified in an actual specimen of cloth illustrated by Fig. 464, in which pairs of black doup threads cross or twist with pairs of white standard threads, to develop the striped leno effect shown at A. This unusual system of crossing

is accomplished by causing the doup slips to completely wrap around the standard threads, as they pass from the doup threads to the heald stave on which they are contained. Thus, whenever a shed is formed, whether it be an open or a cross shed, the doup threads are either up or down *always on the same side* of their respective standard threads, thereby causing them to make a full crossing, as described.

Relative Merits of a Top and a Bottom-Doup Harness.

§ 120. Throughout this chapter frequent reference has been made to the alternative methods of placing doup slips *above* or *below* warp threads, for the production of gauze and leno fabrics, both of which systems are described in § 102. Since the choice of position is quite optional, it is not surprising that the opinions of practical men, respecting the relative advantages of both systems, should vary according to their personal prejudices and practical experience, and that some advocate one system and some the other. From this circumstance, it is quite evident that each method possesses some peculiar advantage over the other, at least for certain classes of fabrics; otherwise, one of the two would long since have been discarded in favour of the superior system. It will, therefore, be both interesting and profitable to briefly compare the relative merits of each system, and to state which it may be more expedient to adopt, under different circumstances.

For the production of net leno and similar fabrics containing thick net doup threads or cords, that are chiefly displayed on one side of cloth, it is more expedient to employ a top-doup harness. By that arrangement, such fabrics are woven face side upward, thereby enabling a weaver to more readily detect imperfections in cloth during weaving. Another great advantage to a weaver, of doups being placed above warp threads, is that they are more accessible and therefore more easily repaired, or else replaced by new ones, which frequently becomes necessary, in consequence of doup slips rapidly wearing out. In the event of breakages, however, top-doup slips are liable to prove a source of serious trouble to a weaver by hanging down and becoming entangled with warp threads, thereby involving the risk of breaking them, and causing faults in cloth. Another disadvantage of top doups is in respect of shedding. If a negative acting dobby and a spring under motion are employed to operate a top-doup harness, it is more difficult to obtain a good lower half of the warp shed, in consequence of healds being depressed and held down negatively, by means of springs. This arises in consequence of the abnormal tension of doup warp threads during the formation of both cross and open sheds, whereby they tend to rise a little above the surface of

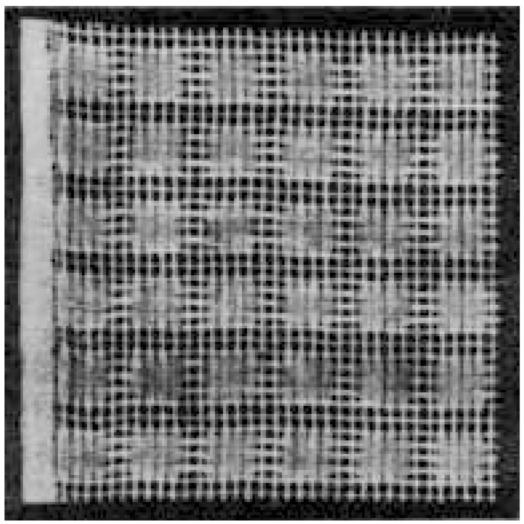


FIG. 465.—Check gauze fabric.

the shuttle race-board, instead of lying well down upon it, as a shuttle is transmitted through the warp shed. If *bottom* doups are employed, cross sheds are formed by *raising* front standard and doup healds positively by the dobby, whereby better and clearer warp sheds are formed. In consequence, however, of the cloth being woven face downward by them, as previously described in § 113, they are not generally used for net leno and similar fabrics, but are chiefly confined to the production of those fabrics not containing thick net doup

threads, and of which both sides are exactly similar, such as that illustrated in Fig. 465. Also, the renewal of bottom-doup slips is much more difficult than the renewal of top doups; but if bottom doups break, they fall away from warp threads, and do not, therefore, become entangled with them.

Relative Merits of Different Types of Dobbies for Gauze and Leno Fabrics.

§ 121. In the production of gauze or leno fabrics it is desirable to effect a crossing of warp threads with the least possible straining or chafing of those threads. This desideratum is the principal stumbling-block to the successful adoption of dobbies that are unprovided with auxiliary attachments which specially adapt them for leno weaving. To avoid excessive straining and chafing of warp threads whilst in the act of crossing each other, one of two conditions must exist, namely, either the crossing threads must be quite level at the *commencement of crossing*, either at the bottom, or in the centre of the warp shed; or else doup threads must pass either from the *upper* or else the *lower* part of the warp shed, when the crossing takes place, according to whether a *top* or a *bottom*-doup harness, respectively, is employed. It will now be manifest, therefore, that either a "closed-shed" dobby, or one that will produce the conditions just described, is better adapted than an "open-shed" dobby for leno weaving. By reason, however, of open-shed double-acting dobbies enabling a loom to be worked at a greater speed than is possible with closed-shed dobbies (which are necessarily single-acting), it is a common practice to employ an open-shed dobby for leno weaving. In such cases it is expedient to equip either the dobby or else the loom with a suitable auxiliary attachment known as a "shaking" device, to enable the crossing of warp threads to take place as freely as possible.

Shaking Devices.

§ 122. The function of a shaking device is to facilitate the crossing of warp threads when forming *both* cross and open sheds; but since it is, under certain conditions, unnecessary to employ a shaking motion for the reproduction of some leno designs, it will be useful to indicate when shaking is, and when it is not, necessary. If either an open-shed dobby or a semi-open-shed dobby is employed for leno weaving, either with a top or a bottom-doup harness, it will be expedient to employ a shaking motion for designs that require a *cross shed to immediately succeed an open shed, and vice versâ;* but such a motion is not required for designs in which one or more than one pick intervenes between cross and open sheds as exemplified in the net leno stripes A, Fig. 438; B, Fig. 439; and B, C, Fig. 442; because for those picks, doup threads would be *raised* by a top-doup harness, and *depressed* by a bottom-doup harness, and would therefore pass either from the upper or lower part of the warp shed respectively, when required to form both cross and open sheds as described in § 121. The reason for this will be manifest after a little reflection upon the circumstances. With a *top-doup* harness, *cross sheds* are formed by *depressing doup threads* on the *crossed* side of their respective standard threads, which are raised; and *open sheds* are formed by *depressing doup threads* on their *normal* side. Therefore, either standard threads should be lowered, or doup threads raised, at least half way, to prevent excessive chafing of the crossing threads during the formation of cross and open sheds. This function is described as "shaking". With a bottom-doup harness the conditions of shaking are exactly contrary to those which obtain with a top-doup harness.

§ 123. "Shaking" is effected in a variety of ways, either by auxiliary attachments fixed either to the loom, or else to the dobby; and, as just indicated, it may be accomplished with a top-doup harness either by *raising* doup healds, or else by *depressing* the healds governing standard or regular warp threads half-way; and with a bottom-doup harness in a contrary manner, by depressing doup healds, or else raising standard threads half-way—the choice being frequently quite optional. One very simple and common method of shaking *depressed* healds, without employing a special leno dobby, is to connect the required heald stave or staves to one of the loom-crank connecting arms by means of a suitable arrangement of levers

and connecting rods, as represented in Fig. 466, in which A represents the loom cranks; B the connecting arms; and C a connecting rod to oscillate an arm D secured to the end of a square cross bar E, placed above, and in the rear of the

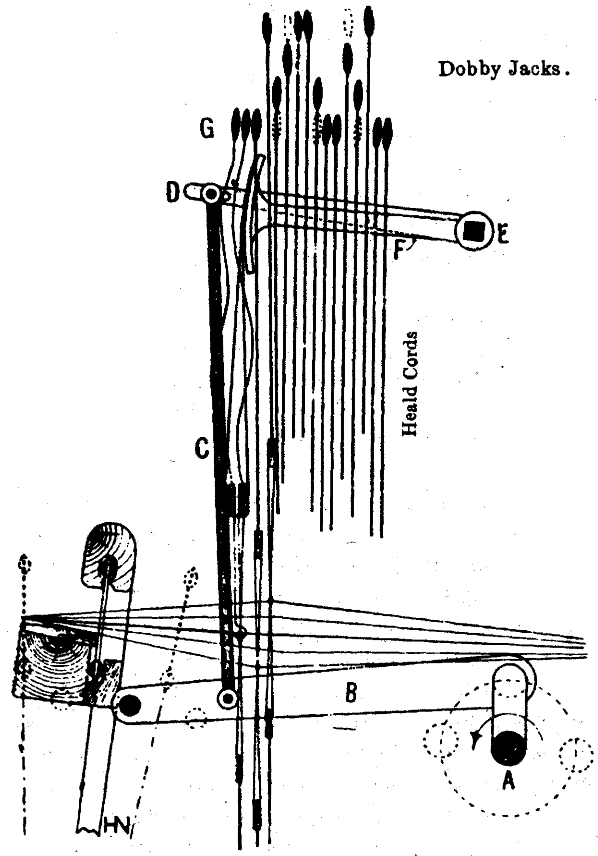


FIG. 466.—"Shaking" device to operate in conjunction with open shed dobbies employed for cross weaving, to facilitate the crossing of warp threads.

healds, and upon which are also mounted half-moon quadrant arms F, to which the required healds are connected. The same healds are also attached to separate dobby jacks G. The disadvantage of this arrangement, however, is that it does not permit of readjusting the timing of its movement in relation to shedding, if such a course were necessary. Thus, the front standard and doup healds, which are being shaked, are raised to the centre of the warp shed by the time the loom cranks arrive at the top centre of their circuit. This is one-eighth of a revolution sooner than the time usually selected for rising and falling healds to meet in the centre of the warp shed, when doup and standard warp threads commence to cross each other. This is indicated in the diagram by representing rising and falling dobby jacks G, a short distance from the centre of their complete movement. Still it has the advantage of being simple and is found to give satisfaction under some conditions.

§ 124. Another method of shaking *depressed* healds from the loom is represented in Fig. 467. By this method, in addition to being connected to separate dobby jack-levers G, the healds required to be shaked are also attached to half-moon quadrant arms F, that are secured to a cross-bar E, placed above and in the rear of the healds. This is caused to oscillate by connecting it, by means of an arm D, and connecting rod C, to a lever H, mounted upon a stud I, and fixed outside the loom framing. Lever H is furnished with a bowl or runner J, and is depressed and raised alternately by the combined actions of a double-acting tappet K (fixed upon the picking shaft L), and a spring M respectively, which may be attached to any convenient part of the loom framing. With this shaking device, shaking may be timed to take place at exactly the right moment, by adjusting tappet K to operate the required healds so that their movement synchronises exactly with the movement of healds controlled by the dobby. This is indicated in the diagram by representing the dobby lifting-crank N in a horizontal position, when rising and falling healds meet midway (as indicated by the three positions of dobby jack-levers G). At the same time the front standard and doup healds have been raised to the centre of the shed, when the crossing of doup and standard warp threads commences. Also the loom cranks are half-way between the top and front centres, and therefore one-eighth of a pick (forty-five degrees) in advance of those represented in Fig. 466.

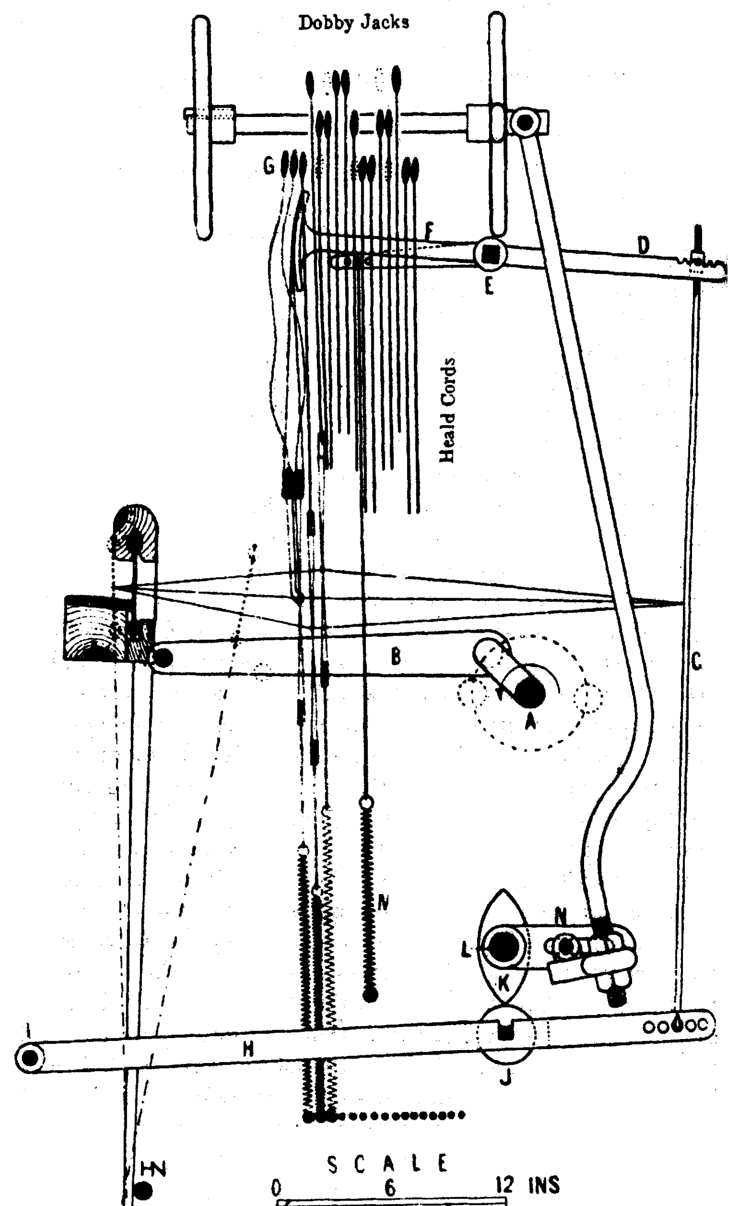


FIG. 467.—Another type of "shaking" device to operate in conjunction with open-shed dobbies employed for cross weaving, to facilitate the crossing of warp threads.

§ 125. When, however, shaking devices are adapted to open-shed dobbies of the "Keighley" type, and not to the looms, they may only shake *raised* healds by first lowering them half-way and then raising them to the top again. Some dobby makers furnish their dobbies with a shaking device of some kind, and style them "leno" dobbies: but one of the most efficient and inexpensive methods of shaking with an open-shed double-acting dobby is to connect *two* contiguous jacks of the dobby to each heald that requires shaking, and operate them from the pattern lags as required. By this means a heald may be lowered by one jack-lever until it falls half-way, when it is caught and taken to the top again by the ascending fellow-jack. By governing the operation of shaking from the pattern lags, this arrangement is superior to all other shaking devices, as it enables shaking to be performed only when it is necessary, and at the exact moment when it is most effective; whereas other shaking devices operate for every pick, whether shaking is required or not; thereby vibrating healds and warp threads unnecessarily and detrimentally, as explained in the following section.

When adapted to a semi open-shed dobby, the function of shaking must be effected with *depressed* healds. This type of dobby is better adapted than an open-shed dobby for leno weaving, because it allows *all* healds to fall half-way after each pick; therefore, by raising half-way those healds that require shaking, standard and doup threads actually meet in the centre of the shed, thereby achieving the same result (in respect of crossing threads only) as that obtained by means of a closed-shed dobby.

§ 126. Before dismissing the subject of shaking, it will be of practical interest to indicate the circumstances under which it is quite inadvisable to employ any kind of shaking device to shake the front standard and doup healds (of a top-doup harness) after every pick; and also when it is more expedient to employ either a closed-shed dobby or else a shaking motion that may be made to operate only when required. For example, if a net leno design requires doup threads to remain down for several picks in succession, when on the open or normal side of their

respective standard warp threads, the doup slips and their warp threads would rise half-way in the warp shed and return to the bottom again for every pick of weft; albeit those threads would be held down by the back standard heald. This would involve excessive straining and breaking of doup threads and rapid wearing out of doup slips. For these reasons, therefore, it would be better to employ either a closed-shed dobby, or else a shaking motion that could be controlled from the pattern lags in the manner described in § 125, whereby shaking may be effected by *depressing standard warp threads* only when it is absolutely necessary.

Practical Details of Leno Weaving.

§ 127. The position of back standard healds, which govern doup threads, in relation to those governing standard or regular warp threads, is quite optional. Some advocate placing them to the *rear* of regular healds, as indicated in Figs. 433, 434 and 435; and others prefer to place them in *front* of regular healds, as represented in Fig. 439, and subsequent charts of drafts for leno designs. The advantage is probably in favour of the latter course; for, whilst it reduces the distance between the "fell" of cloth and the back standard heald eyes (and thereby imparts a little greater tension upon doup threads during the formation of "open" sheds), it averts the chafing of doup threads against the leashes of the regular healds, around which they would bend when forming "cross" sheds.

§ 128. In consequence of the additional tension imparted to doup threads during the formation of cross sheds, and the consequent rapid wear of doup slips and healds, it is expedient, for reasons of economy, to make designs that will require as few cross sheds as possible, consistent with the effect it is desired to produce in cloth. Also, when one or more than one doup thread crosses two or more standard warp threads, it will be better to raise (with a top-doup harness) *all*, in preference to a part, of those threads, when forming cross sheds, and thereby distribute the strain of shedding upon them equally.

§ 129. In the production of some net leno fabrics in which the doup threads are abnormally thick, or which have to cross with a large number of standard warp threads, it is advisable in such cases to remove one or more than one reed wire, if necessary, to prevent excessive chafing of warp threads by being too confined and by bearing hard against the reed wires, as described in § 107. What are known as "flexible" reeds are well adapted for net leno fabrics. Such reeds are formed by wrapping the reed ribs on one side with pitched banding, in the usual manner; whereas those on the other side are wrapped with dry or unpitched banding. By this means considerable flexibility is obtained in the reed, which permits of the easier passage of knots or other obstructions, with less risk of breaking the warp threads. The dry banding allows a limited amount of vertical movement by the reed wires, which enables them to readily recover their original position after being bent out of a straight line. Also a deeper reed than those usually employed should be used for leno fabrics, to allow warp threads more freedom, and also to enable it to be more easily displaced in the event of a shuttle failing to pass safely through the warp shed.

§ 130. Weavers who are engaged in the production of net leno fabrics, and other varieties of cloth containing thick "net" or corded warp threads of folded yarn, in which the presence of large knots would be objectionable or too large to pass through the eyes of the shedding harness, have sometimes to adopt special means of replacing broken warp threads without piecing them by tying their extremities together.

This may be effected by either of two alternative methods, by which the breach is repaired temporarily—namely, (*a*) either by substituting a similar thread withdrawn from a bobbin; or else (*b*) by attaching, in a special manner, to the broken thread on the warp-beam a "thrum" (short length) of similar yarn. The "thrum" is attached by means of a slip-knot to the original warp thread at a point about 18 to 24 in. from the severed end of that thread, and then passed through the harness eye and dent of the reed through which the original thread passed. In both of these cases the free end of the broken warp thread is allowed to droop backward, until sufficient length is unwound from the warp-beam to enable the severed end of the thread to extend well in front of the reed. When the broken warp thread

is long enough, the temporary thread is removed, and the original warp thread is then passed in its proper place through the harness and reed as before the breach occurred.

Tempered Steel-wire Doup Harnesses for Cross-weaving.

§ 131. The loops or slips, termed "doups," that are employed in conjunction either with heald or Jacquard harnesses, for the purpose of effecting the crossing or douping of warp threads that characterises gauze and leno fabrics produced by cross-weaving, are usually made from worsted twine, which is more durable than cotton twine and more supple and elastic than linen twine. Albeit, the rapidity with which worsted doup slips wear out and break during weaving constitutes one of the chief difficulties experienced in the manufacture of fabrics constructed by their aid. The rapid wear and breakage of these doup slips arises from the excessive abrasive friction to which they are subjected, during weaving, within their respective front "standard" heald or mail eyes. Their breakage not only incurs the risk of causing imperfections in cloth by becoming entangled with and breaking warp threads, but the difficulty usually experienced of repairing defective doups, or replacing them with new ones, imposes a severe tax upon the duties of a weaver and, by involving loss of time, curtails production.

With the object of averting the disadvantages of worsted doup slips, and also securing greater efficiency and durability than they afford, tempered steel-wire doup slips have been employed in lieu of twine doup slips in the construction of doup harnesses of various forms adapted to the special requirements of fabrics of different texture, and applicable either to heald or Jacquard harnesses for gauze or leno weaving. After being bent and shaped into the desired forms, the wires composing the respective units of a harness are neatly soldered where it is necessary to either fill up small interstices, or to effect a union between two hitherto separate portions, in order to increase their stability. The wires are subsequently tinned to prevent them from rusting, and also to give them a highly smooth finish, to reduce frictional resistance between them and warp threads to the minimum.

The simplest form of steel-wire doups referred to, and as represented by Fig. 468, differs very little in construction from doup harnesses made from twine. In this example, the upper half only of the front standard S is open, to contain one side of the doup slip D, in which is formed an eye to receive a doup warp thread (as shown) by coiling the wire at the bend. A second form of steel-wire doups suitable for finer warp yarn is represented by Fig. 469. In this example the doup slip D is a simple loop of the usual form, without an eye being formed at the bend. In the present case, however, the doup slip is inserted in both the upper half of the front standard S which is open, and also in loops formed at the bend of the lower half of the front standard, as indicated in the diagram.

§ 132. A third modification of steel-wire doup healds described as "3-part, twin-wire doups," and as constructed by an American firm,[1] are illustrated in Figs. 470, 471 and 472. Thus, Fig. 470 shows the component parts of one unit in their initial or neutral position which they occupy when the warp shed is closed; whilst Figs. 471 and 472 show those parts in their positions which they occupy when forming an "open" and a "cross" shed, respectively. The cardinal feature of this device consists of a doup slip D acting in conjunction with two separate front standards S^1 and S^2, each of which is formed with a long central loop or eye to contain the respective sides of the doup slip, as shown in the diagrams. The doup slip used in this modification, like that shown in Fig. 468, has an eye formed at the bend for the reception of a doup warp thread, and is situated *between* the two front standards. With this device an open shed is formed by raising the doup slip along with *either* of the two front standards; whilst a cross shed is formed by raising the doup and the *other* front standard, whereby doup warp threads will be raised first on one side and then on the opposite side of their respective standard or regular

[1] The Steel Heddle Manufacturing Co., Philadelphia, Pa., U.S.A., for whom H. B. Barlow and Hocknell, Ltd., of Huddersfield, are the sole British representatives.

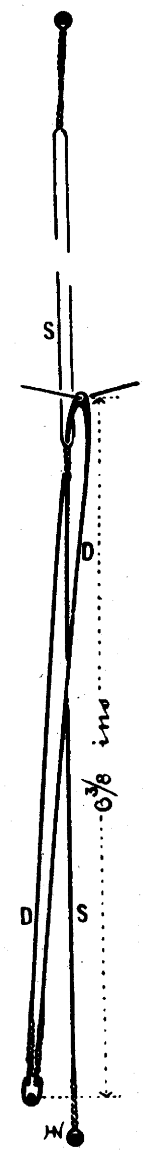


Fig. 468.

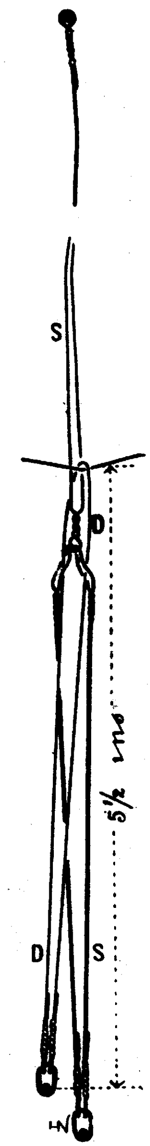


Fig. 469.

Units of two types of a steel wire doup harness for cross weaving

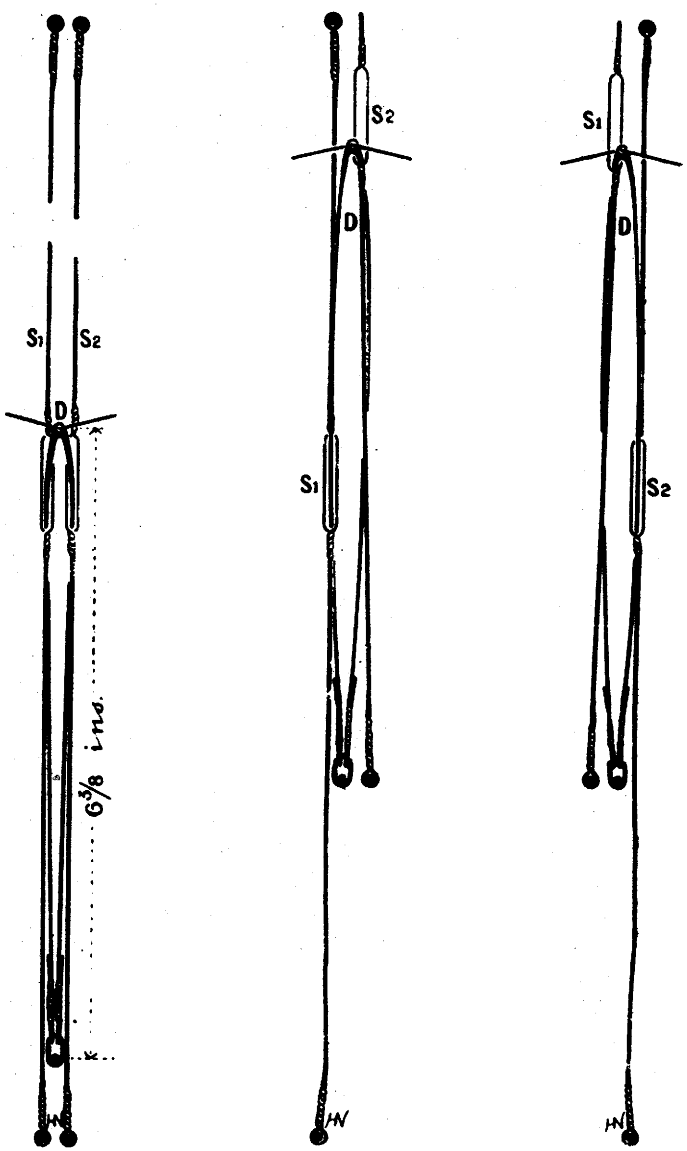


Fig. 470.

Fig. 471. Formation of open shed.

Fig. 472. Formation of cross shed.

Units of a third type of a steel wire doup harness for cross weaving.

warp threads as indicated by Figs. 471 and 472. This arrangement therefore dispenses with the usual back standard healds, as will be seen on referring to the diagram, Fig. 473, which represents a "3-part, twin-wire doup" unit as employed in the production of a simple, plain gauze fabric entirely devoid of any textural embellishment whatsoever. This object is effected simply by raising the two front standard healds in alternate succession, for consecutive picks of weft and, at the same time, keeping the regular heald controlling the standard warp threads down for every pick.

Flat Steel Doup Healds.

§ 133. A single unit of a fourth example of steel doup healds of the latest type, and one that has met with considerable favour by manufacturers in the United States of America, in the production of "marquisettes," and many other varieties of fancy leno fabrics, is illustrated in Fig. 474. This type of doup heald which, like the 3-part, twin-wire doups described in the previous section, is constructed by the same makers, constitutes a distinctly new departure in this class of heald and consists essentially of thin, flat, steel strips formed with heald eyes and end loops, punched out of cast steel sheeting. The heald eyes are polished perfectly smooth, and the strips are heavily nickel plated to ensure smoothness and also to prevent rusting. When these healds are assembled in position on flat, thin, steel carrying-rods of their respective heald shafts or staves, the flat, steel, doup strips are disposed "edge-on," *i.e.*, with their flat or broad sides parallel with the warp threads, thereby permitting of a much closer density or "setting" than is possible with any other type of healds. Thus, in the finest heald of the "duplex" type which, in effect, is equivalent to two rows of healds, as many as 70 heald strips per inch can be placed on each pair (upper and lower) of heald rods, constituting one heald-shaft. Also, by being punched out of the solid steel sheeting, there is, therefore, no crevice in which the warp threads can possibly be caught; neither are there any soldered parts to give way and cause trouble; nor the usual three or four twists or turns of the wire, at each end of the heald eye, such as are necessary in wire healds of the usual type, and which are liable to chafe the warp threads by the vertical movement of the healds, during shedding. Further, a slight "off-set" both at the top and bottom of alternate heald strips ensures perfect spacing, even with the finest or closest "setting" of those strips, on their carrying-rods.

An advantage is also afforded by the facility with which this type of flat steel doup healds are transferred from the rods on which they are supplied (when they are not supplied already assembled on the heald frames, ready for "drawing-in") simply by passing very thin, spring, steel "transfer rods" through the end loops, as the heald strips lie on the original rods, then withdrawing the latter and replacing them by the rods of the frames on which the healds are to be assembled. By this method, a great number of healds may be transferred in a short space of time.

This type of flat steel healds is made with heald eyes of various sizes, as required for the different types and varieties of fabrics, and also from different gauges of steel strip ranging from 8 thousandths of an inch thick, by 75 thousandths of an inch wide, for yarn of the finer counts; and from 42 thousandths of an inch thick, by five-sixteenths of an inch wide, for yarn of medium, coarse and very coarse counts, according to the particular character of fabric for which they may be required and ranging from the finest textures of silk, artificial silk and fine cotton, to such heavy types of fabrics as woven belting, duck cloth and carpets. Also, the full distance between the upper and lower heald rods is available for shedding. Thus, with a 12⅞ inch flat steel heald harness, the full shedding distance is, for example, 12 inches; whereas, with a 12⅞ inch heald harness of cast steel, soldered, twin-wire healds, the shedding distance available is only 11 inches, which is the distance between the turned-in ends of the wire.

Although the first cost of flat steel doup healds is greater than that of cotton, worsted, or round twin-wire healds, yet they possess many distinct advantages over the latter in respect of their much greater durability, ease and facility of adjustment and their more gentle treatment of the warp threads,

during the formation of doup or cross sheds; and although this type of doup healds has been employed successfully in the production of leno fabrics containing as many as 72 warp ends per inch, and with warp threads of 60's single twist yarn, it is not considered advisable to employ single warp yarn of counts finer than 50's T.

§ 134. The operation of a flat steel doup heald harness, of the type under present notice, is illustrated by diagrams, Figs. 475, 476 and 477, in an article[1] on the weaving of leno fabrics, and in which particulars are given, of these flat steel doup healds. From what has already been stated, in § 103, with reference to the diagrams, Figs. 434 and 435, the construction and operation of this new type of doup healds will be the more readily comprehended by reference to the diagrams, Figs. 474 to 477. Thus, as represented in Fig. 474, a single doup unit consists essentially of three separate and distinct members or parts, namely, two front standards, S^1 and S^2, which form a double support for the doup slip or needle D, and the doup needle proper, D, all of which parts are represented down, *i.e.*, in their neutral position, in Fig. 475, in order to keep the doup warp thread down, whilst the regular heald (not shown) is raised, to form a "neutral" or ordinary warp shed. Each member constituting either of the two front standard healds, S^1 and S^2, consists of two separate parts, and although not shown in the drawing, each of these parts is split to allow the doup to operate in the slit thus formed. The sides of the slit are bound together in the centre by an interlacing of the parts, and this interlacing forms a support for the doup. The doup has a supporting bar forming the underside of the eye.

Fig. 475 shows the doup at rest and supported by the front standard heald on each side. Assuming, for example, that, when drawing in the warp threads through the respective heald eyes of the shedding harness, the doup warp threads are crossed *underneath* from *left to right* of their respective standard or regular warp threads, and that it is required to form an "open shed," that object would be effected simply by raising the front

[1] "Practical Methods for Weaving Lenos," by John Reynolds.—*Textile World*, Nov. 22nd, 1924.

standard heald S^1, only, on the *left-hand* side of the regular or ground warp thread, in order to take the doup slip up to the top and on the *left* of the standard warp thread, which remains down on the *right* of the doup warp thread, between the doup needle and the front standard heald on the *right-hand* side, and as represented in Fig. 476. In like manner, if it is required to form a "cross shed," this is effected by raising the front standard heald S^2, only, on the *right* of the regular warp thread, whilst the latter remains down on the *left*, as represented in Fig. 477.

On referring to these diagrams, it will be observed that the top part of the doup slips is well rounded, and that when these slips are raised, the rounded shoulder is drawn well into the split part of their respective front standard healds. This is very essential because, when the doup slips are raised by either of their front standard healds, it is important that those slips should not offer any obstruction or impediment to the free passage of the regular, ground or standard warp threads, as these descend from the upper to the lower warp shed.

When it is desired to cross the doup slip over to the "open shed" or to the left-hand side of the regular ground warp thread (Fig. 476), the harness lever carrying the left-hand side of the front standard heald is moved to the centre ready for the change. At the same time the regular heald brings up the ground warp thread to the centre, in order to permit the change without interference. The right-hand part of the front standard heald continues to move downward to the bottom shed, while the left-hand part of the front standard heald moves upward to the top shed, carrying the doup slip with it. During this movement, the ground warp thread slides over the rounded right-hand shoulder of the top of the doup eye and down to the right-hand side of the doup slip, as seen in Fig. 476. In this way, the "open shed" is completed, and this constitutes one repeat of the ordinary "marquisette" or plain gauze structure.

A yoke, such as is used when weaving with worsted doups, is not required on the flat steel doups, but two yokes for use on each doup harness (not on each doup heald), are supplied by the maker of the doups. These are usually fastened to the bars on which the doups are fastened at the bottom. A light

spring is fastened to these yokes and is then attached to a hook in the floor. The purpose of these yokes is to steady the doups and help to draw them into the split part of the front standard heald so that the ground or regular warp threads can slide the more easily over the top of the doup. Many lenos are woven without the use of these yokes, and it is good practice to operate without them, if possible, because any additional pressure shortens the life of the doup and front standard heald.

When setting the regular or ground harness on this type of doup, it is well to have the ground warp thread at least $\frac{1}{8}$ inch above the doup warp thread when the doup warp thread is crossing from open to cross or from cross to open shed. This will give the doup a chance to settle and present a full rounded surface for the ground warp thread to slide down on. If the doup does not set well in the opening in the front standard heald when changing from one shed to the other, the ground warp thread is liable to settle on the top of the doup and be prevented from sliding down to the bottom shed. Whenever the ground warp thread becomes caught in this manner, it is usually broken; for the rising doup will carry the ground warp thread to the top shed, whilst the regular heald, through which the ground warp thread is drawn, is descending to the bottom of the warp shed.

§ 135. From the foregoing description of the construction and operation of this new type of flat steel doup healds, it will be of special interest to those manufacturers who are engaged in the particular class of fabrics to which this type of harness is applicable, to give further particulars respecting their practical application. This object will be the more effectively attained by the aid of the accompanying excellent working diagrams which, in conjunction with the brief descriptive notes, will be self-explanatory to the technical reader. These diagrams are reproduced from original drawings specially prepared for this purpose, by the makers, and therefore give the American technical descriptions of the various parts referred to in those diagrams. But, by reference to the names of corresponding parts of a doup harness as illustrated by the several diagrams given previously, in this chapter, the reader will have no difficulty in identifying the various parts indicated. Thus,

Fig. 478 illustrates the operation of the "shaker" (Am. "jumper") lifting the "regular" or "ground" heald (jumper harness) which governs the "regular" or "standard" warp threads, in order to raise the latter at the moment when the doup slips (needles) are required to pass from one side to the other side of their respective standard warp threads, and so facilitate the crossing of doup and standard warp threads. This operation of the "shaker" may be controlled optionally either from the crank-shaft of the loom or other convenient source, as described under "Shaking Devices" in § 122. An "easing-rod" or "slackening-rod" (Am. "slacker-rod") is inserted between the "standard" or "regular" warp threads and the "doup" warp threads so as to bear down upon the latter, under the tension of light springs, in the manner indicated in the diagrams (Figs. 478, 479 and 480) which represent the several parts of a doup heald harness in their relative positions when forming a "neutral shed," by raising "standard" or "regular" warp threads only, as illustrated in Fig. 478; an "open shed," by raising "doup" warp threads only, on the normal or "open" side of their respective "standard" warp threads, as illustrated in Fig. 479; and a "cross shed" by raising "doup" warp threads only, on the "crossed" side of their respective "standard" warp threads, as represented in Fig. 480.

A diagram illustrating the flat steel doup harness in greater detail, and in its entirety, is shown in Fig. 481, which also demonstrates the method of "gaiting-up" a harness of this type. This diagram also indicates the various parts of the harness in their proper relative working positions in a loom furnished with a special "shaking" device (of the Crompton and Knowles Loom Works) to operate the "regular" or "standard" heald ("jumper" harness) as represented in the diagram.

Marquisette Lenos in which Two Threads Cross Two.

§ 136. The following particulars and diagrams, Figs. 482, 483 and 484, indicate the method of drafting or drawing-in the warp threads, and the order of shedding, when weaving "marquisette" lenos in which four warp threads weave plain, thus, $^{1}{}_{\text{I}}{}^{1}{}_{\text{I}}$, and then cross over in pairs, thus $^{11}{}_{\text{II}}$, by em-

ploying a flat steel doup harness comprising a set of eight healds, and consisting of two distinct sets of doup or front standard healds 1, 2 and 4, 5, two back standard (Am. "anchor") healds 3 and 4, and two regular healds 7 and 8, as represented in the diagrams. Thus, the first pair of doups or front standards 1 and 2 control the first doup slip or needle which, in conjunction with the back standard 3, governs the first doup warp thread *a*: In like manner, the second doup warp thread *b*, is governed by the second doup needle controlled by the second pair of front standards 4 and 5, operating in conjunction with the second back standard 6: Whilst the two regular or standard warp threads, *c* and *d*, are governed by the two regular healds 7 and 8, in the rear, as represented in the diagrams, which also indicate the relative positions of the several healds when inserting the picks of weft, A, B, C, D, and E, respectively, and fully explained in the footnotes accompanying those diagrams.

Flat Steel Jacquard Doup Harness.

§ 137. A diagram illustrating another modification of the flat steel doup harness, as described in §§ 133 and 134, and adapted to be operated by a Jacquard figuring harness, is given in Fig. 485. This object is effected by supporting a special form of doup slip or needle (from which a "lingoe" or wire weight is suspended) between two front standard units that are under independent control by separate hooks of the Jacquard machine. In all other respects, the operation of these doup units of a Jacquard harness is exactly the same as that of a doup heald just harness, as described in the previous sections (§§ 133—136).

Limitations Imposed by the Use of a Steel Doup Harness.

§ 138. As stated previously in § 131, the steel-wire doup harnesses under present notice are applicable both to heald and Jacquard harnesses. If they are to constitute a heald harness, their looped extremities are slid upon wires stretched along and secured to heald staves; but if they are to constitute a Jacquard harness, the wire units composing the harness are attached to mounting threads and lingoes, after the manner of ordinary twine couplings, and as illustrated in Fig. 478. It should be observed, however, that whatever form the harness may assume, the use of tempered steel-wire doups imposes certain restrictions and limitations in either the choice of shedding apparatus by which they are to be actuated, or else in the character of the designs that may be produced by their use, for reasons to be presently stated. The tempered steel wire, of which the units of the harnesses are made, is comparatively rigid, and lacks the suppleness and pliability of twine, which is capable of readily yielding and bending, and of freely adapting itself to the conditions imposed by shedding with a doup or leno harness.

For these reasons, steel doups may only be employed in conjunction with single-acting Jacquard machines, single-acting dobbies, or other shedding appliances that bring all standard and doup warp threads parallel after each pick is inserted, to facilitate their crossing from their normal or open position to a crossed position or *vice versâ*. Otherwise, if they are employed in conjunction with open-shed machines, designs produced by them will have to be restricted to such as may be developed without the necessity of bringing doup and standard warp threads parallel after each pick, unless that object is achieved by means of a "shaking" device.

For the same reasons, steel doups may not be employed in the form of a half-heald to operate in conjunction with either a leno brocade (Jacquard) harness, or a leno heald harness in which several back standard healds operate in conjunction with one doup and one front standard heald (as described in §§ 108 to 116). In either of these two circumstances, it frequently occurs that some doup slips are taut, whilst others are buckled, according to the different relative positions occupied by standard and doup warp threads in different parts of the harness. Hence, if wire doup harnesses (which are not so pliable as twine) are employed in such cases, each unit of the harness will require to be under separate control.

Mock or Imitation Leno Effects.

§ 139. The term "mock" leno describes a variety of weaves of ordinary construction, in which the scheme of interweaving warp and weft is designed to produce open-work effects which simulate, in a very realistic manner, the genuine gauze and leno

effects produced by the principle of cross weaving, as described in the previous sections of this chapter. Mock leno or open-work effects are sometimes produced alone, but more frequently in combination with the plain, a twill, satin or other simple weave, and sometimes with brocade figuring, to produce striped fabrics, which oftentimes bear a very close resemblance to true leno fabrics. They are also frequently used as ground fillings in brocade fabrics containing elaborately figured Jacquard designs, in imitation of leno brocade fabrics produced by a special gauze or leno harness.

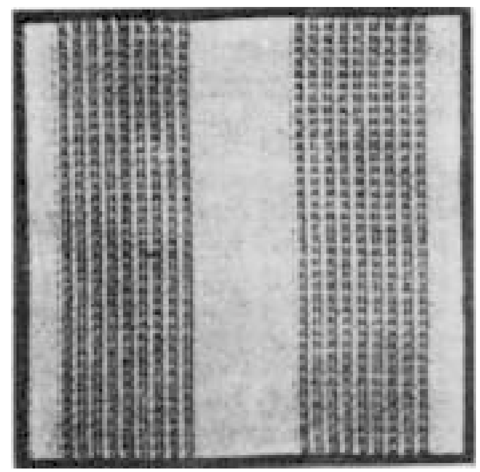


FIG. 486.—Fabric with mock leno stripes.

Fig. 486 is a photographic reproduction of an example of cloth woven with mock leno and warp satin stripes arranged alternately, and will serve to illustrate the realistic leno effects that may be obtained without employing a leno harness. Mock leno weaves are of very simple construction, and are chiefly dependent upon the frequent counterchanging of a suitable weave, to produce the desired effects. A few examples of these weaves are given in Figs. 487 to 490. Fig. 487 is a simple pattern counterchanging on three warp threads and picks, and therefore repeats on six threads of warp and weft. The counterchange after the third and sixth warp threads and picks, combined with the particular method of interweaving them, produces distinct gaps or "frets" both lengthwise and crosswise of the fabric, and thereby creates a decided gauze or leno effect in cloth. The warp threads may be passed in pairs through each dent of the reed; but the leno effect will be emphasised by passing them in groups of three through each dent, commencing with the first three warp threads in the design.

Another good mock leno effect is produced by the "canvas" weave represented in Fig. 488, so extensively employed in the manufacture of the well-known canvas cloth, usually produced

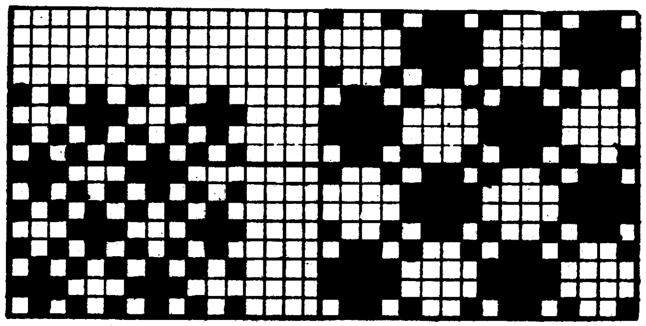


FIG. 487. FIG. 488.
Mock leno designs.

in coarse textures from strong folded warp and weft, and chiefly used for the purpose of cross-stitching and other fancy needlework. This design is really a further development of that given in Fig. 487 and is made to counterchange after every four threads in both warp and weft, so that the pattern repeats on eight threads each way. The small perforations characteristic of this fabric, and through which the needle is inserted (when employed for fancy needlework), result entirely from the counterchange of the threads. The occurrence of the perforations is quite incidental to that weave, and therefore unavoidable. If it is required to introduce the canvas weave as a mock leno effect, in conjunction with another weave, to form stripes, a

superior effect will result by passing warp threads in groups of four through each dent of the reed.

A third example of a mock leno effect, which is very extensively employed, is that illustrated by Fig. 486. The design for that example (as given in Fig. 489) repeats on six warp threads and six picks, and is counterchanged after the fifth and sixth threads in both directions, thereby causing the sixth thread of warp and weft to become quite isolated from adjacent threads, and so develop a leno effect of a very pronounced character. By drawing the first five warp threads in the first dent, and the sixth warp thread in the third dent, with the second and fourth dents left empty, a very realistic simulation of a genuine gauze or leno effect is developed in cloth. A modification of this

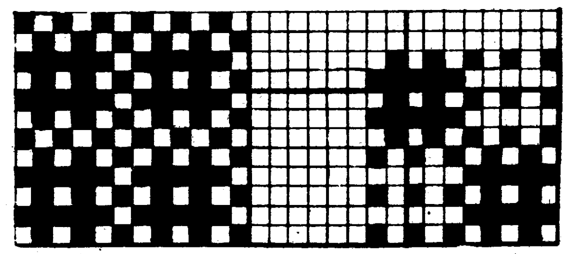


FIG. 489. FIG. 490.
Mock leno designs.

weave is given in Fig. 490. With this weave warp and weft would be displayed in equal quantities on both sides of cloth. This circumstance is favourable to the effective introduction of coloured threads (say, the second, fourth, seventh and ninth warp threads and picks) to produce pleasing decorative effects. The mock leno designs given in Figs. 489 and 490 bear a close resemblance to the sponge design given in Fig. 237 (§ 43) and also to the huck-a-back weave, Fig. 245 (§ 44), to which they are closely allied; and if warp threads were suitably drawn through the reed, those weaves would also develop good mock leno effects. Many other varieties of mock leno designs could be given, but the present examples will suffice to demonstrate the general character of this useful class of imitation gauze and leno effects.

CHAPTER X.

FIGURED LENO BROCADE FABRICS.

§ 140. "Leno brocade" is a term descriptive of an interesting and important variety of textures that are characterised by the

FIG. 491.—Jacquard leno brocade fabric.

gauze or leno principle of cross weaving introduced in combination with an ordinary brocade fabric consisting of one series each of warp and weft threads. They are produced in every variety

of texture and material, according to the purpose for which they are intended. When manufactured of cotton, they are usually of light texture, for use as window curtains, light summer dress materials, and fancy aprons for domestic wear. They are usually constructed either with a leno figure surrounded by a ground filling of plain cloth, as exemplified in Fig 491; or with

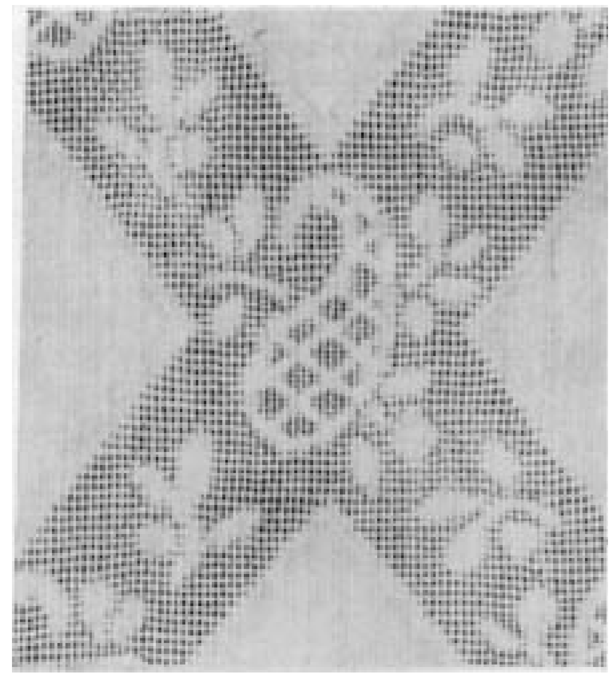


FIG. 492.—Jacquard leno brocade fabric.

a figure of the plain weave surrounded by a ground filling of leno, as in Fig. 492. In some examples of leno brocades, warp, weft (or both) are allowed to float as required for the development of brocade or float figuring. In others, stripes or bands of net leno effects are developed by introducing coarse "corded" or "net" warp threads as an additional means of embellishment, as exemplified in Fig. 493; and also by means of swivel figuring, as illustrated in Figs. 494. and 495.

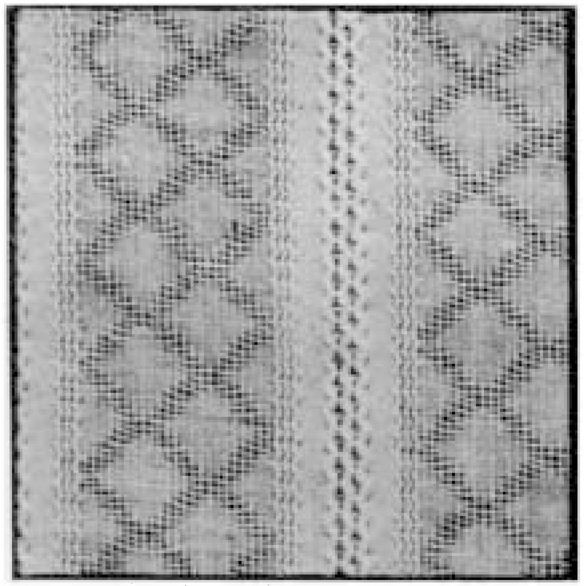


FIG. 493.–Fabric embellished with leno brocade and net leno effects.

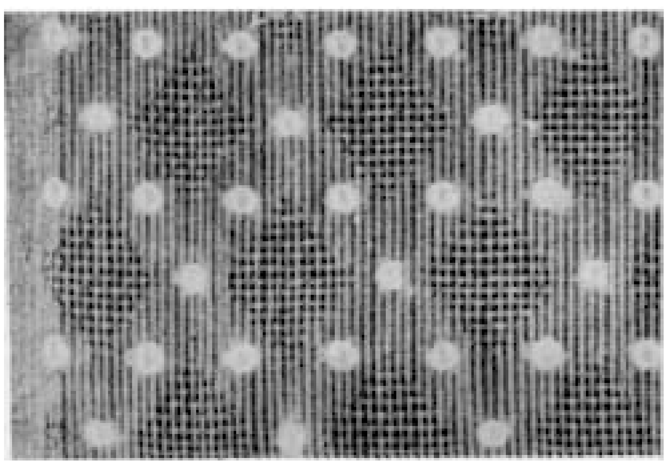


FIG. 494.–Fabric embellished with leno brocade and swivel figuring.

Leno brocade fabrics offer practically unlimited scope to a designer in the production of decorative effects of both a floral and geometrical character, which are sometimes developed with a considerable amount of detail, especially when produced in silk and the finer cotton textures, some of which are admirable specimens of the art of weaving. The contrast afforded by the combination of a relatively close and compact texture of plain cloth with a leno texture of a more or less open character (which characterises these fabrics) produces a very pretty effect,

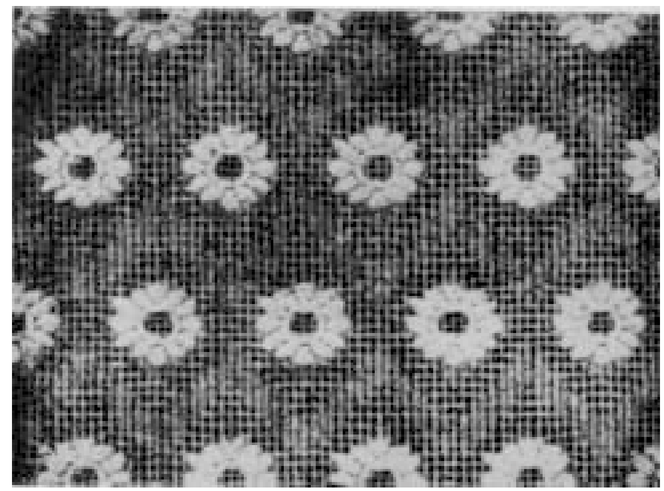


FIG. 495. –Fabric embellished with leno brocade and swivel figuring.

especially when they are lined with a fabric of an agreeably contrasting colour. Designs of a very simple character may be woven by means of an ordinary set of doup heald harnesses; but for the more elaborate designs it is necessary to employ a gauze or leno brocade Jacquard harness, which may be controlled either by a Jacquard machine of ordinary construction, or preferably by one that is specially adapted for the purpose, and as described in §§ 148 and 149.

The principles governing the construction of leno brocade fabrics are identical (so far as the leno structure is concerned) with those governing the construction of gauze and net leno fabrics that are produced by means of a heald leno harness. The scheme of douping or crossing the warp threads may either be of a uniform character in all parts, or else different schemes may be introduced to give greater variety of effect. Also doup and standard warp threads may either be arranged alternately with each other to form a "one-and-one" crossing, or else with one doup and two standard warp threads alternately: or, again, the threads may be arranged in alternate pairs, so as to form a "two-and-two" crossing. In the majority of leno brocade fabrics, the warp threads cross each other in pairs, with a uniform scheme of douping in the leno portions, in which either one pick or else two or more consecutive picks of weft are placed contiguously in each warp shed.

§ 141. Three graphic illustrations of a leno brocade Jacquard harness arranged on the "top doup" principle, and with both doup and standard warp threads crossing each other in pairs, are represented in Figs 496, 497 and 498. Such a harness consists of three distinct parts—namely, the principal or brocade harness A, immediately in front of which is situated the doup harness proper B, both of which are drawn through the same comber-board E; and D, the "easer" harness situated about 12 to 15 ins. to the rear of the principal harness, and drawn through a separate comber-board G. The doup harness operates in conjunction with a set of doup slips C, which depend from a stave F fastened on the front edge of the comber-board E. Each doup slip passes separately through a mail eye of the doup harness, and receives a pair of doup threads. The principal harness is precisely similar to that of an ordinary brocade harness, and may be used as such, quite independently of the other portions of the harness, for the development of brocade figuring, as required. The easer harness is usually furnished with large glass mails to receive doup warp threads, and is situated between two rods H, forming what is termed the "bridge," fixed underneath the warp threads, with the mails placed about 3 ins. below the bridge rods, whereby doup threads are deflected from a straight course so as to increase their length between the warp beam and "fell" of cloth, and thereby permit of those threads being "slackened" to relieve them of undue tension when they are required to form a cross shed.

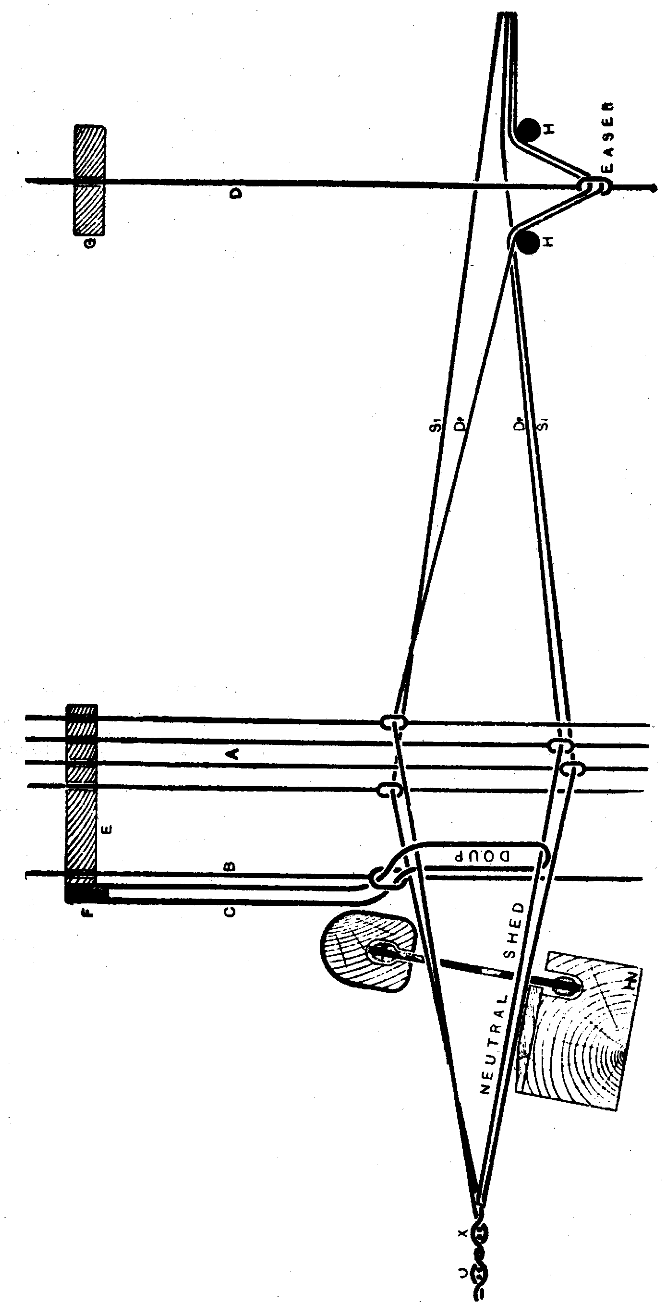


FIG. 496.—Leno Jacquard harness, illustrating formation of "neutral" warp shed.

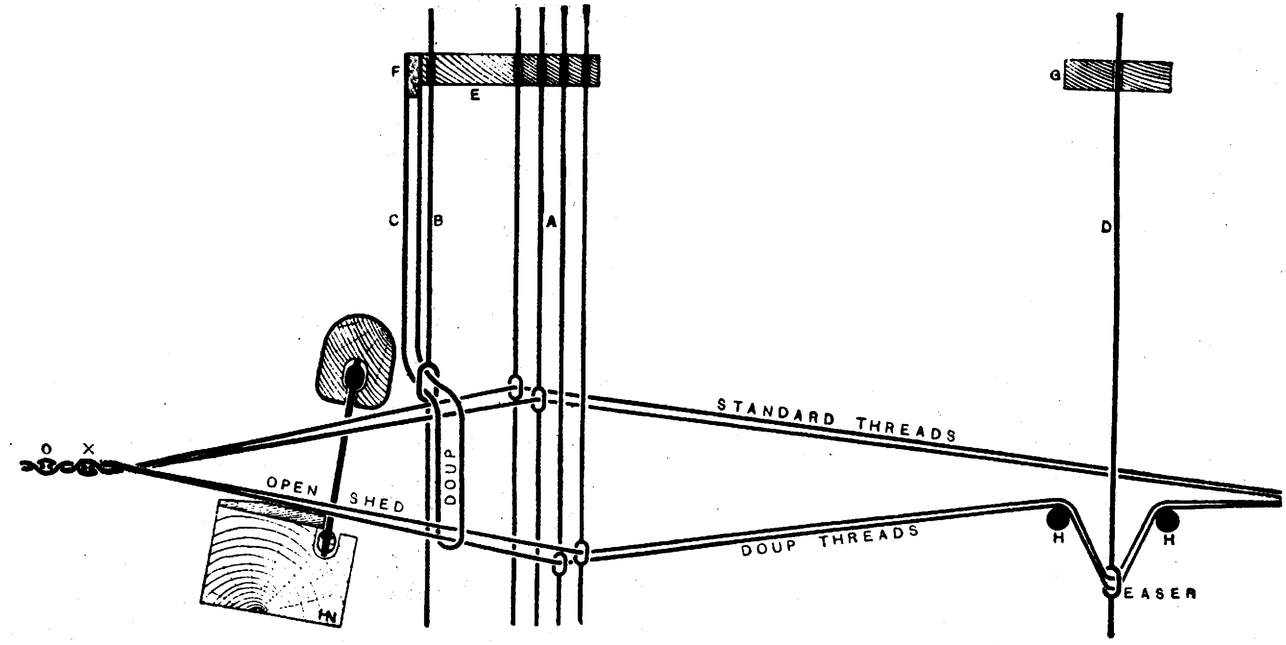


Fig. 497.—Leno Jacquard harness, illustrating formation of "open" warp shed.

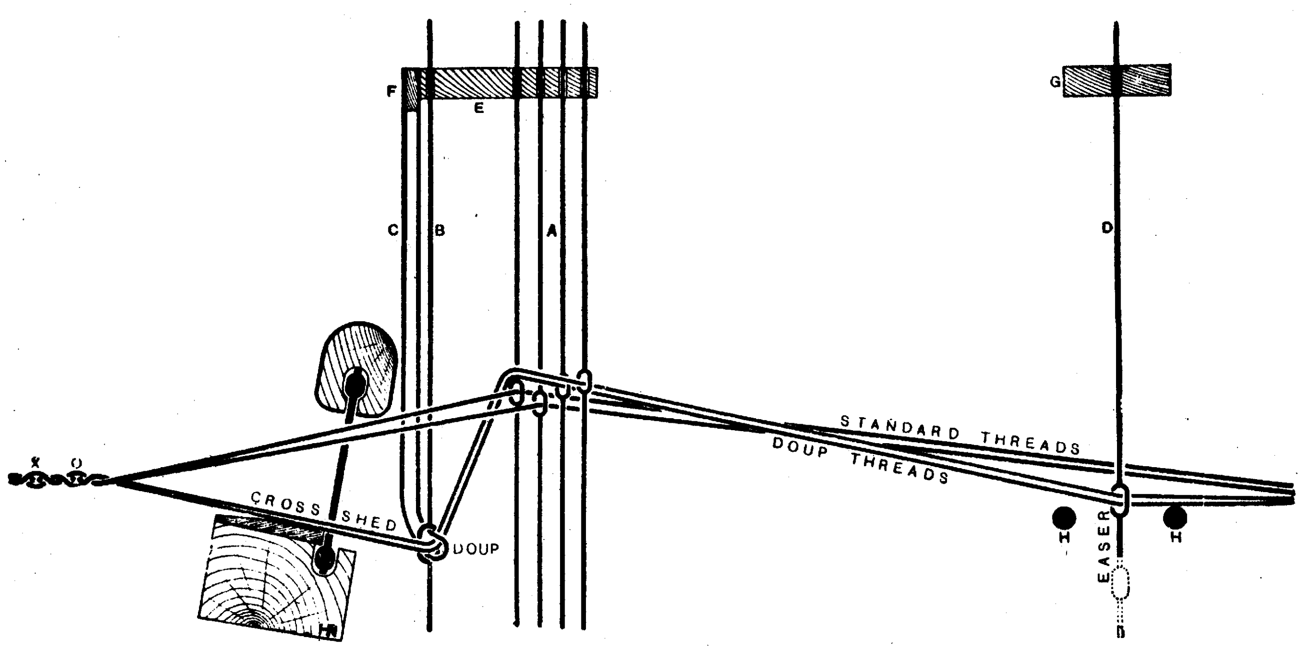


Fig. 498.—Leno Jacquard harness, illustrating formation of "cross" warp shed.

All warp threads are contained upon the same warp beam, excepting when net leno stripes are introduced, in which case, such number of extra warp beams are required (to contain the thick net doup threads) as corresponds with the different schemes of douping in the same fabric. If a two-and-two crossing of warp threads is required, alternate pairs of threads are passed together through the glass mails of the easer harness, to serve as "doup" warp threads, leaving intermediate pairs of threads for "standard" warp threads. Excepting for the deflection of doup threads by the easers, all warp threads pass perfectly parallel from the warp beam to their respective mail eyes of the principal harness, through which they are separately drawn in consecutive order.

After all warp threads have passed separately through the mails of the principal harness, each pair of doup threads is crossed in regular succession over a pair of standard threads, always in the *same direction uniformly* (say from right to left when stood in front of the loom, as represented in the diagrams), after which *the doup threads only are passed together* through their respective doup slips, when the two pairs of warp threads that cross each other are passed together through the *same dent* of the reed.

§ 142. The method of drawing-in and crossing the warp threads in a leno brocade harness will be easily comprehended on referring to Figs. 496, 497 and 498, which illustrate the formation of a "neutral," an "open" and a "cross" shed respectively.

A "neutral" shed is one in which warp threads are raised in any desired manner (irrespective of whether they are standard or doup threads) for ordinary brocade weaving, in which no crossing of threads occurs. It is formed by raising the doup mails where required for the purpose of relieving the respective doup slips, in order to permit of doup warp threads separating within them to form a shed; whilst the corresponding easers remain down, as clearly indicated in Fig. 496,

An "open" shed (Fig. 497) is formed by raising standard warp threads and keeping doup threads down, by means of the principal harness; and at the same time raising the corresponding doup mails so as to relieve the doup slips and permit of standard threads rising between them and the doup mounting threads, as indicated in the diagram, whilst the easers remain down.

A "cross" shed (Fig. 498) is formed by keeping doup threads down by means of the doup harness, and by raising standard and doup threads by means of the principal harness, and at the same time raising the corresponding easers to slacken doup threads, and so compensate for the short interval allowed them for the formation of a "cross" shed.

§ 143. As observed previously in § 140, the scheme of douping or crossing warp threads in leno brocade fabrics may be either of a uniform character, or else, several schemes may be introduced in different parts of a pattern to give variety of effect; though the usual practice is to employ only one scheme of douping, with warp threads crossing in pairs, and with either two, three or four consecutive picks inserted in each leno shed. It was further stated that, when drawing in warp threads through the harness, doup threads were crossed from the normal or open side to the crossed side of their respective standard threads uniformly in the *same direction.* It should at once be observed, however, that such circumstance does not make it imperative that all doup threads must cross either simultaneously or in the same direction, as it would under similar conditions if warp threads were drawn through a heald harness.

By employing a Jacquard machine to govern warp threads independently, some may be made to form a cross shed, whilst others are forming an open shed for the same picks. Designers for leno brocade fabrics usually turn this opportunity to advantage by developing the leno portions of a design so that, when reproduced in cloth, those doup warp threads that were contained in *alternate dents* of the reed, when in the loom, will be on the *crossed side*, whilst those that were in the intermediate dents will be on the normal or *open side*, of their respective standard threads, for the same pick or picks of weft. Thus, a leno effect is produced in which successive pairs of doup threads cross their standard threads in *reverse directions* for the same picks, exactly as if they had been crossed in reverse directions in the harness, and made to form a cross and open shed alternately for consecutive picks or pairs of picks.

§ 144. The foregoing observations are clearly demonstrated in Fig. 484, in which the arrangement of warp threads in the various sections of a "top doup" leno brocade harness and in the reed, and also a plan of cloth, are represented graphically. By carefully studying this diagram in conjunction with those given in Figs. 496 to 498, the operation of a leno brocade harness will be more readily understood.

The plan of cloth represents a portion of a fabric in which a gauze figuring is developed by crossing warp threads in pairs, and inserting two picks in each leno shed; whilst warp threads and picks interweave as single threads to develop a ground texture of the plain calico weave. The scheme of douping is that in which warp threads contained in alternate dents of the reed cross in one direction whilst those in intermediate dents cross in the reverse direction for the same picks. For example, doup warp threads are held down and standard warp threads are raised, on their *normal* sides, in dents 3 and 5, to form an "open shed" for the last pair of picks inserted; whilst, in dents 4 and 6, doup threads are down and standard threads are raised, on their *crossed* side to form a "cross shed" for the same picks of weft. At the same time, warp threads in dents 1 and 2 are forming a "neutral" shed, to weave either plain cloth or brocade figuring, in which warp threads always occupy their normal relative position.

By a little closer observation of Fig 499, it will be seen that a "neutral shed," as in dents 1 and 2, is formed by raising doup mails to relieve their doup slips and permit of warp threads being raised or left down in any order, to produce an ordinary brocade texture, as represented in Fig. 496. An "open shed," as in dents 3 and 5, is formed by raising doup mails to relieve their corresponding doup slips and allow the doup threads to return to the normal side of their respective standard warp threads, which are raised, whilst doup threads and their easers remain down as represented in Fig. 497.

A "cross shed," as in dents 4 and 6, is formed by raising

both standard and doup warp threads by means of the principal harness, slackening the corresponding easers, and keeping doup

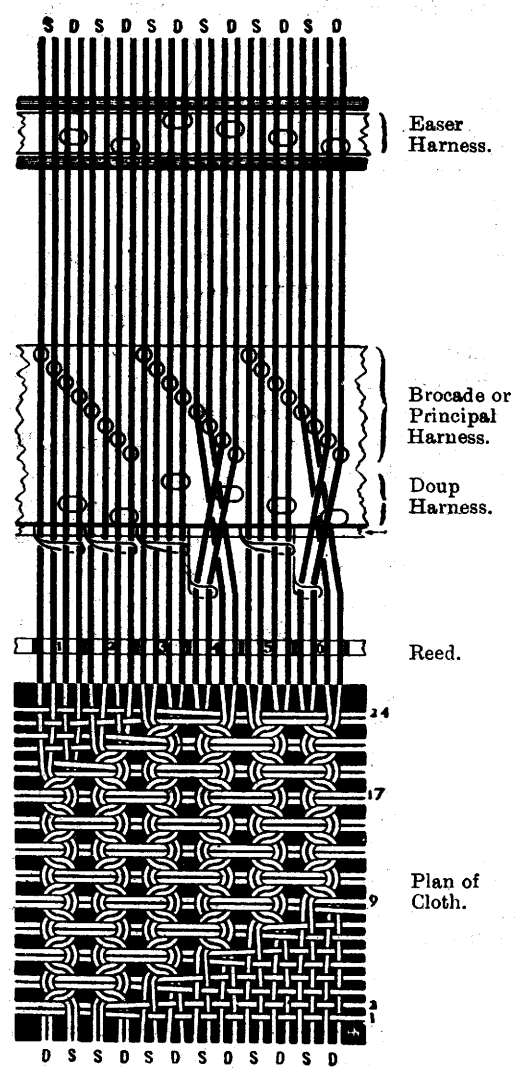


Fig. 499. –Plan of leno brocade harness and fabric.

mails down to retain doup threads on the crossed side of their respective standard threads, as represented in Fig. 498.

§ 145. In § 140 it is stated that a leno Jacquard harness may be controlled either by means of a Jacquard machine of ordinary construction, or preferably by one that is specially adapted for such a harness. In either case precisely similar results are obtained, but an economical advantage is gained by the use of special leno Jacquard machines, inasmuch as they greatly facilitate and simplify both the preparation of designs to be reproduced by them, as well as the subsequent operation of card-cutting. If an ordinary Jacquard machine is employed for leno fabrics, it will be necessary to equip it with sundry auxiliary attachments to perform the functions of douping or lenoing and easing.

These supplementary appliances vary in character to suit the particular construction of the harness, of which there are various modifications, to be described presently. Such harnesses may be constructed on either the top doup or the bottom-doup principle as desired; although it appears to be the prevailing practice to employ a bottom-doup harness for the production of Jacquard leno fabrics. But whatever particular form a leno brocade harness may assume, it will be found to consist essentially of three distinct sections, as represented in Figs. 496, 497 and 498.

A simple and efficient adaptation of an ordinary single-acting Jacquard machine to govern a leno harness is represented in Fig. 500, which shows the connection of the harness to the machine. The harness is represented as a *bottom-doup* harness, with the doup slips C contained upon a stave F which is operated by spare hooks I of the machine, so that it is raised for every pick inserted. The depression of the doup stave is effected by means of a spring J attached to the floor. When the stave containing the doup slips is placed *above* warp threads to constitute a *top-doup* harness (as represented in Figs. 496. 497 and 498), it is screwed to the front edge of the comber-board E, and therefore becomes a fixture. The position of the doups, however, is quite optional provided the respective portions of the harness are governed in accordance with that position.

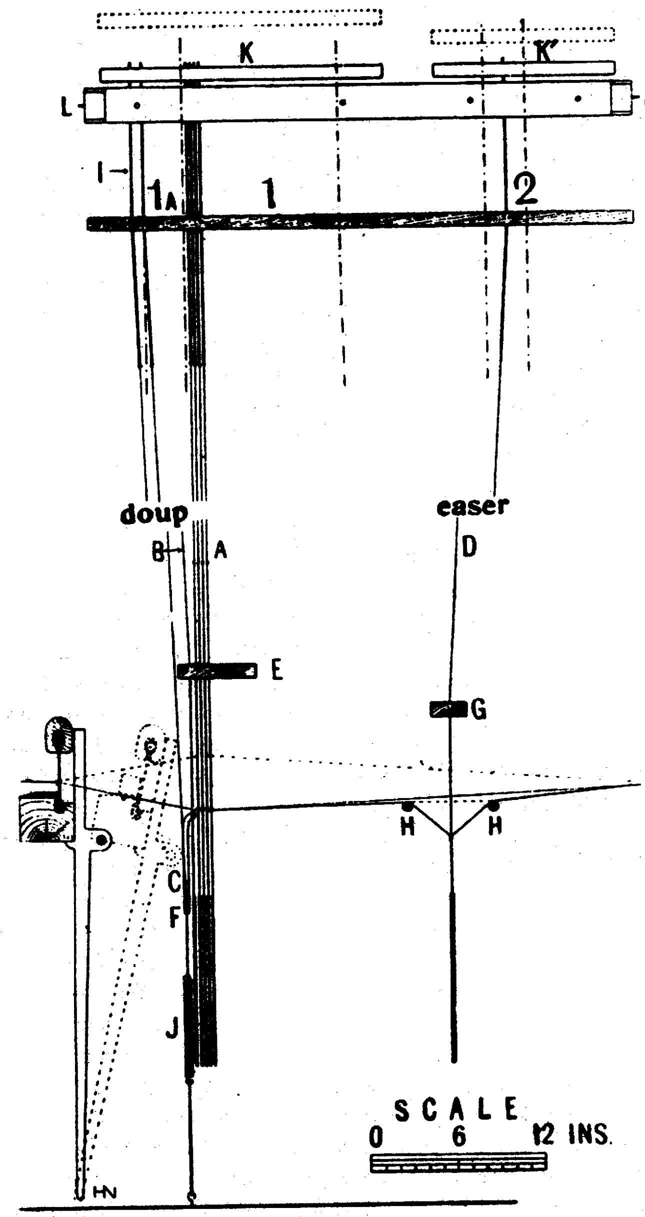


Fig. 500.—End elevation showing one type of a *bottom-doup* leno Jacquard harness governed by ordinary Jacquard machines.

The Jacquard machine represented in Fig. 500 consists of two distinct sets of hooks and needles (1, 1A and 2) contained in the same framing, and actuated by two separate sets of pattern cards, which pass over the same cylinder L, and therefore operate simultaneously for consecutive picks of weft. The larger division contains, say, 408 hooks and needles, with the "25 side" of the machine (which is on the left when facing the cylinder) over the front of the loom. This portion is subdivided into two parts, 1 and 1A, and governs both the principal and doup harnesses respectively. The smaller division (2) has a capacity for 208 hooks and needles to govern the easer harness D, though it need not contain more than one-quarter of the number contained in division 1 when warp threads are required to cross in pairs, in which case only one hook and needle is required for every four warp threads.

Thus, assuming a "tie-up" of 320 hooks, in part 1, for the brocade harness A, and that warp threads are required to cross in pairs, 80 hooks would be required in part 1A to govern the doup harness B, and 80 hooks in part 2 to govern the easer harness D. This ratio is indicated in the diagram by 4 hooks in part 1, and 1 hook each in parts 1A and 2. It should be observed that when tying up a bottom-doup leno harness it is advisable to tie up the doup portion of the harness, so that the mails of that portion, which contain the doup slips, will be about $\frac{1}{8}$ in. lower than those of the principal harness, when the shed is closed, to facilitate the crossing of doup and standard warp threads. Also, doup mails should be a little larger, and the lingoes preferably slightly heavier than those of the principal harness; whilst the mails for the easer harness are usually of glass, and the lingoes for that harness should weigh about 10 per lb. for warp threads of medium counts of yarn.

§ 146. It is unnecessary, when slackening doup warp threads during the formation of cross sheds, to raise the mails of the easer harness through the same distance as those of the principal and doup harnesses. Some means, therefore, must be adopted whereby the easer mails will be raised a little shorter distance

than those of the principal and doup harnesses. This object is effected in a variety of ways by different machines and harnesses, as will be described presently. Thus, if the easer harness is governed by an independent set of hooks in the Jacquard

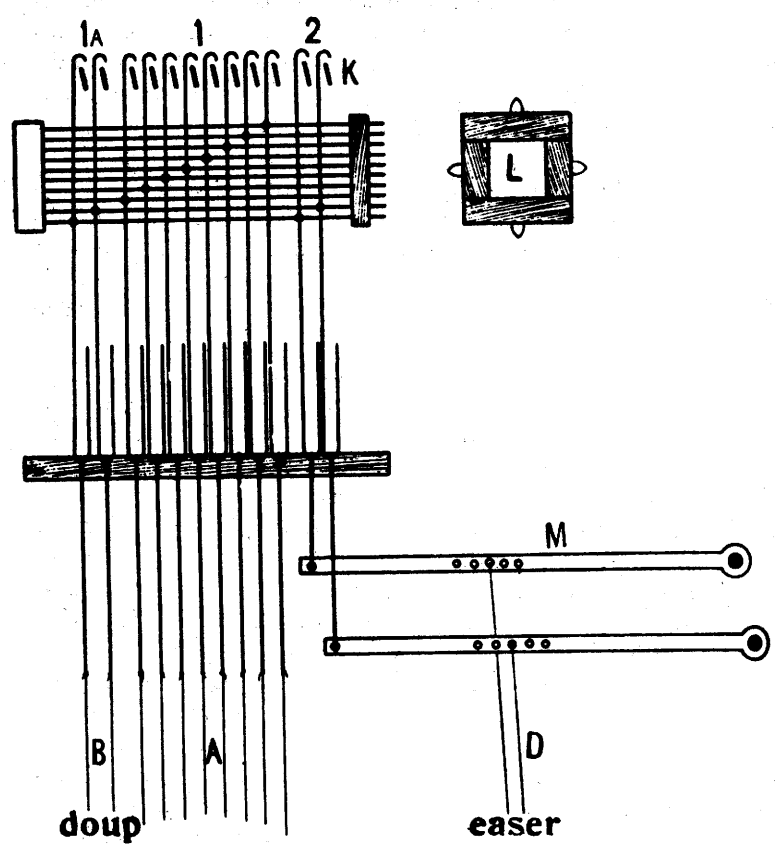


FIG. 501.—Jacquard machine adapted specially for governing a *bottom-doup* leno Jacquard harness.

machine, the function of easing may be accomplished by one of several optional methods, namely, (1) by employing two separate and distinct sets of griffe blades (as represented in Fig. 485) with one set K to raise doup and principal harness hooks, and another K^1 to raise easer harness hooks. By this method both griffes are actuated from the crank shaft of the loom, and therefore act in unison; but the easer griffe is raised for a shorter distance than the principal griffe, as indicated by dotted lines:

(2), By another method (illustrated in Fig. 501) only one set of griffes K is employed for all hooks, but the easer hooks (2) communicate with the easer harness D through the medium of a corresponding number of levers M of the second order, so as to reduce the lift of that harness:

(3), By a third method, illustrated in Fig. 502, which also dispenses with the second set of griffes, the function of easing is effected by attaching the mounting threads of the easer harness D either to the corresponding mounting threads, or else to the neck cords of the doup harness B, so that the complementary doup and easer mails controlling the same doup thread or threads will always rise and fall simultaneously. This latter method of easing, however, may only be adopted with a *bottom-doup* harness, which forms cross sheds by *raising* doup warp threads by means of the doup harness, whilst standard warp threads remain *down*, at which periods it is necessary to slacken doup warp threads to relieve them of undue tension.

This harness also illustrates another departure from the leno harnesses described previously. Thus, instead of employing a stave containing all doup slips, these are attached to separate lingoes, and connected by means of mounting threads B^1 to *each* of the two principal harness threads which also govern *doup* warp threads. By this means the doup slips are raised independently by the principal harness threads, only when that is necessary, both for the formation of open sheds by particular groups of crossing threads, and also by doup harness threads for the formation of cross sheds. A disadvantage of this arrangement of a leno brocade harness, however, is that the connecting threads B^1 become slack, as shown in the diagram, whenever their respective doup harness threads B are raised to form cross sheds.

§ 147. With the type of leno harness represented in Fig. 502 it would appear, at first sight, that, in consequence of the easer harness threads D being attached directly to their complementary doup harness threads B, the easer harness would

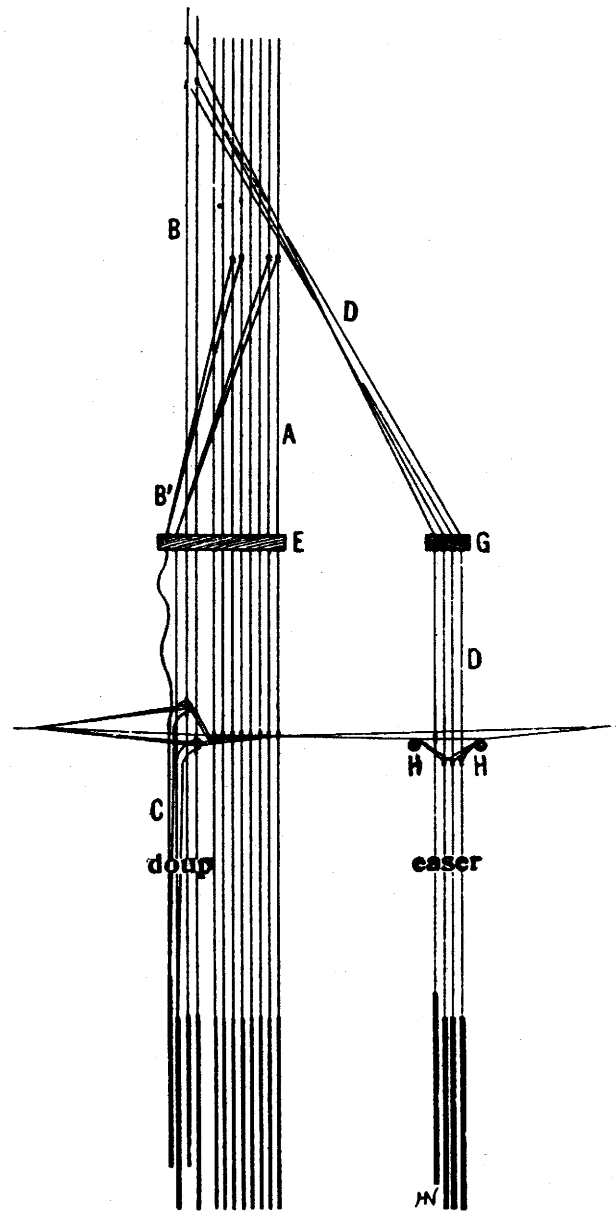


FIG. 502.—A second type of *bottom-doup* leno Jacquard harness governed by an ordinary Jacquard machine.

be raised as high as the doup harness, which would be quite unnecessary. Such, however, is not the case, as a little reflection will show. In consequence of the divergence of easer mounting threads from their points of connection with the doup mounting threads (which are perpendicular) to the points where they pass through their comber-board G, the length of threads D, between these points, will not increase in a measure equal to the lift of doup mounting threads; hence the shorter lift of easer mails, which may be increased or reduced by tying easer mounting threads to doup mounting threads at a higher or lower point respectively.

Leno Jacquard Machines.

§ 148. A simple and efficient method of actuating a leno brocade mounting, with the object of raising the easer harness for a shorter distance than the principal and doup harnesses, is that provided by Devoge's special leno Jacquard machine as illustrated in Fig. 503, which represents a machine of this type adapted for governing a *bottom-doup* harness. In machines of this type, the hooks are disposed in three sections, namely, 1, 1A and 2 (as also represented in Fig. 501), to govern the principal, doup and easer harnesses respectively. The shorter lift of easer hooks constituting section 2, than that of the principal and doup hooks in sections 1 and 1A respectively, is effected by employing two distinct sets of griffes K, K¹, each contained in a separate frame and actuated by independent lifting levers. The frame containing griffes K, which raise the principal and doup hooks, is connected by means of a link-rod P directly to the primary lifting lever Q, and is raised for the full height of the shed; whereas the frame containing the easer griffes K¹ is connected by means of a connecting link-rod P¹ to a secondary lifting lever N, fulcrumed on a pin O, fixed in a bracket situated on the *same side* of the machine as that containing *easer hooks*, to ensure a shorter lift of those hooks. The free end of the secondary lifting lever N is furnished with a slot for the reception of a stud R projecting from the connecting link-rod P, by means of which the lever N is oscillated. The primary lifting lever

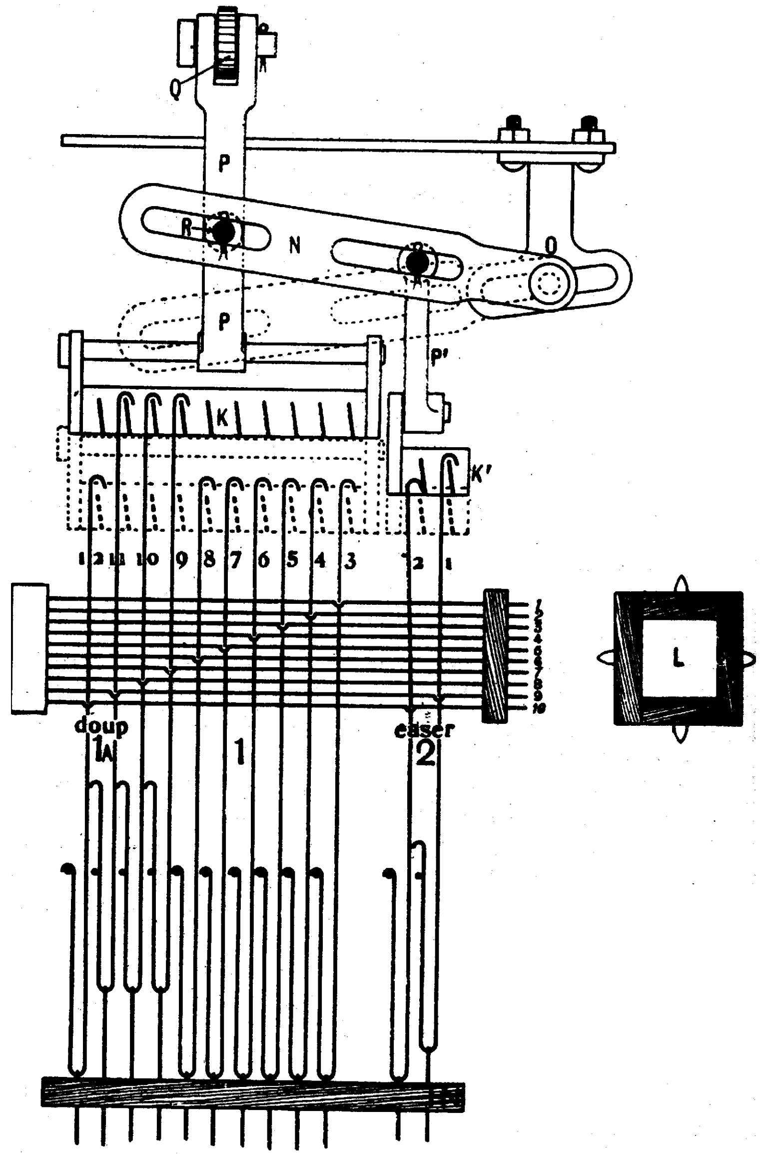


FIG. 503.—Devoge's leno Jacquard adapted for a *bottom-doup* harness.

Q communicates, through the medium of a long connecting rod, to a crank fixed on one end of the crank-shaft of the loom. Hence both the primary and secondary lifting levers oscillate in unison with the rotation of the lifting crank.

In a 400's Jacquard machine of this type, the hooks are arranged in twelve rows containing 51 hooks in each row. These are controlled by ten horizontal rows of needles or lances, thereby requiring a card cylinder bored with ten long rows of holes in each side, to receive pattern cards of a corresponding index or gauge. The 408 hooks forming the middle eight rows (Nos. 3 to 10 inclusive) govern the principal or brocade section of the harness, and are controlled by the eight upper rows of needles. If the machine is mounted on a loom with the card cylinder at the back, the easer harness must be attached to, and governed by, the hooks forming the first and second rows; and the doup harness must be governed by the eleventh and twelfth rows of hooks. If, however, the machine is mounted with the cylinder towards the front of the loom, those conditions would be reversed by placing the easer hooks and griffes, in the rear part of the machine, to constitute the eleventh and twelfth rows, for governing the easer harness; and by placing the doup hooks at the front, to constitute the first and second rows for governing the doup harness. Also, the secondary lifting lever N would have to be reversed, so as to place the fulcrum O on the same side as the easer hooks which require to be raised for a shorter distance, as described.

In the machine represented in Fig. 503, the first and last two rows of hooks, consisting of easer and doup hooks respectively, are controlled by only two rows of needles, namely, the ninth and tenth rows. Each needle in those rows is formed with two loops or cranks—one to receive an easer hook, and another to receive a doup hook, both of which hooks thereby become complementary to each other, and must, therefore, always respond in unison to the movement of the same controlling needle. Thus each needle in the ninth row simultaneously controls the two complementary easer and doup hooks that are contained in the first and eleventh rows respectively, whilst the complementary easer and doup hooks

in the second and twelfth rows are controlled simultaneously by the same needle in the tenth row.

§ 149. If a machine of this type is adapted for governing a *bottom-doup* harness, in which complementary doup and easer mounting threads must, of necessity, rise and fall simultaneously and in unison, the dual control of both a doup and an easer hook by the same needle will require those two series of hooks to be placed in the same direction, uniformly, as indicated in the diagram, Fig. 503. If, however, these machines are adapted for governing *top-doup* harnesses, in which complementary doup and easer mounting threads rise and fall in a contrary manner to each other simultaneously, the doup and

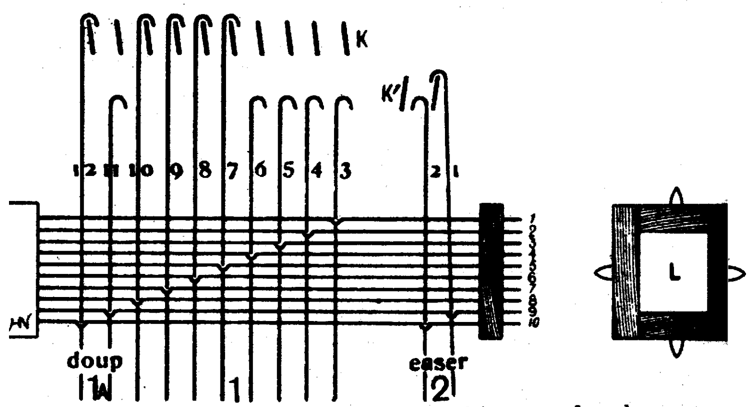


FIG. 504.—Devoge's leno Jacquard adapted for a *top-doup* harness.

easer hooks of the machine would, in that case, require to be placed in reverse directions with the *easer* hooks pointing away from the card cylinder and resting, normally, *away* from their griffes, as indicated in Fig. 504.

By adopting the simple expedient just described, and as indicated in Fig. 504, in the construction of a leno brocade Jacquard machine of this type, adapted for governing a *top-doup* harness, it thereby ensures the control of complementary doup and easer hooks always in a contrary manner; that is to say, *if doup hooks remain down*, for the formation of "*cross-sheds*," the corresponding *easer hooks are raised*, at the same time, for easing the doup warp threads; and, *per contra, if* *doup hooks are raised*, for the formation of "open" and "neutral" sheds, the corresponding *easer hooks remain down* at the same time.

Leno Jacquard machines of the type under present notice

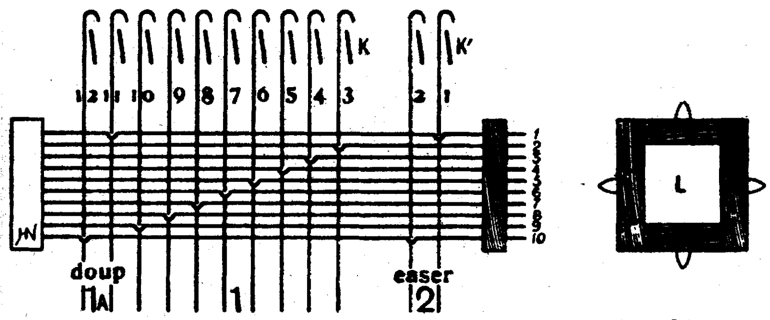


FIG. 505.—A second modification of Devoge's leno Jacquard adapted for a *bottom-doup* harness.

are sometimes made with minor and unimportant modifications to suit the personal preference of manufacturers. Thus, in some machines, the doup and easer hooks are controlled by

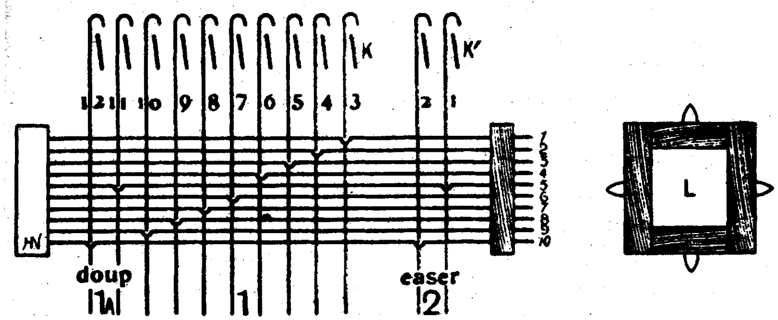


FIG. 506.—A third modification of Devoge's leno Jacquard adapted for a *bottom-doup* harness.

needles forming the first and tenth rows, as represented in Fig. 505. In others, those hooks are controlled by the fifth and tenth rows of needles, as represented in Fig. 506. These modifications, however, in no way affect either the operation of the machines or the preparation of designs for them. The choice of these arrangements is quite optional, and only affects the convenience, or prejudice, of the card cutter, who may favour either one or the other of the optional arrangements as described.

Methods of Preparing Leno Brocade Designs.

§ 150. The method of indicating upon squared point paper an applied design, for a leno brocade fabric, varies according to the particular type of Jacquard harness and machine by which the design will be reproduced in the fabric, and of which there are several modifications that are designed specially for fabrics of this type. It is essential, therefore, that a designer for these fabrics should have some knowledge of the construction and operation of these special leno Jacquard machines and harnesses to enable him to prepare the applied designs with greater technical accuracy.

The small fragment of a leno brocade design, Fig. 507, will serve to demonstrate the general method of procedure in indicating, upon point paper, a design to be reproduced by means of a Jacquard machine in which the hooks and needles controlling the three sections of a leno brocade harness constitute three separate and distinct divisions, namely—A, for the principal or brocade harness, B, for the doup harness, and C, for the easer harness, gaited-up as a top-doup harness, as represented in Figs. 496, 497 and 498. The portion of the design indicated in Fig. 507 corresponds to the plan of cloth represented in Fig. 499 comprising twenty-four warp threads and twenty-four picks of weft; and, unlike most applied designs for fabrics of a simple brocade texture, which indicate the actual interlacing of warp and weft threads, the leno portions of a leno brocade design bear no resemblance whatever to the plan of inter-weaving those threads, nor does it really indicate the order in which warp threads are raised or left down for the respective picks of weft.

What a leno brocade design actually does indicate is the operation of the harness threads in the respective sections. Thus, the operation of the principal harness threads is indicated at A, whilst that for the doup and easer harness is indicated at B and C respectively. It is the relative positions of the warp threads, during shedding, that determines their relative positions in the cloth. Thus, in the leno portions of the design, standard warp threads are represented as being raised for every pick, whilst doup threads are represented up for alternate pairs of picks and down for intermediate pairs of picks. On examining the plan of cloth, however, as represented in Fig. 499, it will be seen that, although *standard* warp threads are *raised* in the leno portion for *every pick*, *doup*

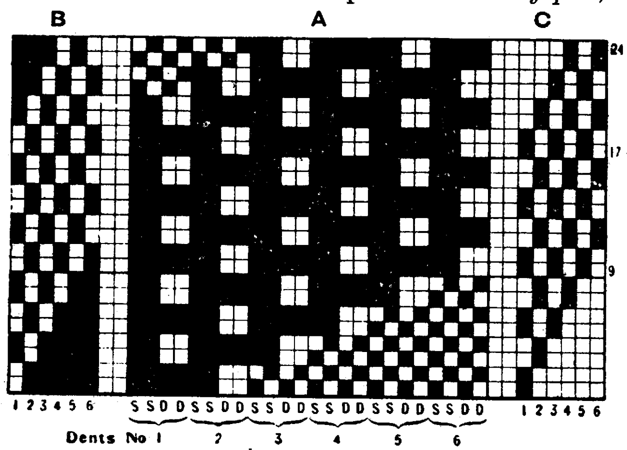


FIG. 507.—Method of preparing an applied design for a *top-doup* leno Jacquard harness governed by ordinary Jacquard machines, as represented in Fig. 500.

threads are *always down* in that portion, because, although they are raised by the principal harness when forming a cross shed, they are held down on their crossed side by their respective doup mails and slips, as explained previously in § 144.

§ 151. On examining this fragment of a design, it will be seen that whenever both standard and doup threads are raised together in the same dent of the reed, the corresponding *doup* harness thread governing those doup threads remains down, thereby retaining them on their crossed side to form a *cross shed* in that dent. At the same time, the corresponding easer harness thread is raised to slacken the doup threads, and thereby

prevent excessive strain upon them. If, however, standard threads only are raised in a given dent of the reed, the corresponding doup harness thread also is raised to permit of the doup threads returning to their normal side in order to form an *open shed*, whilst the corresponding easer harness thread remains down.

The same operation of doup and easer harness threads takes place when it is required to form neutral sheds in the calico and brocade portions of the fabric. It will be seen, therefore, that corresponding doup and easer harness threads always work in a contrary manner to each other: thus, when one is up, the other is down.

It should also be observed that, when preparing a design, it is more expedient to allow warp threads to form an *open shed for at least two picks of weft* between a cross shed and the calico weave, as indicated in the plan of cloth and the design, Figs. 499, and 507 respectively, and thereby permit of warp threads opening out more gradually from their congested state in the leno portion of the fabric. By carefully comparing those figures, the analogy existing between them will be clearly manifest.

The leno effect represented in Fig 499, in which warp threads in contiguous dents of the reed cross in reverse directions, has a far superior appearance to that in which they cross in the same direction uniformly. And although, as suggested previously, an exactly similar effect would result by crossing contiguous pairs of doup threads in reverse directions in the harness, and forming cross and open sheds alternately for successive pairs of picks, that course would not be so practical as the plan adopted, owing to the greater strain imposed upon warp threads when forming a cross shed, and the consequent greater strain exerted upon the various parts of the loom.

For these reasons it is more expedient, when drawing-in the warp threads through the shedding harness, to cross all doup threads in the *same direction* uniformly, and to form cross and open sheds alternately in successive dents of the reed for the same picks of weft, than it is to cross doup threads in reverse directions, and form cross sheds only for some picks and open sheds only for others during weaving. By the former method, the power absorbed by shedding is of a more uniform value for every warp shed, thereby conducing to a more uniform velocity, and consequently less straining and wear and tear of the various parts of a loom. But if the latter course were adopted, the disparity between the greater power required to form a cross shed, and the lesser power required to form an open shed, would tend to cause a loom to work with a more or less jerky and irregular action, due to the excessive straining of the various parts during the formation of cross sheds.

§ 152. The manner of setting out and developing an applied leno brocade design upon squared paper, ready for card-cutting, depends upon the relative disposition of the three divisions of hooks, and also the arrangement of needles controlling them, in the Jacquard machine by which the design will be reproduced in cloth. The method of preparing a design for a *top-doup* harness governed by a machine of the type represented in Fig. 500 is indicated in Fig. 507 whilst the same portion of design arranged for a *bottom-doup* harness to be governed by the same machine is indicated in Fig. 508, The only difference between the two designs is that they are counterchanged in respect of the principal and doup harnesses, to conform with the reverse conditions imposed by the respective arrangements of those harnesses, as described previously in § 149. Thus, in Fig. 507, (for a top-doup harness), the leno portion of the design is developed by raising standard warp threads for every pick of weft, and forming cross sheds by keeping the doup threads depressed by the doup harness, and raising them by the easer harness; whilst open sheds are formed by raising standard warp threads only. In Fig. 508, however (for a bottom-doup harness), those conditions are exactly reversed.

In leno Jacquard machines of the type for which those designs are prepared, the hooks commanding the doup and easer harnesses are situated respectively on *each side* of those commanding the principal harness; also doup and easer hooks are controlled by independent sets of needles that are in *horizontal*

alignment with those controlling the principal division of hooks. The three divisions of hooks and needles may be contained either within the same framing (provided easer hooks have an independent griffe), and actuated by only one set of pattern cards; or else easer hooks and needles may be quite separate from the others, as represented in Fig. 500, and actuated by an auxiliary set of pattern cards. In either case, it is necessary to prepare a design for such a machine in three sections, as indicated in Figs. 507, and 508, to correspond with the three divisions of hooks and needles in those machines.

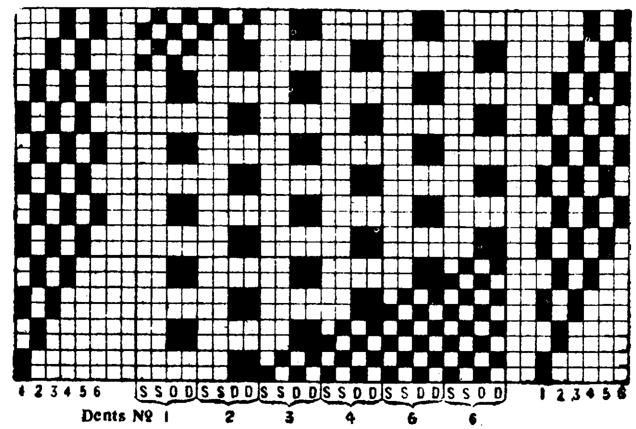


FIG. 508.—Method of preparing an applied design for a *bottom-doup* leno Jacquard harness, governed by ordinary Jacquard machines, as represented in Fig. 500.

It is customary, however, for a designer to economise time and labour by indicating the operation of doup hooks only, on one side of the design, to be "read" by a card-cutter when cutting for both the doup and easer hooks. Thus, when cutting the easer set of pattern cards (for a top-doup harness) he would counter-change the doup chart of the design; but for a bottom-doup harness, the doup chart of the design would be "read" and transferred to the easer set of cards in exactly the same manner both for the doup and easer hooks.

§ 153. The preparation of designs, and also the subsequent operation of card-cutting, is very greatly facilitated and simplified by the use of leno Jacquard machines of the type represented in Figs. 501 to 506; as it is unnecessary, in these circumstances, for the designer to indicate, by means of separate charts on each side of the principal chart of the design, the actual operation of the doup and the easer hooks of the Jacquard machine, as is necessary when preparing applied leno brocade designs that are to be reproduced by Jacquard machines of the ordinary type, as represented in Fig. 500. This advantage is afforded by both the easer and doup hooks, each being placed in two long rows situated in front and behind respectively those governing the principal harness, and also by the dual control of doup and easer hooks by only one set of needles that are placed in two separate horizontal long rows, but in *vertical* alignment with those controlling the principal figuring hooks. By such a disposition of hooks and needles the needles controlling doup and easer hooks are contained in the same short *vertical* rows as the principal set of needles, and, therefore, come within the compass of the narrow width of a pattern card. This circumstance enables the operation of doup and easer hooks to be indicated on the design by using a distinctive colour of paint for that purpose. By this means a card-cutter is enabled to "read" and cut for both sections of needles simultaneously for successive "bars" on the design paper, in a manner to be explained presently.

The method of indicating a design upon squared paper, for machines of this type, to govern a *bottom-doup* harness, is indicated in Fig. 509. (It may be desirable, at this point, to observe that the type of leno harness in mind is that represented in Fig. 500, which requires the doup slips, constituting the doup or half heald, to be situated *below* warp threads, and controlled either by spare hooks in the Jacquard machine, or preferably by the griffe of the machine, to which it may be connected directly so that the doup heald stave will rise with the formation of *every* warp shed.)

Although Jacquard machines of this type contain ten rows of needles, the design paper requires to be ruled with only eight vertical divisions in each "bar," albeit they represent a row of ten needles, and are "read" as such by the card-

cutter, as just stated. The portion of design given in Fig. 509 is executed for a leno brocade fabric having a leno figure, with a ground of the plain calico weave. The scheme of douping or crossing indicated in the design is one in which warp-threads would cross in pairs, with three consecutive picks of

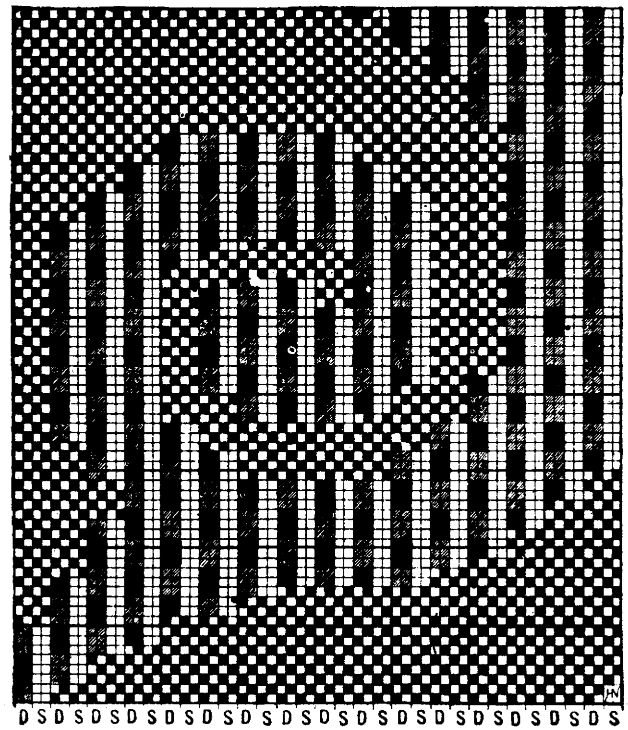


FIG. 509.—Method of preparing an applied design for a *bottom-doup* harness governed by the leno Jacquard machines represented in Figs. 503, 505 and 506.

weft inserted together in a cross and an open shed alternately, to produce the reverse crossing of threads, as described previously in §§ 143 and 151, and represented graphically in Fig. 499. Black squares in the design indicate corresponding warp threads raised by the principal harness, and shaded squares (which would be indicated by another colour of paint) indicate corresponding doup warp threads only, raised by the doup and easer harnesses.

§ 154. When cutting the pattern cards from a design to be reproduced by a Jacquard nachine, in which the needles are arranged as represented in Figs. 503 and 504, the eight vertical divisions in each "bar" of the design paper correspond with the first eight rows of needles controlling the principal hooks, in respect of black squares only, whilst shaded squares placed in the third and fourth divisions of each "bar" (from the right) indicate that holes must be cut in a pattern card so that when this is presented to the needles, by the card cylinder, they will coincide with the corresponding needles in the *ninth* row of needles; also, shaded squares in the seventh and eighth divisions in each "bar" of the design paper, signify that holes must be cut opposite the corresponding needles in the *tenth* row. (It may be explained that, although it is really only necessary to indicate the operation of doup and easer hooks by painting the *fourth* and *eighth* divisions only in each "bar," wherever such indication is required, it is customary, in actual practice, to paint *both* divisions on the design paper, representing the two contiguous doup warp threads, as indicated in the fragment of the design, Fig. 509.)

If, therefore, a leno brocade design is prepared for a leno Jacquard machine which is specially adapted for governing a *bottom-doup* harness, and as represented in Fig. 503, the applied design will require to be developed in the manner indicated in the fragment of a design represented in Fig. 509.

If, however, the design is prepared for a leno Jacquard machine adapted for a *top-doup* harness, and as represented in Fig. 504, it will be necessary for the designer also to paint up, on the design paper, those divisions which represent the *standard* warp threads, in the leno portions of the design, as indicated in Fig. 510 A. This course is necessary by reason of raising both standard and doup warp threads together, in the same dents of the reed, whenever these threads are required to form a cross shed, as described in §§ 142 and 144, and illustrated in the graphic diagram, Fig. 498.

If the needles are arranged as in Fig. 505, the third and

fourth divisions in each "bar" would correspond with the first row of needles, and the seventh and eighth divisions

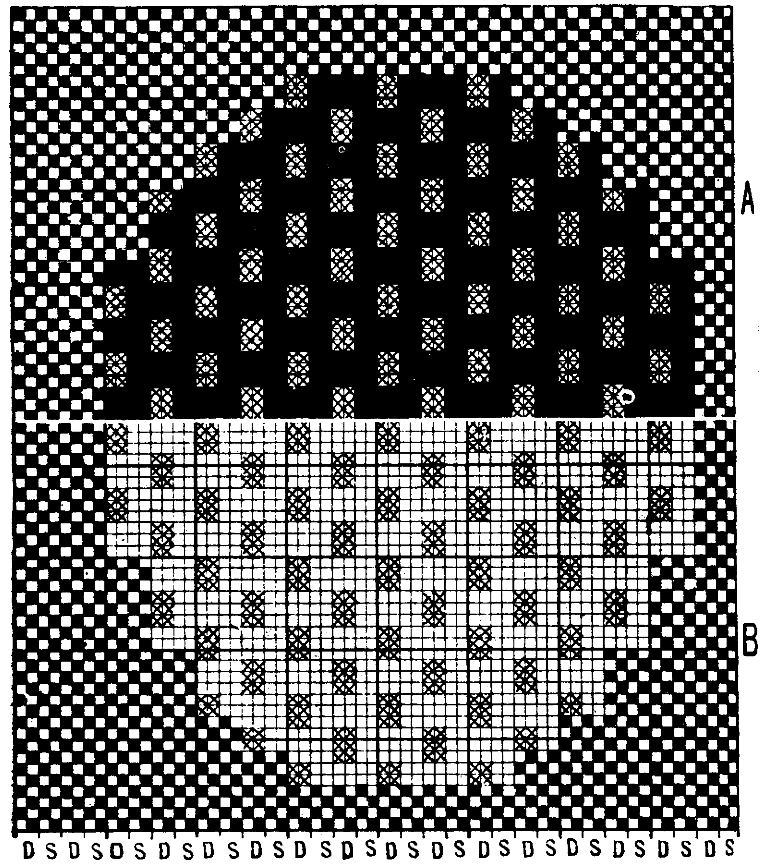


FIG. 510.—Alternative methods (A and B) of preparing an applied design for a *top-doup* harness governed by the leno Jacquard machine represented in Fig. 504. By adopting the method as indicated at B the work of the designer is facilitated. Also, the card-cutter punches holes for blank squares, and misses filled squares, when "reading-off" the design.

would correspond with the tenth row, in respect of shaded squares only. This arrangement is probably the most convenient one for a card-cutter, inasmuch as he would have the advantage of employing both thumbs when cutting for the doup and easer harnesses. That circumstance would involve less risk of error than if the card-cutter employed the little finger and thumb of the left hand, as would be necessary when cutting for the ninth and tenth rows of needles for the arrangement shown in Figs. 503 and 504.

With the arrangement of needles as represented in Fig. 506, which is perhaps the least convenient one for a card-cutter, the third and fourth divisions in each "bar" of design paper correspond with the fifth row of needles, and the seventh and eighth divisions with the tenth row, when cutting for the shaded squares for doup and easer hooks.

§ 155. When preparing an applied leno brocade design, it is necessary to exercise great care at the margin of the figure and ground to ensure a good and clear outline where they meet. This may be best achieved by adhering to a uniform system of allowing fellow standard and doup warp threads to form either an open or a cross shed, in the leno portions of the fabric, for not less than two picks of weft immediately before and after weaving plain calico cloth in the ground portions, as observed in Fig. 509.

For fabrics of coarse textures, it may suffice to allow only one pick of weft to be inserted in the cross and open sheds at the extreme margin of the leno portions of the fabric. By adopting this simple expedient, warp threads are partially relieved of the tensile strain that would arise by causing them to immediately and abruptly change from weaving in pairs in the leno portions, to the plain calico weave in other portions of the fabric. This precept is not always observed by designers for leno brocade fabrics, as an inspection of such fabrics sometimes reveals; still, it is advisable to observe it as far as may be practicable. Also, if floating or brocade figuring is introduced as an additional means of embellishment in a leno brocade fabric, it should always be well separated from the leno portions by a good margin of the plain calico weave; otherwise the margin where the two portions meet will present a very straggling and unsatisfactory outline.

Another important consideration to observe in the preparation of leno brocade designs, is the free and uniform distribution of the figure and ground portions of the design. This necessity arises in consequence of the greater rate of contraction by warp threads, and therefore a greater degree of tensile strain upon those threads, when weaving the leno portions than when weaving the brocade portions of the fabric. This disparity of contraction results from warp threads bending or deviating from a straight course in a greater measure in the leno than in the brocade portions of the fabric. Hence, it is necessary to distribute those portions as evenly as possible over the available surface, and so ensure a uniform rate of contraction by warp threads, and, therefore, a corresponding degree of tensile strain upon them uniformly.

CHAPTER XI.

TISSUE, LAPPET AND SWIVEL FIGURED FABRICS; ALSO ONDULE FABRICS.

§ 156. The terms "tissue," "lappet," "swivel," "ondulé" and "looped" fabrics are used to designate certain varieties of woven fabrics, each of which is distinguished by distinctive characteristic features. Fabrics of these descriptions do not, as a rule, embody any special feature of constructive design, but they consist chiefly of light and simple textures which, during weaving, are embellished with a scheme of figuring developed by one or other of the methods of figuring as specified. Since these fabrics, therefore, owe their chief interest to the special mechanical devices employed in their production, it is proposed to describe the salient features of those fabrics, in conjunction with such descriptions of the mechanical devices employed in their production as will enable readers the more readily and intelligently to comprehend how the scheme of figuring is developed upon them. The chief advantages of embellishing textile fabrics by means of tissue, lappet and swivel figuring are to produce decorative effects without materially increasing either the bulk or weight of the fabric, and also to produce such decorative effects with the minimum amount of material.

Tissue-Figured Fabrics.

Tissue figuring is a method of weaving employed chiefly in the production of light cotton muslin textures intended for use as window curtains, and of which an example is illustrated in Fig. 511. Fabrics of this class are frequently embellished with elaborate Jacquard designs of great beauty. These designs are developed by means of a series of extra picks of weft which

interweave with a foundation texture either of the plain calico weave, or else, as in "Madras" muslin, upon a texture of gauze produced on a principle of cross weaving, whereby the extra figuring weft is firmly secured to the principal or foundation texture. The figuring weft is both softer and coarser than that employed for the foundation texture of the fabric, with the special object of imparting prominence to the figure. These two series of picks may be inserted in the order either of two ground and two figuring picks alternately; or else one pick

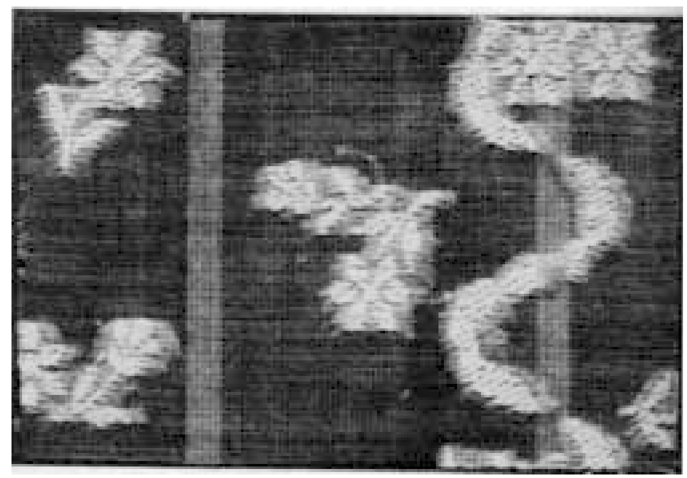


FIG. 511.—Light muslin fabric embellished by tissue figuring.

of each alternately; or with one ground pick and two figuring picks alternately. The two-and-two system of picking is, however, more economical, as it may be accomplished in a loom equipped with an ordinary picking motion, and with two shuttle boxes at only one end of the sley. If either of the other two systems of picking were adopted, they would involve the use of a loom provided with a special picking motion, to permit of picking two shuttles in succession from each end of the sley, which latter would therefore require to be furnished with two shuttle boxes at each end.

The example of tissue weaving, illustrated in Fig. 511, has a foundation texture of muslin of the plain or tabby weave, woven with two ground and two figuring picks alternately. In fabrics of this class, the extra figuring weft interweaves only with warp threads where it is required to produce figure, and (when in the loom) floats loosely *above* all warp threads in the ground portion of the fabric, from which it is subsequently cut away as superfluous material. By weaving these fabrics face downward the work of shedding is made considerably easier, as all warp

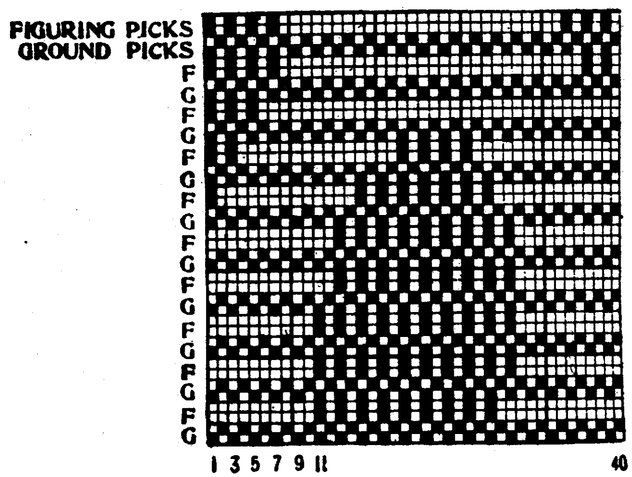


FIG. 512.—Method of preparing an applied design for tissue figuring, as represented in Fig. 511.

threads in the ground portion are left down *en masse*. A portion of the design showing the method of interweaving figuring weft with the foundation texture is given in Fig. 512, in which it will be seen that the first two and subsequent alternate pairs of picks (which are fine ground picks) interweave separately with warp threads on the tabby (plain calico) principle throughout, and thereby develop a perfect texture, irrespective of figuring weft; whereas, the third and fourth, and subsequent alternate pairs of picks (which are coarse figuring picks), interweave with warp threads, only where they are required to be

retained in the fabric for figuring purposes, and float above intervening warp threads. In the figure portion, figuring picks lie together in pairs (although inserted separately during weaving) between odd-numbered and even-numbered warp threads by which they are firmly secured to the principal texture.

On examining the design it will be observed that figuring picks always lie between the *same series* of warp threads; that is, say, with odd-numbered threads above, and even-numbered threads below them. This circumstance permits of a more economical production of these fabrics, as *alternate* warp threads only require to be governed by means of a Jacquard machine, and intermediate warp threads by means of a heald. Thus a Jacquard machine with 408 hooks would serve to produce a design extending over any number of warp threads up to 816. Also, since two figuring picks are inserted between the same series of warp threads, only one pattern card would be required for four picks of weft, provided the card cylinder and griffes were controlled independently. For example, when the first ground pick is inserted, the heald only is raised; when the second ground pick is inserted, the griffes of the Jacquard machine are raised with the card cylinder *out*: and for the third and fourth picks, which are figuring picks, the griffes ascend and take up only such hooks as govern *alternate* warp threads in the figure portion of the fabric, in accordance with the selection made by the pattern card for those picks.

Not only does the foregoing system effect a considerable saving in the cost of harness threads, pattern cards and card cutting, but it also greatly facilitates the preparation of designs, as the latter may be prepared *en bloc*, instead of with the actual order of interlacing of each thread of warp and weft being indicated as in Fig. 512. Therefore, since only alternate warp threads are governed by the Jacquard machine, and only one pattern card is necessary for four picks, the counts of design paper required for a design is in the ratio of *warp threads per inch*, divided by two, to the *total picks per inch*, divided by four. Thus, assuming there are to be forty-eight warp threads and eighty-four picks of weft per inch in the finished fabric, the required counts of design paper (for a 400's Jacquard machine with eight rows of hooks from front to back) would be in the ratio of $(48 \div 2) = 24$ to $(84 \div 4) = 21$, or ruled with eight squares by seven squares in each bar.

"Madras" Muslin Fabrics.

§ 157. Fig. 513 is a diagram showing the structure of that variety of tissue-figured fabrics known as "Madras" muslin,

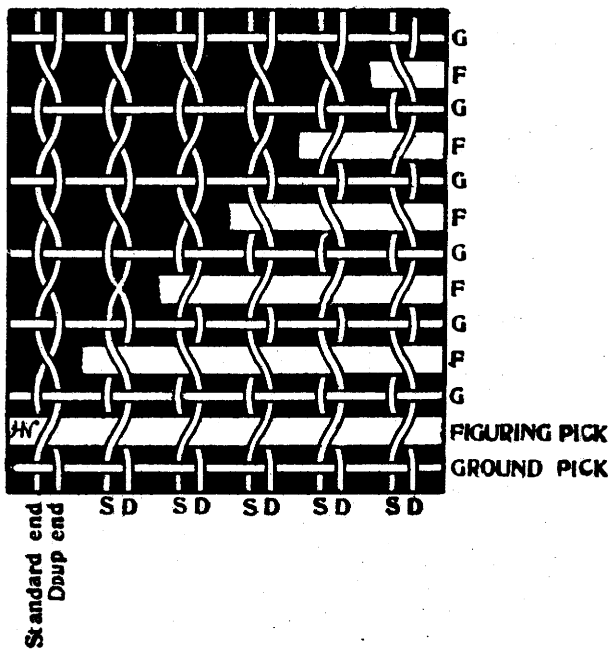


FIG. 513.—Graphic diagram illustrating the structure of "Madras" muslin fabrics.

of which the foundation texture is of a gauze or leno structure produced by the principle of cross weaving. The diagram represents a fabric in which ground and figuring picks are inserted *alternately*, thereby requiring for its production a loom having a "pick-and-pick" picking motion, and with two shuttle boxes at each end of the loom sley.

The peculiar partial crossing of warp threads in these

fabrics is obtained by the use of a special kind of reed known as a "gauze" reed, which is auxiliary to the ordinary beating-up reed carried by the sley. A gauze reed, as illustrated in Fig. 514, is constructed with wide dents or divisions A, in each of which there is fixed, centrally, a short pointed reed wire B, secured to the bottom rib C, and extending about half-way between the bottom and top ribs. The shorter reed wires

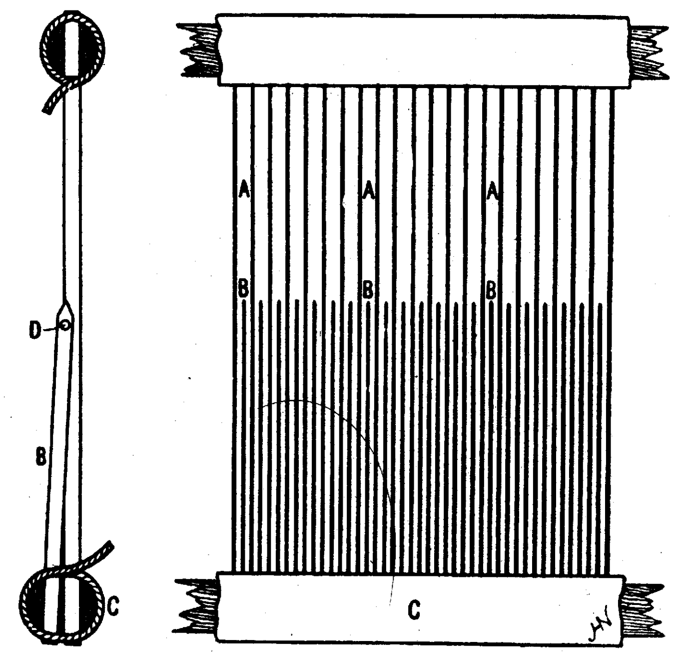


FIG. 514.—Gauze reed, employed in weaving "Madras" muslin fabrics.

are each provided with an eye D, near the top, for the reception of alternate warp threads termed "doup" threads. The intermediate warp threads, termed "standard" threads, which are controlled by the Jacquard harness, pass separately between the wide dents of the reed. A "doup" and a "standard" thread, contained in the same dent of the gauze reed, are also passed together between the *same dent* of the ordinary reed to permit of their crossing each other. When in the loom, a gauze reed is placed a little in front of the Jacquard figuring harness, as shown at E (Fig. 515), and is raised to form a warp shed for the insertion of ground picks only. Its function, therefore, is analogous to that of a "doup" heald in an ordinary gauze or leno loom. Previous to the ascent of the gauze reed, the Jacquard harness is moved side-

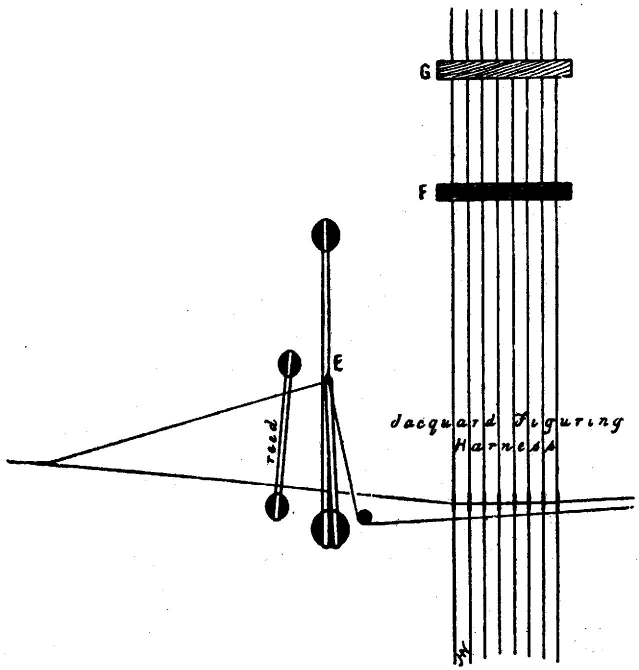


FIG. 515.—Part sectional end elevation of a loom for weaving "Madras" muslin fabrics.

ways for a short distance, first to the right (when facing the loom) and then to the left, for consecutive ground picks, thereby placing "standard" warp threads on opposite sides of "doup" warp threads for the purpose of crossing and re-crossing them. The lateral side movement of the harness threads, and the consequent movement of "standard" warp threads which they control, is accomplished by means of

an auxiliary comber-board F, situated a few inches below the ordinary comber-board G. The auxiliary comber-board is virtually a coarse wire comb of which the teeth are crossed at right angles by three or four wires, so as to form compartments for the reception of several mounting threads, to prevent the latter from swinging. Comber-board F receives its lateral movement in one direction by means of a lever connected to it at one end, and actuated by a cam; whilst its return movement is effected by means of a spring attached to the opposite end of the comber-board, and which is constantly pulling against the lever.

On referring to Fig. 513 it will be seen that all "doup" warp threads only are raised for the insertion of ground picks, and that "standard" warp threads are raised *en masse* in the figure portion only, and left down *en masse* in the ground portion for the insertion of figuring picks. Thus, figuring weft lies *between* "doup" and "standard" warp threads in the figure portion, and floats loosely above *all* warp threads in the ground portion of the fabric, from whence it is subsequently cut away as waste material.

"Madras" Muslin Fabrics with Two and More Colours of Figuring Weft.

§ 158. "Madras" muslin fabrics are sometimes woven with two different colours of figuring weft to increase their decorative effect. In the production of this variety, three shuttles are required, namely, one to insert the fine ground picks, and one each to insert the respective figuring picks of coloured weft. The three shuttles are picked across the loom in succession; and although it may not at first appear to be practicable, it will, upon reflection, become manifest that a loom furnished with an ordinary picking motion, and two shuttle boxes at each end of the sley, will enable that order of picking to be adopted without having recourse to a more complex and costly type of loom equipped with a "pick-and-pick" motion, and three shuttle boxes at each end of the sley.

A pick of each colour of figuring weft is inserted after every ground pick; and the different colours of weft may be displayed in any manner according to the desired scheme of decoration. For example, each colour of weft may be either displayed alone, or else the picks of each colour of weft may be inserted alternately with each other in the same part of the fabric, in order to produce a chintz or mingled effect by blending the two colours together. In the figure portions that are developed in such a manner, alternate standard warp threads only are raised in those parts for picks of one colour, and intermediate standard warp threads only for picks of the other colour. In all other respects, this variety of "Madras" muslin is similar to the two-shuttle variety described in § 157. Some "Madras" muslins contain as many as three and four different colours of figuring weft, which may be displayed either independently, or in any combination with each other, as desired.

Lappet-Figured Fabrics.

§ 159. Lappet figuring is usually confined to the ornamentation of light muslin textures of cotton, and sometimes of silk, of the plain or calico-weave; and less frequently it is employed in combination with gauze or leno and other woven effects. It consists of the development of figured effects produced by a more or less zigzag arrangement of extra warp threads, withdrawn from one or more than one auxiliary small warp beam. These extra warp threads are wrought into the foundation texture *without interweaving with warp threads*, and are permanently held in position by passing *underneath picks of weft* (when cloth is viewed obversely). The figuring warp threads, termed "whip" threads, are thereby made to lie in the same direction as picks of weft, which float quite freely on the face side of cloth only, between the points of their intersection, as clearly indicated in the accompanying photographic reproductions of lappet-figured fabrics. These characteristics are specially emphasised because they constitute the essential principles of lappet figuring, which sometimes bears a close resemblance to swivel figuring as described subsequently in § 164; and when once properly understood, they enable the difference between lappet and swivel figuring to be readily discriminated.

Lappet figuring is confined to the production of comparatively simple decoration, as that system of figuring is incapable of producing elaborate designs such as are frequently met with in tissue-figured and swivel-figured fabrics that are usually produced by means of a Jacquard machine. The examples of cloth represented in Figs. 517 to 527 will serve, better than any verbal description, to indicate the general character and

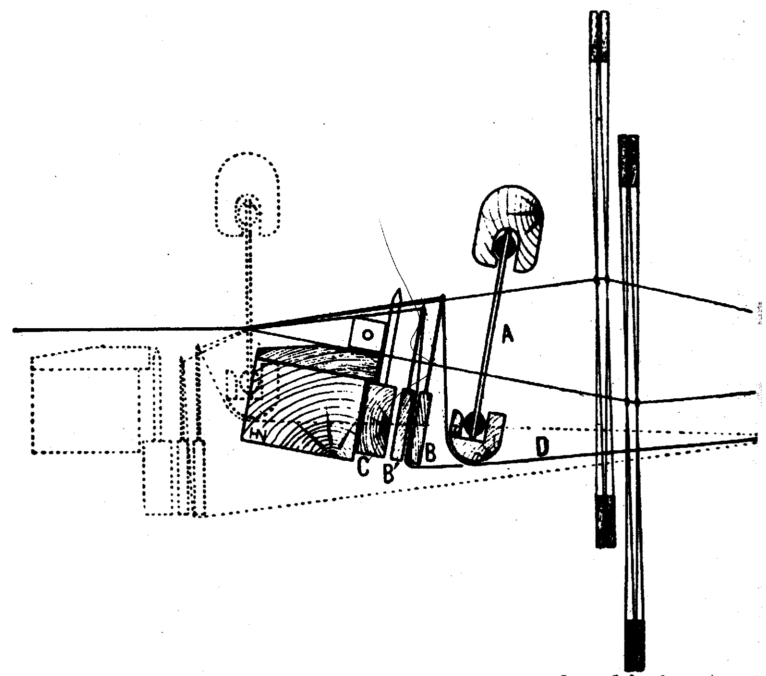


FIG. 516.—Part sectional end elevation of a loom adapted for lappet figuring.

scope of lappet figuring; whilst the following brief description of the essential features of a lappet loom will enable the production of these fabrics to be more easily comprehended.

§ 160. Lappet looms differ in details of construction with different loom makers; but there are certain essential and incidental parts that are common to all looms of this type. These parts, which are represented in part sectional elevation in Fig. 516, comprise one or more needle-frames B, B[1], situated between a reed A of ordinary construction, and a false reed or pin-stave C, all of which parts are supported by, and oscillate with, the loom sley, as indicated by representing those parts at their rear and forward extremities of their movement, by means of full and dotted lines respectively. The reed A, which is situated several inches to the rear of the position a reed usually occupies, serves the usual functions of maintaining an even distribution of warp threads over the required width of cloth, and of beating-up picks of weft. The pin-stave C is

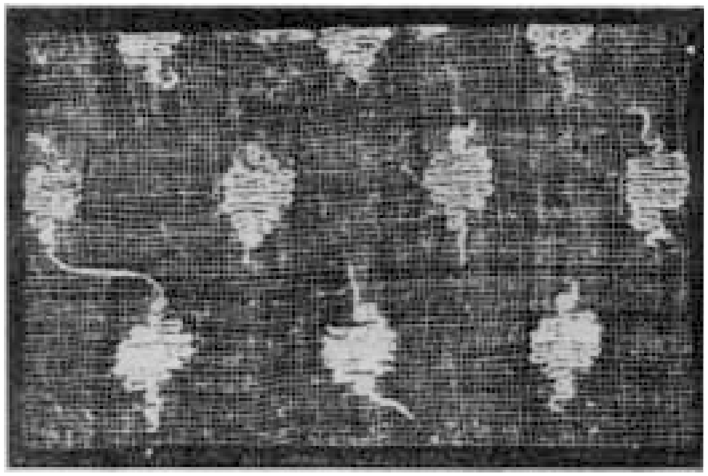


FIG. 517.—Simple spot lappet figuring developed by one needle-frame.

a stave containing a number of sharply-pointed pins, placed vertically at intervals of about an inch to an inch and a quarter. This is placed immediately behind the rear edge of the shuttle race-board, and rises and falls alternately in unison with the backward and forward strokes of the sley. Its function is to serve as a guide for the shuttle in its passage through the warp sheds, after which it disappears below warp threads and cloth, as the sley advances to beat up the picks of weft.

The needle-frames B, B[1] are narrow staves, each containing a series of sharply-pointed needles placed vertically, and having

eyes formed near the top, for the reception of whip or figuring threads, which they control. In addition to their oscillation with the sley, needle-frames receive a reciprocal compound movement both vertically and laterally. These movements synchronise with the backward and forward strokes of the sley respectively. Thus, as the sley recedes, and just before picking takes place, needles are raised to insert their whip threads between the ordinary warp threads, to take their place with the upper half of the warp shed. Then, after each pick of

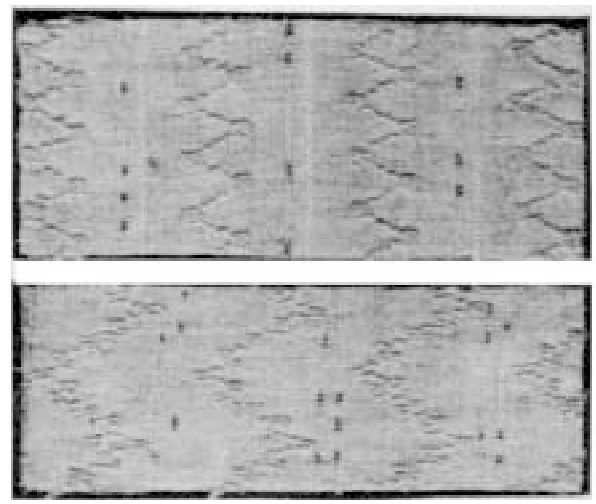


FIG. 518.—Lappet figuring developed by one needle-frame.

weft is inserted in the shed, the needles descend, as the sley advances to beat up the picks of weft, which, by passing *underneath whip threads*, prevent the withdrawal of these as needles descend, and retain them at the points at which they were inserted between ordinary warp threads. When the needles have descended a sufficient distance to be quite clear of warp threads and cloth, they may be moved laterally, in either direction, for the purpose of passing figuring threads from side to side of the figure, and placing them in the required positions, according to the pattern, ready for insertion into the warp shed for the next pick of weft.

The lateral movement of needle-frames may be effected in various ways, either by means of lattices furnished with pegs of different lengths, varying according to the amount of movement required; or by means of shaped pattern or "lappet" wheels, of which there are several varieties. The device known as the "Scotch" lappet motion is that which is more generally adapted to lappet looms. This motion consists essentially of a wooden pattern wheel or disc, mounted freely

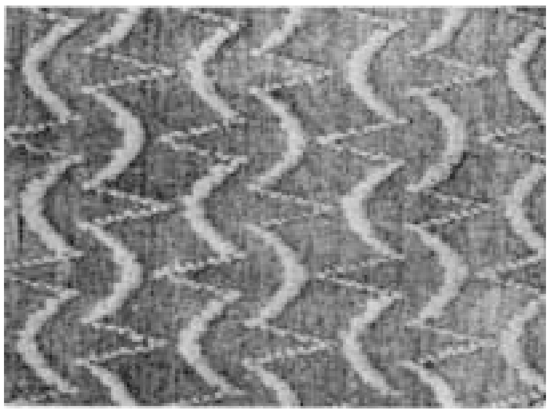


FIG. 519.—Lappet figuring developed by two needle-frames.

on a stud at one end of the loom, and having such number of irregularly stepped concentric grooves of uniform depth cut into the face side as corresponds with the number of needle-frames to be actuated by it. The configuration of each groove is in accordance with the particular movement to be imparted to the respective needle-frames, for the development of the required pattern. Each groove receives and acts upon a small bowl or runner mounted upon a short pin or stud fixed in an extension of each needle-frame. These extensions pass horizontally in front of the wheel, so as to place the axes of the runners and pattern wheel in exactly the same horizontal

plane. The rim of the pattern wheel is also formed with such number of saw or ratchet teeth as corresponds with the number of picks (or half that number, according to special circumstances) to be inserted in each repeat of the pattern. It will now become manifest that by rotating the pattern wheel intermittently one tooth for each pick (or for every two picks) the needle-frames will be moved sideways in accordance with the configuration of the respective grooves, and thereby cause the whip threads to assume a more or less zigzag course, and float freely between the *extreme edges of figure without intermediate intersections.*

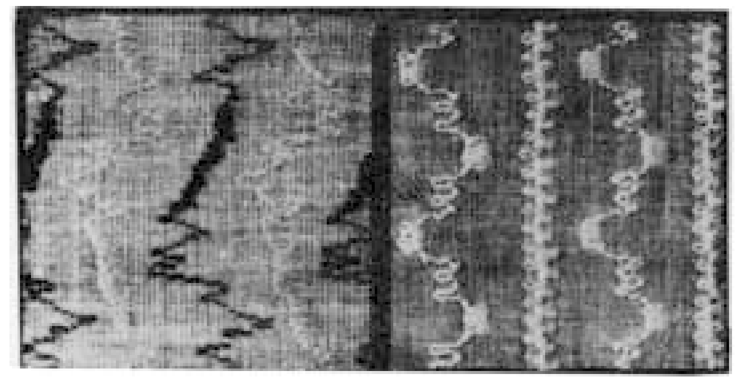


FIG 520.—Two-frame lappet figuring with design, Fig. 521.

FIG. 522.—Two-frame lappet figuring with design, Fig. 523.

A separate needle-frame is required for each distinct order of interweaving the figuring threads. If all figuring threads are required to interweave in the same manner, only one needle-frame, operated by one groove in the lappet wheel, is required; but, if figuring threads are required to interweave in two or more different orders, then a corresponding number of needle-frames operated by a figuring wheel constructed with the same number of grooves will be required. It is rarely, however, that more than three needle-frames are employed in the same loom.

Since needle-frames are situated below warp threads, it follows that the cloth will be woven face downward, and that the pattern is thereby obscured from the observation of a weaver. This circumstance is obviously to the disadvantage of a weaver, who is unable to readily detect any imperfection in the pattern that may arise during weaving: hence, in some lappet looms needle-frames are situated *above* warp threads, with the needles inverted, so as to weave the cloth face upward, and with the pattern in full view of a weaver. With this arrangement, however, the small warp beams containing the figuring threads are conveniently placed above the healds; and as those threads descend in front to their respective needle eyes, they form an obstruction to a weaver when piecing and drawing in broken warp threads. Also, in consequence of inserting "whip" threads from *above*, instead of from *below*, regular warp threads, during shedding, they are more liable to cause the lower half of the warp shed to become uneven, and thereby impede the free passage of a shuttle during picking.

§ **161.** Fig. **517** illustrates an example of a simple spot lappet figuring produced by means of one needle-frame which is governed in such a manner that, after inserting one horizontal row of spots, it becomes inoperative for an interval equal to ten picks of weft, and then inserts the spots of the next row so that they occupy an intermediate position in relation to those of the preceding and succeeding rows of spots, as indicated by the unsevered trailing whip thread observed in the photograph. Two other examples of lappet figuring, developed by only one needle-frame, are indicated in Fig. 518, which illustrate two simple zigzag or wavy stripe effects produced by the continuous operation of the respective needle-frames by which they were obtained.

Three examples of two-frame lappet figuring are illustrated in Figs. 519, 520 and 522. The ingenious effect represented in Fig. 519 is obtained simply by reversing two similar stripes in order to produce a "drop turn-over" design having the appearance of an "all-over" pattern. The neat effect represented in Fig. 520 is obtained by alternating a straight and a zigzag stripe, as indicated; whilst that illustrated in Fig. 522 is produced by reversing and dropping two irregular wavy

stripes that are developed by white and gold-coloured silk whip threads respectively, to impart additional attractiveness to the fabric.

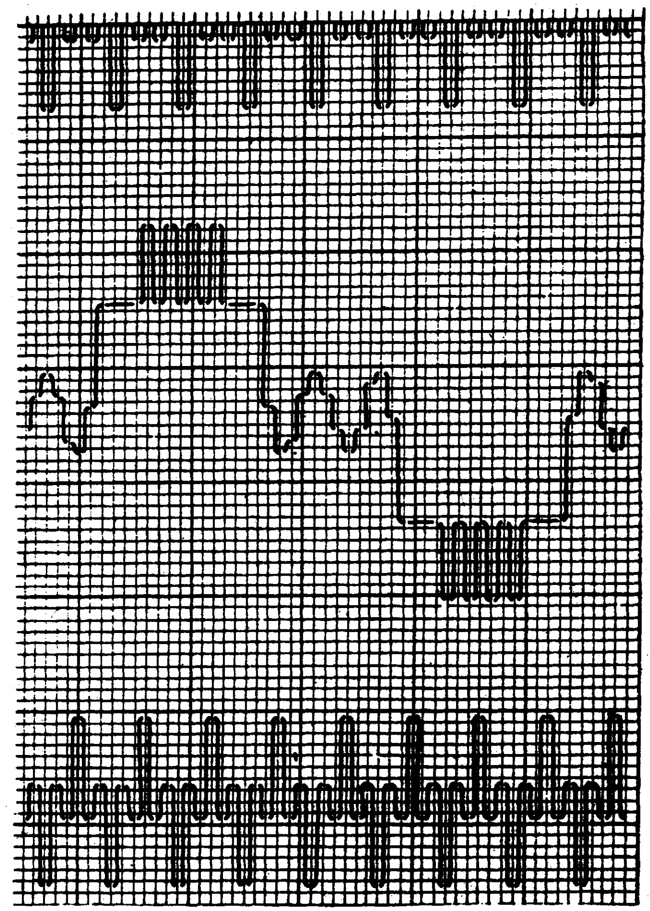


FIG. 521.—Design for two-frame lappet figuring, Fig. 520.

A good method of indicating, on squared paper, a design for lappet figuring, is demonstrated in Figs. 521 and 523, which are the designs for the lappet fabrics illustrated in Figs. 520 and 522 respectively, and of which designs the vertical and horizontal *lines* on the squared design paper, and *not the spaces* between those lines, represent the warp and weft threads

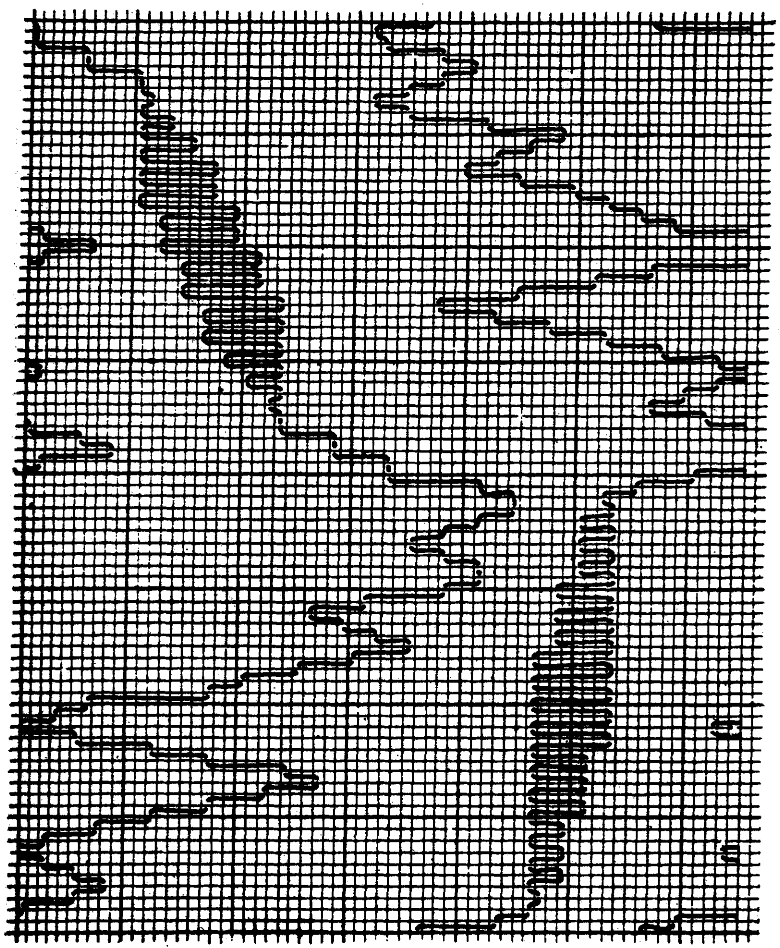


FIG. 523. —Design for two-frame lappet figuring, Fig. 522.

respectively of the foundation texture on which the lappet figuring is developed. Instead of indicating the respective whip threads by means of thick lines, however, as observed in

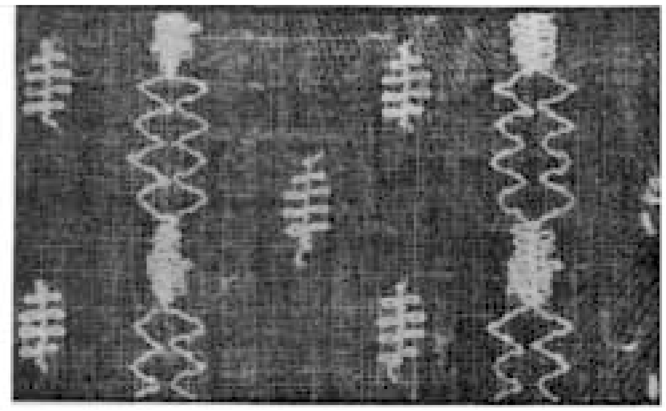


FIG. 524. —Good example of three-frame lappet figuring.

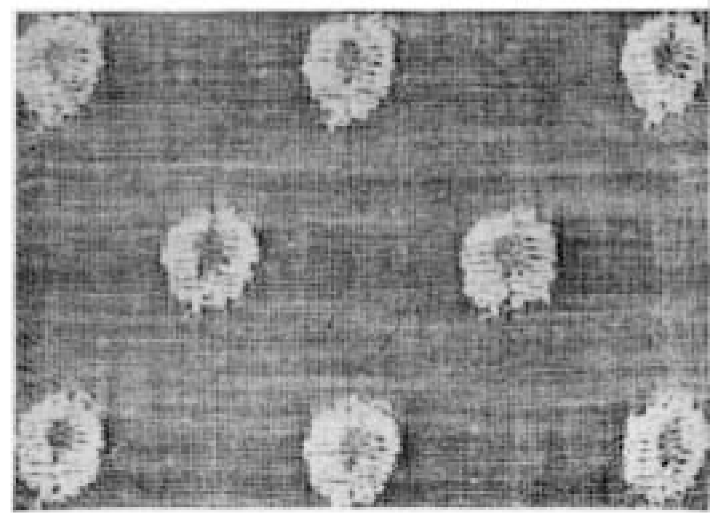


FIG. 525.—Three-frame spot lappet figuring, with centre of spots of yarn of different colour from that of outer portion.

the accompanying designs, a simpler and easier method is to fill in the squares of the ruled paper solidly, and thus indicate the lappet figuring as a block pattern in the usual manner of preparing an applied textile design.

Two good examples of lappet figuring produced by three needle-frames are represented in Figs. 524 and 525. The stripes in Fig. 524 are developed by means of two needle-frames operated in a similar manner, but in reverse directions

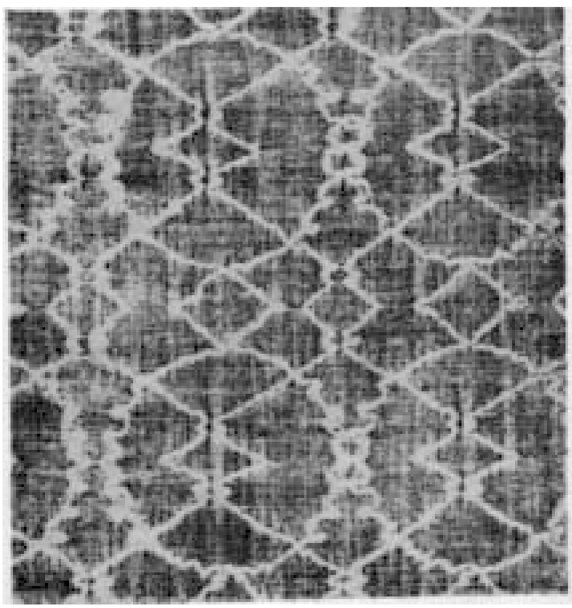


FIG. 526.—Four-frame lappet figuring.

simultaneously and continuously, to produce symmetrical stripes, whereas the detached figures between the stripes are produced by one needle-frame which disposes those figures alternately, as exemplified in spot lappet figuring, Fig. 517

The example of lappet figuring illustrated in Fig. 525 is of an unusual character, and consists of a white spot enclosing a pale blue spot, with an alternate disposition. The right and left halves of the white spots are developed by means of two separate needle-frames operated in reverse directions simul-

taneously, whilst the coloured whip threads are controlled by a third needle-frame to develop the inner spots, as indicated.

Cross-thread Lappet Figuring.

§ 162. A specimen of lappet figuring of a novel and ingenious character is illustrated by Fig 527. In this example, figuring threads are caused to actually cross each other in reverse directions, and thereby develop an effect closely resembling that of a net leno produced by the principle of gauze or cross weaving,

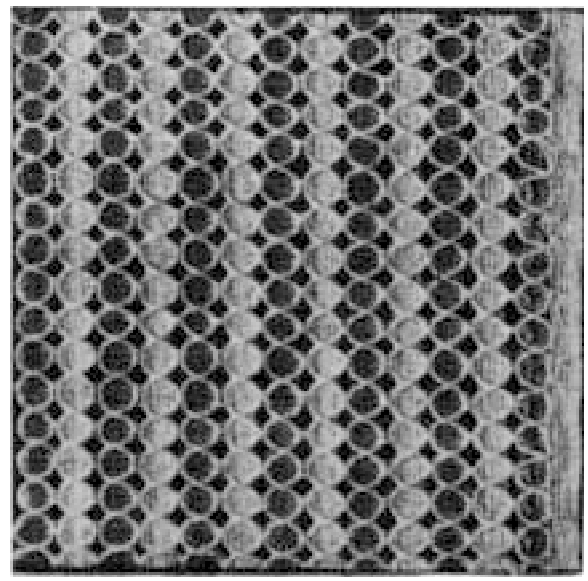


FIG. 527.—Cross-thread lappet figuring developed by two needle-frames.

for which it might easily be mistaken. For the production of such effects, it is only necessary to pass the figuring threads of one or more than one needle-frame entirely underneath the needle-frame or frames that are in the rear of those, and thus permit of figuring threads passing or crossing each other. For example, if two needle-frames are employed, the figuring threads of the first frame must pass entirely underneath the second frame before passing through their respective needle eyes, as represented in the diagram, Fig. 516. The usual method of passing whip threads through the needle eyes is to take them upward immediately after passing underneath the lower reed case, and then insert them through their respective needle eyes, as indicated in the diagram by means of a dotted line extending from the lower reed case to a needle in the front frame B^1.

Spot Lappet Figuring.

§ 163. Some lappet fabrics are woven with detached figures arranged alternately, or otherwise, to distribute them evenly over the surface of cloth, as exemplified in Fig. 517. In the production of such examples it is the usual practice, after weaving each horizontal row of figures, to cause the needle-frame or frames to automatically become inoperative until they are required for the next row of figures, when they are "shunted" sideways for the required distance, so as to dispose the figures of alternate rows either midway between those of intermediate rows, or otherwise, in a manner similar to the swivel-figured spots illustrated in Figs. 528 (A), and 528 (B). Now, seeing that lappet fabrics are usually woven face downward (as explained at the end of § 160), it follows that the figuring whip threads will trail loosely between the intervals separating the detached figures produced by the same whip thread. These loose threads are subsequently cut away, thereby leaving a short remnant or tail of thread *exposed on the face side of cloth*, at both the initial and final extremities of each figure, and causing blemishes of an objectionable character. This disfigurement, however, may be averted by causing the needles to rise in exactly the same position for all picks inserted between the end of one row of figures and the beginning of those in the next row, thereby inserting the respective whip threads uniformly between the same warp threads for those picks. The object of this procedure is to cause the whip threads to trail or lie *above* the picks of weft between the horizontal rows of figures (when in the loom) and therefore to be on the reverse side or *back* of cloth, whence they are subsequently cut away, leaving the

severed tail ends exposed on that side, and thus keeping the face of cloth free from such blemishes. Lappet figures or spots developed in accordance with this practice, and which are known in the trade as "tailless" lappet spots, constitute a superior style of lappet figuring as compared with those constructed in the usual manner.

Swivel-Figured Fabrics.

§ 164. Swivel figuring is a system of ornamentation by means of *extra weft* inserted by auxiliary shuttles that are designed expressly for that purpose. This method of figuring is adopted extensively for the decoration of silk fabrics, book-marks, ties, ribbons, ladies' dress materials, and sometimes of light cotton fabrics for similar uses. Being of a more refined and elegant character than either "tissue" or "lappet" figuring, it is capable of producing decorative designs, figures and pictorial representations of a floral and scenic description, in a very effective manner. The extra figuring weft is usually of silk, and, unlike "lappet" figuring, it may interweave with the warp threads in any conceivable manner, instead of floating loosely and quite freely between the extreme edges of the figures. Swivel figuring is usually developed upon a foundation texture either of the plain calico or tabby weave, or else that of a simple three-end or four-end twill weave. An example of swivel figuring of a very simple character is illustrated in Fig. 528 which shows both the obverse and reverse of the same fabric at A and B respectively.

Swivel figuring is very easily distinguished from "lappet" figuring, by the interlacement of the extra figuring weft with warp threads, between the extreme edges of figure; and also by that weft bending around *warp threads* when returning at the edges of figure, and *not* around picks of weft, as in "lappet" figuring. During the operation of weaving, swivel-figured fabrics, like lappet-figured fabrics (produced by means of bottom needle-frames) are produced face downward, as represented in Fig. 528 (B). The swivel shuttles containing the figuring weft are of a very different form to those of ordinary loom shuttles; and, unlike the latter, they are not propelled separately and independently across the entire width of the loom; but in the prevailing type of swivel loom several of these special shuttles are carried simultaneously and positively through a corre-

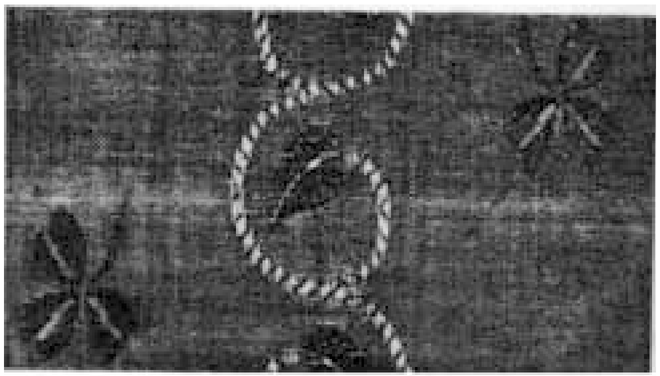


Fig. 528 (A).—Swivel figuring (showing the obverse of Fig. 528 (B)).

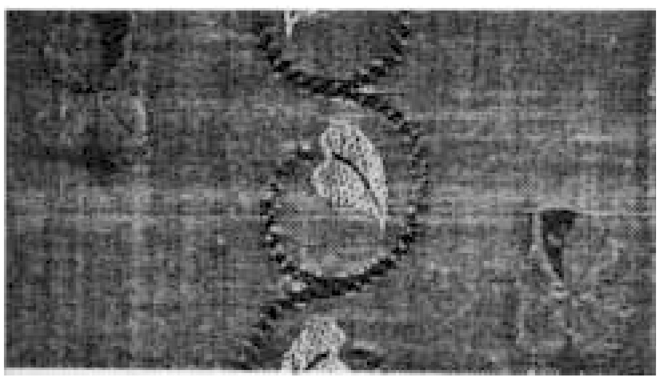


Fig. 528 (B).—Swivel figuring (showing the reverse of Fig. 528 (A)).

sponding number of sectional warp sheds formed at regular intervals apart across the width of cloth, for the purpose of inserting the extra figuring weft for the development of figure.

The swivel shuttles, termed "poppets," are carried by, and move to and fro with, the sley, as the latter oscillates; and

they may be arranged in one, two or more horizontal rows, or tiers (according to the number of colours of figuring weft required for the *same figure*) above the warp threads. Each tier may contain any practicable number of "poppet" shuttles, but with a corresponding number in each row; and they are supported at regular intervals apart, in a frame termed the "poppet rack," as illustrated in Fig. 529, which represents front and end elevations and a plan of the swivel shuttles, at A, B and C respectively. The poppet rack is depressed and

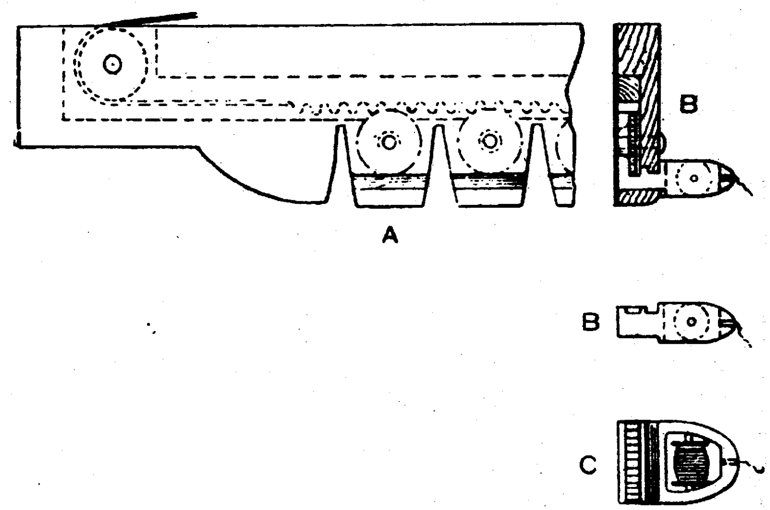


Fig. 529.—"Poppet" rack and shuttles for inserting picks of extra figuring weft in the development of swivel figuring.

raised in a prescribed manner, in order to place any particular tier of "poppets" in position for the latter to enter the sectional warp sheds, and insert picks of figuring weft. The "poppet" shuttles are then passed simultaneously through the sectional warp sheds, and then raised quickly above the cloth to permit of the reed advancing to beat up the short picks of weft. A warp shed is then formed all across the entire warp for the passage of the ordinary shuttle to insert an ordinary pick of weft for the foundation texture; after which, the sectional figuring sheds are again formed for the reception of figuring weft from the same or another tier of "poppets," according to the colour of weft required.

Warp Ondulé Fabrics.

§ **165.** The term *ondulé* is used to distinguish an unusual and interesting variety of woven fabrics in which either warp threads or picks of weft are caused to assume undulating, wavy, or sinuous lines. An example of warp *ondulé* is represented by **Fig. 530,** which is reproduced from a specimen of cloth of this

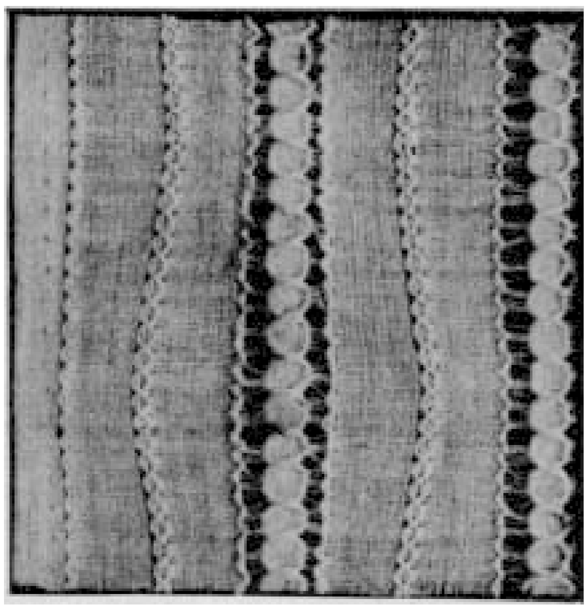
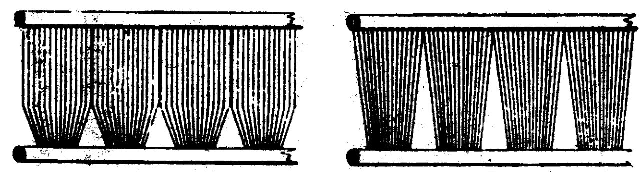


Fig. 530.—Warp ondulé fabric, with net leno and cross-thread lappet figuring.

description. (It may be observed, incidentally, that the specimen here represented also embodies the principles of cross weaving, in combination with lappet figuring, of the special cross-thread variety described in **§162,** and illustrated in Fig. **527,** in which the whip or figuring threads cross each other in reverse direc-

tions.) Apart from the features just indicated in parentheses, there is nothing of an unusual structural character in the class of fabrics under present consideration, which are generally of simple construction. Their chief interest, therefore, lies in the special mechanical devices required for their production, which are sometimes of a novel and very ingenious character. When the undulations are required in the direction of warp threads, these special devices consist essentially of some means whereby the warp threads are gradually spread apart and then closed in alternately, to produce contrary sinuous lines running lengthwise of the fabric, which object may be achieved by either of two distinct methods. One method is to employ a reed, of which the dents may be contracted in some parts and expanded in others according to the effect desired; but a more approved



A B

Fig. 531.—Ondulé, paquet or fan reeds, for developing warp ondulé effects.

and practical method of obtaining warp ondulé effects, however, is by means of what are variously termed "*paquet*," "*ondulé*" and *inverted* "*fan*" reeds, in which some of the reed wires are permanently inclined at gradually varying angles, and in opposite directions; albeit, they are all in the same vertical plane when viewed from the ends of the reed.

Ondulé or paquet reeds are made in a great variety of forms according to the particular effect desired in cloth; and, during weaving, they are operated by auxiliary mechanism which slowly raises and depresses them alternately, thereby causing warp threads to gradually deviate from their normal straight course, and assume the characteristic undulating or sinuous lines. Three typical varieties of ondulé reeds are represented at A, B, Fig. 531, and at R, Fig. 532. That shown in Fig. 532 is a common variety termed a double or inverted fan reed, for

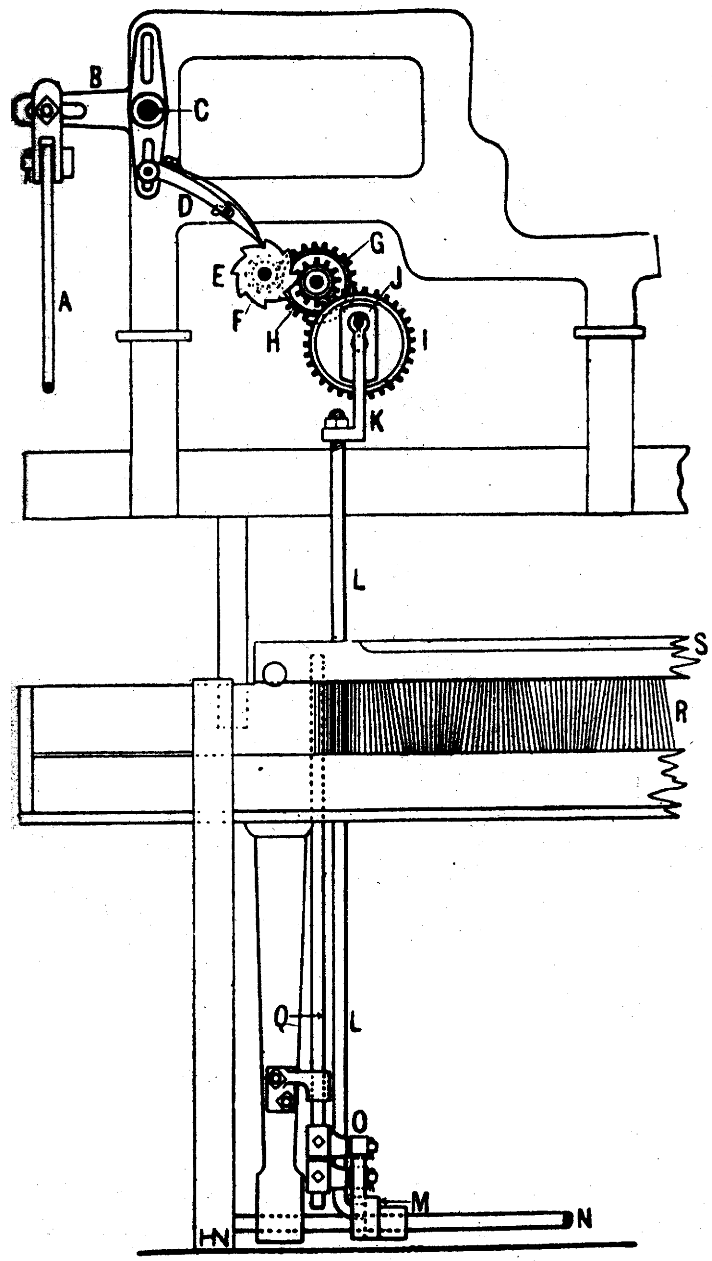


Fig. 532.—Part front elevation of a loom for developing warp ondulé effects by means of reeds of a special type, of which an example is shown at R. (See also Fig. 533.)

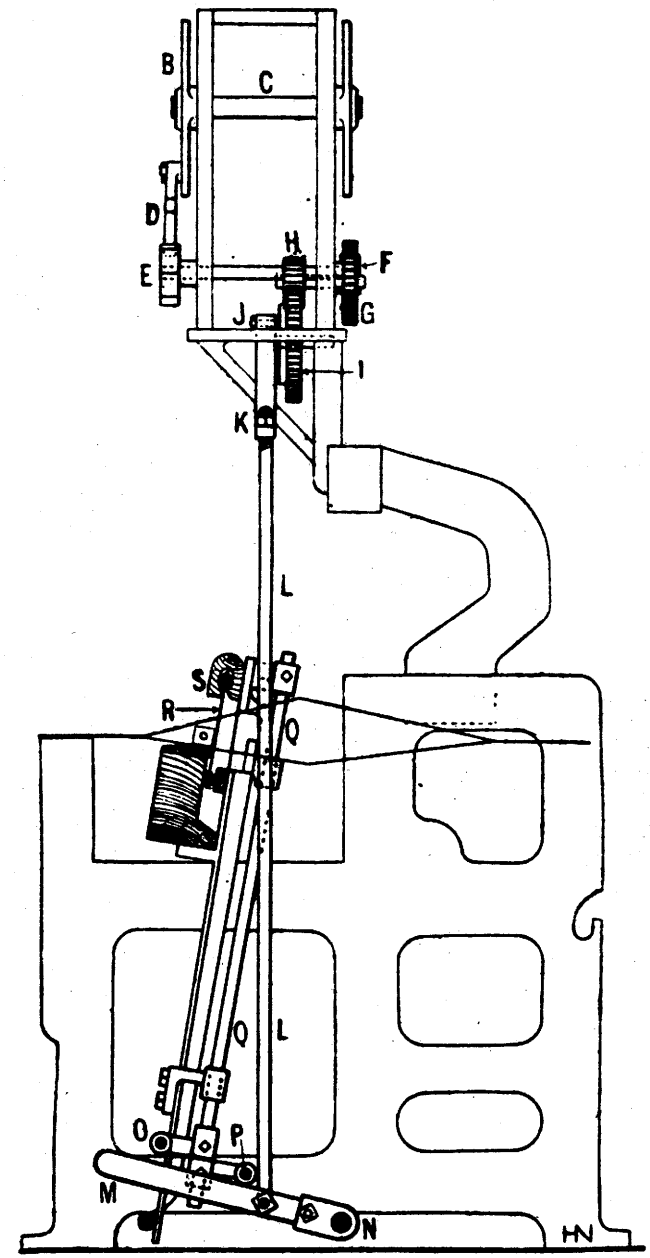


Fig 533. -End elevation of a loom for developing warp ondule effects. (See also Fig. 532.)

the production of regular and contrary sinuous lines; whilst those represented at A, B, Fig. 531, are designed to produce perforations in cloth. The intervals at which the perforations will occur both horizontally and vertically, in cloth, is determined by the distance between the gaps in the reed, and the velocity with which it is reciprocated respectively. Some ondulé or paquet reeds are of a variegated character, with vertical dents alternated with dents inclined at various angles to the right and left, on each side of the vertical dents. They are also made in a variety of other forms according to the effects desired.

Foulds' Ondulé Loom.

§ 166. A loom equipped with a device (invented by R. Foulds) for the development of ondulé effects, is represented by front and end elevations in Figs. 532 and 533 respectively. In this loom, an inverted fan reed R is contained in a frame to which there is imparted a slow reciprocal, vertical and intermittent movement by means of a dobby acting through the medium of a train of wheels and suitable connections of rods and levers, as indicated in the diagrams. Mounted freely upon a stud or pin J, fixed in a wheel I, is a pendant arm K, from which is suspended a long rod L, with its lower end attached to a lever M, fixed to a cross bar N, on the opposite end of which is a duplicate lever M. Resting upon the respective levers M are two rods Q, which slide freely in brackets bolted to the sley swords, and therefore oscillate with the sley. The sley cap S, containing the upper ribs of the reed, is secured by means of brackets to the upper ends of rods Q, which are supported (at different times) by means of one or other of two arms, secured to their lower ends, and furnished with bowls or runners O, P, that rest upon their respective levers M. It will now be seen, therefore, that as wheel I is slowly and intermittently rotated, levers M will alternately rise and fall with a corresponding velocity, whereby different parts of the reed wires are brought opposite the "fell" of cloth *only when beating up the weft*. Thus, in consequence of the angular disposition of reed wires, the warp threads are either congested or expanded in width, according as they pass through the congested or expanded extremities of the reed dents, respectively.

The object of employing two runners O, P, placed at the ends of separate arms extending both forward and rearward of the respective rods Q to which they are secured, is to cause the reed to assume a *neutral* position midway between its highest and lowest elevations, during the formation of successive warp sheds, and thereby prevent excessive chafing of warp threads that would otherwise be caused by their bearing hard and rubbing against the reed wires at the upper and lower extremities of a fan reed. This object is achieved in the following manner: As the sley oscillates, runners O and P are alternately brought to bear upon different parts of levers M, thereby causing the reed to either descend or ascend to a *neutral* position as the sley recedes, according to the upward or downward inclination (from the cross bar N) of levers M respectively.

Fielden's Ondulé Motion.

§ 167. One of the latest devices for the production of warp ondulé effects is that patented by F. Fielden (of Lupton and Place, Ltd.) and of which the special ondulé mechanism, as applied to an ordinary type of plain loom, is shown in relief, in Fig. 534. This ondulé motion is designed so that, at a very small cost and with little trouble, it can be readily adapted to existing looms of the usual standard types, to which it may be fixed by a mechanic or loom overlooker. Also, when not required for weaving ondulé effects, it may, within the space of about half an hour, be detached, and the loom again adapted for ordinary weaving.

From the description, given in the previous section (§ 166), of the special features incidental to ondulé looms, the following description of the cardinal features of Fielden's motion will be the more readily understood. In order to permit of the vertical, reciprocal movement of the ondulé reed A, according to the particular ondulé effect required, that reed is mounted in a movable, strong rectangular framing constructed of angle-iron and supported by two vertical poker-rods B, whilst the usual sley-cap or hand-tree is replaced by a steel tube C to provide a hand-grip for the weaver when starting and stopping the loom.

From the upper extremity of these two poker-rods, their projects an anti-friction bowl or runner inserted, respectively, in the grooves of two radial guide-arms D constructed of channel-iron, and hinged on studs in order to permit of a prescribed angular movement. These two radial guide-arms are hinged, approximately, in the same horizontal plane as that of a line passing midway between the upper and lower ribs of the reed when this is at the rear extremity of its stroke, at the moment of picking.

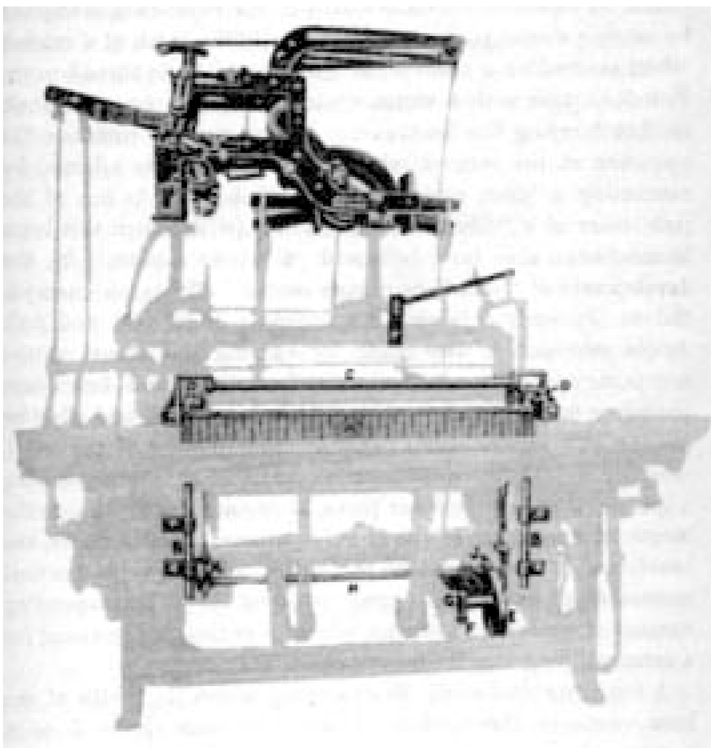


FIG. 534.

The special function of these radial guide-arms is important, inasmuch as their angle of inclination determines the vertical position of the reed, at the critical moment of beating-up the

picks of weft, *i.e.*, when the reed is in actual contact with the "fell" of the cloth. At the same time, the position of these guide-arms is determined and controlled by the intermittent operation of a positive-acting heart-cam E which, through the medium of suitable connections, imparts to those arms and, therefore, to the reed, a prescribed movement according to the particular ondulé effect desired in the cloth produced, and of which those illustrated in Figs. 530 and 659 are typical examples.

The intermittent, slow movement of the heart-cam is effected by causing a ratchet pawl to engage with the teeth of a ratchet wheel secured on a short shaft carrying a single thread-worm F, that engages with a worm-wheel G fixed on the same shaft as that carrying the heart-cam. In the present instance, the operation of the ratchet wheel and heart-cam is effected by connecting a lever, carrying the ratchet pawl, to one of the jack-levers of a "Climax No. 6" dobby (with which this loom is mounted), also furnished with a "leno motion" for the development of "leno" or "cross woven" effects, as exemplified in the ondulé fabrics illustrated in Figs. 530 and 659. Ample provision is also made for varying the extent of the intermittent movement of the ratchet wheel and heart-cam according to the number of teeth in that wheel, and also by moving one, two or more teeth at each impulse of the pawl, whereby a complete revolution of that cam may occur during a greater or a lesser number picks, as required, according to the length of one repeat of the ondule pattern. Furthermore, the heart-cam is also designed to impart to the reed a vertical movement of exactly the same distance for a corresponding number of teeth in the ratchet wheel or (which is the same) for a corresponding angular movement of that cam.

A low horizontal shaft, H, extending across the width of the loom, conveys the motion of the heart-cam lever J to a corresponding lever K, at the opposite end of the loom, in order to ensure a perfectly true and parallel, vertical, traversing movement of the reed, without the risk of the latter tilting at either end. Also, with a view to providing ample scope in that movement of the reed these levers, as well as the radial guide-arms, are formed with slots which permit of a reed movement ranging from one inch up to five inches, with the same heart-cam, whereby the same reed may be employed to produce ondulé stripes of various widths and lengths.

§ 168. It will be obvious, however, that, unless the reed were of an inordinate and impracticable depth between the ribs, such a wide range of movement by the reed would incur the risk (if this were not provided against) of reducing the depth of the warp shed and so impeding the free passage of the shuttle through that shed, when the reed is at either extremity of its vertical movement. Hence, it is necessary, during picking (when the sley is backward) to bring the reed to a central or neutral position, after each pick, and quite irrespective of the position which it occupies when in contact with the "fell" of cloth, to beat-up the previous pick of weft. In the present ondulé motion, therefore, this object is effected by fixing the fulcrums of the two grooved, radial guide-arms (which determine the vertical position of the reed) in such relative positions that the reed, on reaching the backward extremity of its stroke, always and automatically compels the reed to assume the same central position during the passage of the shuttle through the warp shed. Then, as the sley advances to beat up the weft, the reed either ascends or descends from its neutral position to the required position as determined by the heart-cam and the angle of inclination of the two grooved, radial guide-arms controlled by that cam.

Weft Ondulé Effects.

§ 169. An exceptional and interesting specimen of cloth of the ondulé variety is illustrated in Fig. 535. This example may be described as a weft or "cross-over" ondulé effect, since they are *picks of weft* and not warp threads that assume a wavy character (as indicated by the selvedge, on the left of the fabric). This example is produced from organzine silk warp picked with genapped worsted, to produce a light muslin texture of the plain or calico weave, suitable for a summer dress material.

A weft ondulé effect may be developed in a variety of ways, either by means of shaped reeds expressly designed to produce the required effect in cloth; or by applying a constantly varying degree of tension to alternate groups of warp threads. Reeds, styled "Erdmann" reeds (after their inventor), are either constructed of shaped wires placed vertically, so as to appear curved on their front edge when the reed is viewed end-wise; or the wires may be straight and arranged at varying angles, so that if the reed were viewed end-wise, they would appear to cross each other like the letters **V** or **X**; and if viewed in plan, they would form a serpentine or undulating line from end to end of the reed. By slowly and alternately raising and depressing such reeds, the picks of weft will assume

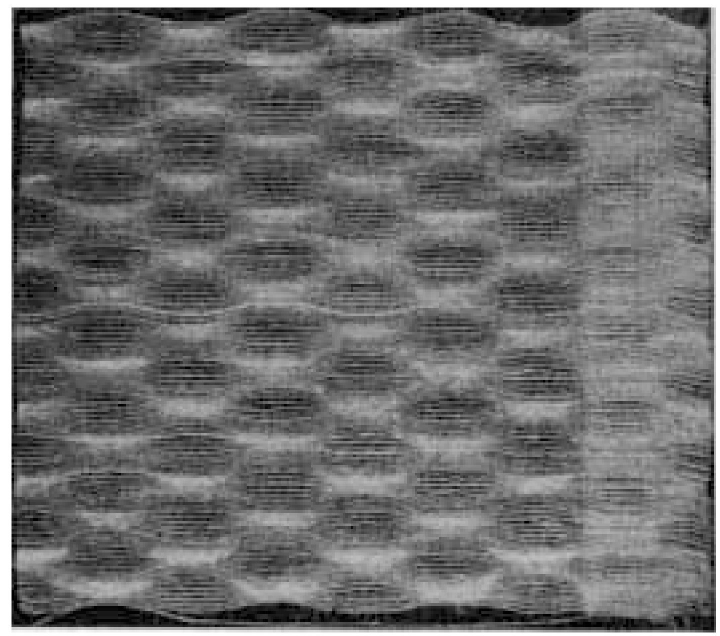


FIG. 535. —Weft ondulé fabric.

varying degrees of undulation according to the velocity with which the reed is vertically reciprocated. By keeping the reed stationary at any given point, picks may be inserted uniformly parallel with each other, either straight, or in more or less undulating lines, as required.

§ 170. Weft ondulé effects may be produced in looms furnished with ordinary reeds, by dividing warp threads (immediately after leaving the warp beam) into groups according to the length of wave required, and by passing alternate groups of threads over one bar, and intermediate groups over a second bar. By slowly oscillating both bars in contrary directions (by means of cams, cranks or eccentrics) a gradually varying degree of tension will be imparted to warp threads, whereby the two divisions of threads will be alternately tautened and slackened. This will cause the picks of weft to assume more or less wavy lines, according to the disparity between the tension of the two divisions of threads. An alternative, though less practical method of obtaining a similar result would be to wind the two divisions of threads upon separate warp beams, and, by any suitable means, apply varying degrees of resistance to the withdrawal of yarn from them, and thereby alternately increase and diminish the tension of the two divisions of warp threads in a contrary manner.

CHAPTER XII.

BROCADE FABRICS.

§ 171. The term "brocade" is commonly employed as a generic term virtually comprising all varieties of woven fabrics of simple texture consisting of only one series each of warp and weft threads, and as distinct from compound types of fabrics of more complex construction. In its more limited application, however, the term "brocade" refers more particularly to the lighter and medium weight textures of silk, linen and cotton fabrics of simple structure and embellished by more or less elaborate Jacquard figuring which may be developed by displaying either warp threads or picks of weft only, or both series of threads, more or less freely upon a ground texture usually consisting either of the plain calico or "tabby" weave or other simple and neutral weave such as the smaller twill, satin and matt or dice weaves, according to the particular effect desired in the fabric.

Weft Figuring.

A typical example of cotton brocade fabric of medium quality and intended for bleaching, or dyeing, is that illustrated in Fig. 536, taken from a specimen of grey cloth produced with weft figuring only, on a ground texture of the plain calico weave and containing seventy-six warp threads per inch, of ordinary 30's T, with two warp threads in each dent of the reed; and ninety-eight picks per inch, of 20's soft-spun weft.

In consequence of the great difference in the firmness of texture that usually exists between the ground weave and the figure portion of a brocade fabric, the figure is liable to be somewhat weak and flimsy, more especially if a ground weave of plain cloth—the firmest and most compact of all weaves—is employed. By reason of the threads being loosely interwoven in the figure portion, they crowd together; whereas in the ground portion they are so compacted that they tend to open out and encroach upon the figure where they have

FIG. 536.—Cotton brocade fabric with weft figuring and a ground weave of plain calico.

more room. The tendency of the warp and weft threads to leave their proper place is more pronounced in respect of the weft than the warp threads, as the picks of weft are being constantly acted upon by the reed, whereas the warp threads are held taut during weaving. The result is that the former system of threads, instead of lying in a perfectly straight line

across the cloth, assume a decidedly wavy appearance, and cause thin open places near the edges of the figure, especially those edges that lie in a more or less horizontal direction of the picks of weft, as may be clearly observed in the photographic reproduction, Fig. 536.

Although the defects just indicated are, in a greater or a lesser degree, inherent to brocade fabrics generally, and cannot, therefore, be prevented entirely, they may, however, to some extent, be minimised by the textile designer exercising certain very simple precautions, when preparing the applied designs for the card-cutter, and as demonstrated subsequently in § 176 The defects referred to may also be minimised by ensuring a proper ratio between both the counts of warp and weft yarn, and also between the number of warp and weft threads per inch in the fabric, according to the particular character of the ground weave employed; and since the ground portion of a fabric, and not the figured portion, should constitute the firmest and strongest texture of cloth, that part should be taken as the foundation on which to base the particulars indicated above according to the science of cloth structure and practical experience; for unless a firm and well-balanced ground structure is obtained the entire fabric will be faulty. For example, if the yarn is too coarse, or if there are too many warp and weft threads per inch in the fabric, the ground portion will be harsh and boardy, and will tend to wrinkle. On the other hand, if the reverse conditions prevail the whole fabric, and especially the figured portion, will be flimsy and weak.

§ 172. Designs of almost any style or character may be developed in brocade fabrics, but those having fulness of figure give the best result. Unless the cloth is of very fine texture and of good quality, any minute detail of the pattern would be lost; also, the design should not consist of heavy masses of figure, but the various elements composing it should be disposed evenly over the whole surface. This is not merely to obtain any artistic effect, but with a view to causing all warp threads to bear an equal strain. If the design is of a decidedly stripy character, with the stripes running in the direction of the warp, the warp threads weaving the ground stripe will bear the greater strain during weaving; and when the cloth is cut out of the loom it will tend to wrinkle or buckle in those places, through contraction, on being relieved of such strain.

As stated in the previous section, brocade figuring may display either warp or weft threads only, or both series of threads, on the obverse of the fabric. The latter course offers considerably more scope to a designer in the development of a greater variety of textural effects, more especially if the warp and weft threads are of different colour. Also, the character of the warp and weft must not differ materially from each other either in respect of the counts or quality of the yarn, otherwise those figures in the design which are developed from the inferior material will suffer by comparison with those of the superior material, and thereby impart to the entire fabric the appearance of one of an inferior quality.

The manner of developing applied designs for brocade fabrics of the variety illustrated in Fig. 536 is indicated in Fig. 537, which represents a small fragment of the design for that fabric. After sketching in the design on squared or point paper, the designer proceeds to indicate the margin of the figure and ground portions by means of a single dotted outline consisting of single dots that are produced on the same "tab" or "shed" which requires alternate warp threads only to be raised for alternate picks of weft, and intermediate warp threads only for intermediate picks of weft, whereby two or more contiguous warp threads are never raised at the same time, nor is a warp thread ever raised for two or more consecutive picks of weft, although any *odd* number of consecutive warp threads may be left down at the same time; also warp threads may remain down for any odd number of consecutive picks of weft. When the outline of the ground and figure is completed in the manner described, the designer then proceeds to bind the floating weft figures with such elementary binding weaves as will ensure the desired effects in the cloth and, at the same time, prevent too long floats of weft on the face side of cloth, and too long floats of warp threads at the back.

It should be observed, however, for reasons to be stated presently, that the binding weaves selected for this purpose must consist of single binding points only, and with those points or dots always on the same "tab" or "shed," as explained previously. Also, when selecting the binding weaves to employ for this purpose, care should be exercised to employ

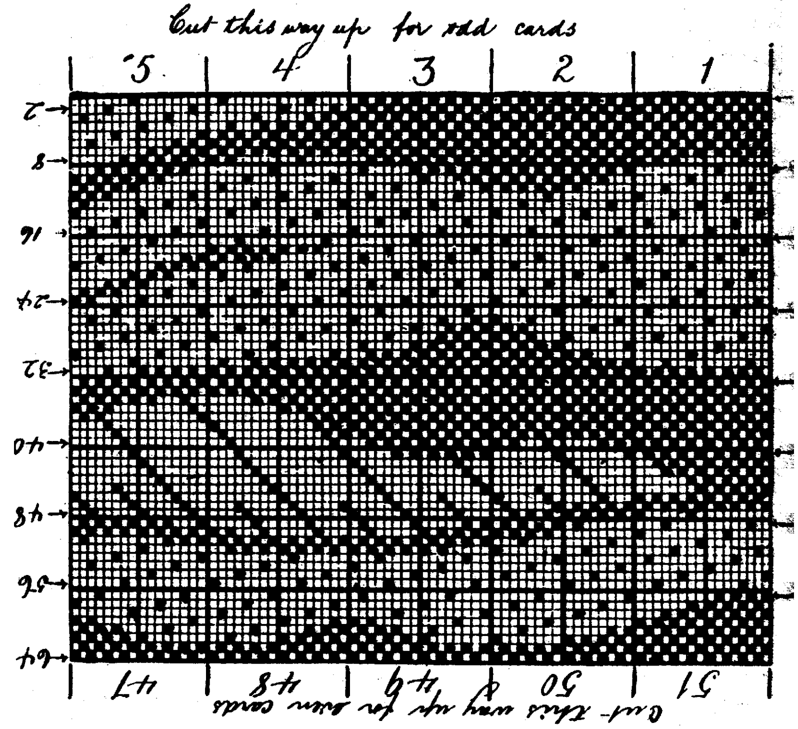


FIG. 537.—Portion of applied design for brocade fabric, Fig. 536.

such as will give due prominence to the figures without leaving too long floats that will weaken the fabric; and fabrics of relatively finer texture may be bound with weaves of a looser character than those of coarser textures, without detriment to the stability of the fabric. The binding weaves employed in the portion of design, Fig. 537, are the 10-end satin and the 12-end twill weaves.

It is unnecessary to fill in the ground portion of the design by indicating the plain tabby weave in the manner represented in Fig. 537, but with the object of saving both time and labour on the part of the designer, it is the usual practice to fill in the ground portion with a thin wash of green or yellow paint to distinguish it from the figure portion, which is left blank. In this case the green or yellow paint signifies the plain calico weave, and must be "read" accordingly by the card-cutter when cutting the pattern cards.

§ 173. Although the raising of warp threads uniformly on the tabby principle of weaving in the manner described, and as indicated in the portion of a brocade design, Fig. 537, imposes certain limitations upon a designer both in the choice of a design and also in the choice of suitable binding weaves, the practice incidentally affords an opportunity of effecting economy in the production of this variety of brocade fabrics by adopting what is termed the "split-shed" method of tying up the Jacquard figuring harness or mounting threads to the *separate hooks* of an ordinary double-acting two-cylinder Jacquard machine which, in this case, virtually consists of two separate and distinct sets of hooks and lances constituting two machines in the same framing. Thus, by operating the two sets of hooks in alternate succession for the odd and even-numbered pattern cards and picks of weft respectively, only one-half the number of pattern cards will be required as compared with the number that would be necessary if warp threads of both the odd and even series were raised together for the same picks of weft, thereby saving the cost of one-half the number of pattern cards, card-cutting, lacing and wiring.

For example, a double-acting two-cylinder Jacquard machine tied-up with a "split-shed" harness may control a given number of warp threads and employ a pattern card for each pick of weft only, whereas if the same number of warp threads were controlled by an ordinary "straight-tie" harness, it would be necessary to employ either a Jacquard machine of double the capacity of the former, or else two separate machines of equal capacity, and to operate them simultaneously for each pick

of weft, thereby requiring twice as many pattern cards. With a "split-shed" tie-up, however, it is only possible to weave fabrics either with all-weft or else all-warp figuring, according to which is to constitute the face and back of the fabric. But in either case the fabrics must of necessity be woven with the *weft figuring uppermost*, seeing that odd and even warp threads cannot be raised together, although they may remain down at the same time as described previously. Also, in consequence of the margin of the figures ending abruptly against a ground weave of plain cloth, they assume a somewhat broken and irregular outline, more especially in fabrics of coarser texture and poor quality.

Warp and Weft Figuring.

§ 174. The embellishment of brocade fabrics with both warp and weft figuring affords considerably greater scope, to a textile designer, than is possible either with weft or warp figuring only, but the development of warp and weft figuring in the same design requires a much higher degree both of artistic and technical ability on the part of the designer because of the greater variety of textural effects that are thereby afforded, and also of the increased danger of faulty construction arising from a much greater freedom of interlacement of warp and weft threads.

Unlike many other types of fabric, the brocade type generally will permit of the successful development of designs of almost any kind, whether of a geometrical or floral character, provided there is a free distribution of figure over the surface of the fabric in order to ensure uniform tension upon the warp threads. Those in which both warp and weft threads are employed in the development of figure are rendered much more effective by having each of a different colour, but such as will give an agreeable contrast, and at the same time produce a harmonious combination. Each colour may be employed separately in its full tone, or both may be combined to produce any intermediate tone.

It is usual to employ the full tones of each colour for the figure portion and a neutral tone for the ground portion of the fabric. There is then no danger either of warp or weft figure being overpowered or lost by contrast with the ground, such as would be liable to occur by contrast with a ground weave in

FIG. 538. –Cotton brocade fabric with both warp and weft figuring and a ground weave of plain calico.

which either warp or weft were allowed to preponderate on the face. Portions of figure that occupy a central position in a large object, or those that require subduing, may also be developed in a neutral weave, or other suitable intermediate tone, inclining to that either of the warp or the weft.

A very simple example of warp and weft brocade figuring is that illustrated in Fig. 538, which is a photograph of a cotton brocade fabric containing 84 warp threads per inch of 2/80's bleached yarn, and 78 picks per inch of 30's indigo weft. And although the design is of a plain character, its effectiveness is enhanced by the employment of a variety of simple binding weaves. Thus, the white warp flowers are bound with the 8-end satin weave, with the central weft spot bound with a single diagonal twill cutting; whereas the weft leaves are variously bound with the 8-end satin and 8-end twill weaves; whilst the ground consists of the plain calico weave which produces the best of all neutral effects by reason of the warp and weft being displayed in exactly equal proportions, and with the least possible exposure of the surface of the threads.

The choice of suitable binding weaves in the development of an applied textile design is of the greatest importance; for what may, in all other respects, constitute a suitable design, this may be marred by unsuitable or unskilful binding. As a general rule, only such binding weaves should be employed for brocade fabrics as will produce a plain and even surface. Honeycomb and similar rough-looking weaves should, therefore, be avoided, unless such effects are, for some special reason, desirable. For ordinary purposes, elementary weaves such as simple twill, satin, "diamond" and "rice" weaves, will be found to meet most requirements; but if these are inadequate, recourse may be had to weaves of a more elaborate character such as small matt, rib, cord, corkscrew, hopsack, granite and such-like effects.

Experience, combined with judgment, can alone guide a designer in the choice of suitable weaves; but it will generally be found that the boldest effects are produced by those weaves in which the intersections of warp and weft are least distributed, and also by those containing few intersections; and that the more subdued effects are produced by those weaves in which the intersections are most uniformly distributed, and also by those containing frequent intersections. For example, a twill weave gives a much bolder effect than a satin weave, or than the plain or calico weave.

Designers would frequently dispense with the use of binding weaves in some portions of a design, were it not an absolute necessity to employ them to ensure the stability of the fabric. The employment of these binding weaves often mars what would otherwise have produced a far more pleasing effect;

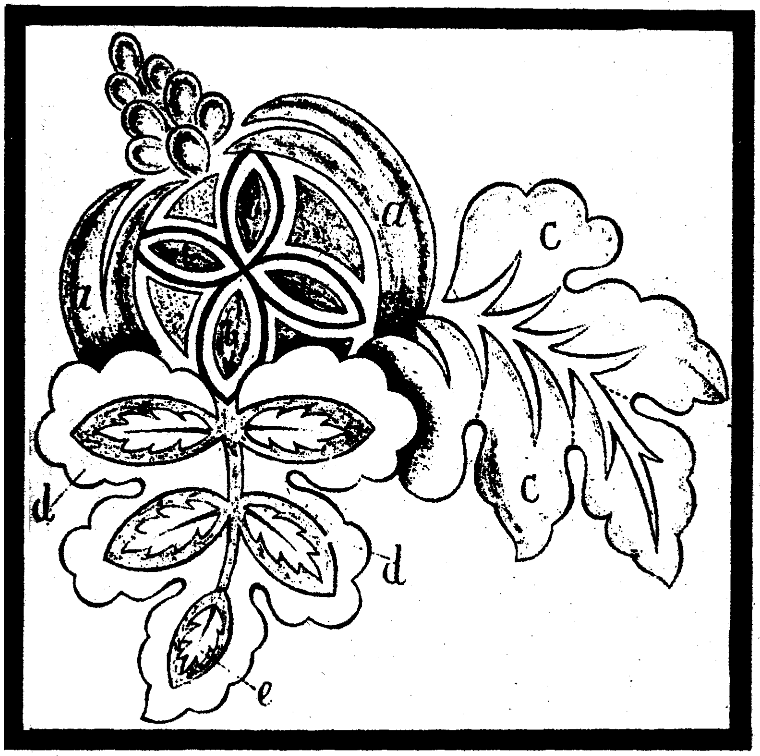


FIG. 539.—Part of sketch design for a brocade fabric with warp and weft figuring developed as in applied design, Fig. 540.

but seeing that they are a technical necessity, they should be turned to the best possible advantage by imparting the most agreeable effect of which they are capable. On the other hand, however, portions of the figure that do not require binding are sometimes treated as if they did, in order to harmonise

those parts with others that require binding for structural purposes. Also, unimportant and obscure portions of a design may be bound with the intersections disposed irregularly, in order to prevent, in the most effective manner, too long floats of warp or weft.

A skilful designer will rarely employ more binding points in a design than are essential to ensure structural stability; but he will avail himself of every opportunity of combining structure and design so as to obviate any necessity for binding. For example, when developing a leaf, he will take advantage of the venation, marking and edging which, by extending or increasing them in a suitable manner, may also serve the additional purpose of binding or stitching.

§ 175. A portion of a sketch which is eminently suited for development as a brocade design containing both warp and weft figuring is illustrated in Fig. 539. From the varied character and the scope which this sketch offers to a designer for skilful treatment, it is selected as a suitable theme for demonstrating the practical application as a textile design of which a portion is indicated in Fig. 540.

The group consists of a conventional fruit *a* of the dehiscent kind which open to allow the seeds *b* to escape, in which act it is represented in the sketch; and two simple five-lobed leaves *c*, *d*, with sinuate margins, upon the lobes of which latter leaf *d*, five small serrate-edged leaves *e* are superimposed.

By carefully studying the design, Fig. 540, much useful information respecting the development of a brocade design will be obtained. Black squares on design paper represent warp of one colour, and white squares weft of another colour. The surface of the fruit is bound with a 10-end warp satin weave to impart smoothness, whilst the seeds are developed with a 6-end diamond weave to give them due prominence. The interior of the fruit is treated in a subdued manner to cause it to recede. The upper half of the leaf *c* may be bound with an 8-end warp twill weave, and the lower half with an 8-end warp satin weave, or *vice versâ*.

Or, another effective plan would be to develop alternate lobes with a twill, and the others with a satin weave, care

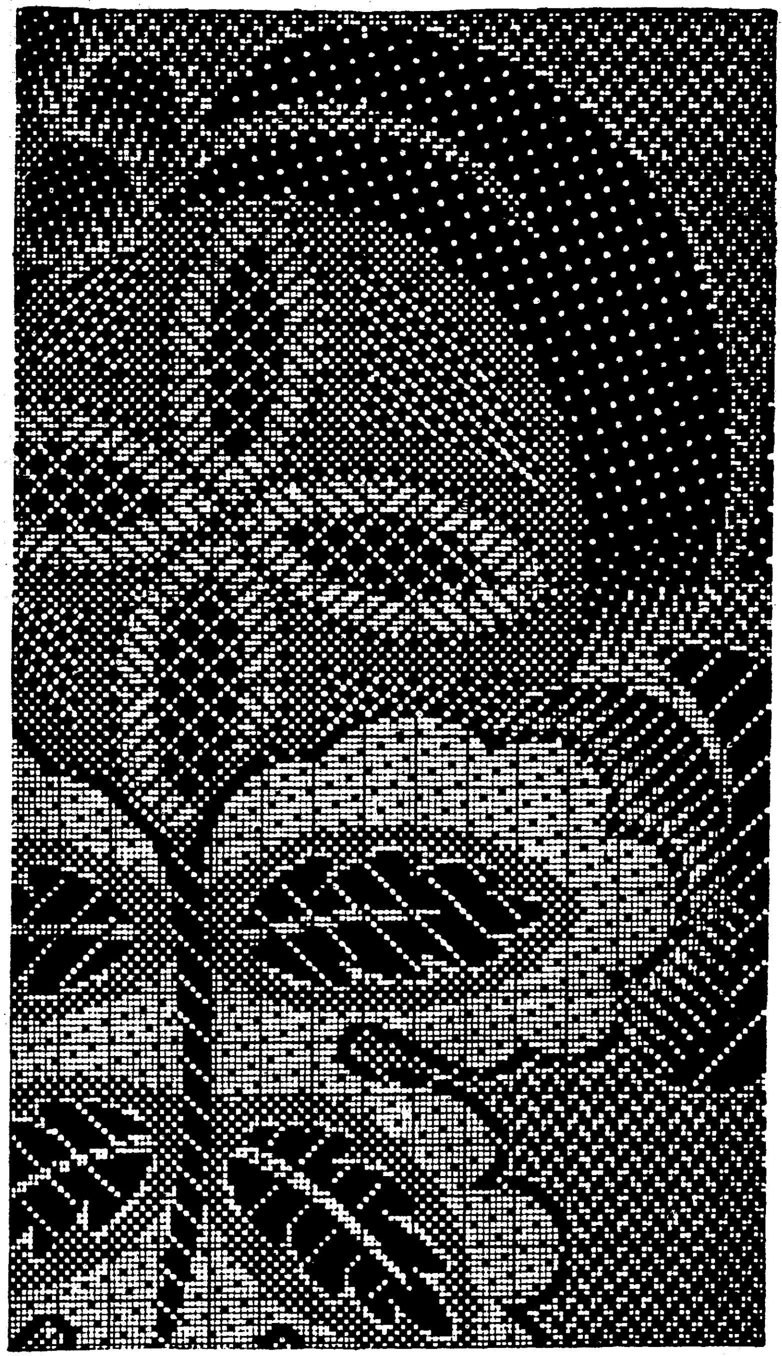


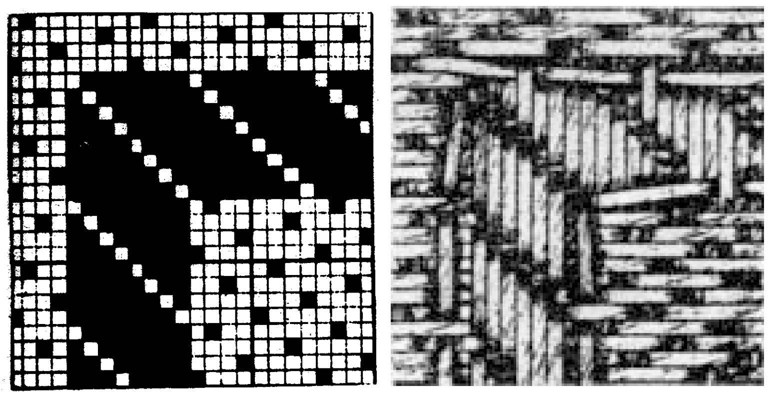
FIG. 540.—Part of an applied design for a brocade fabric with both warp and weft figuring developed in several different weaves to obtain variety of effect as in sketch design, Fig. 539.

being taken to prevent long floats of yarn where the two weaves meet. If the latter plan were adopted, it would perhaps be better to entirely separate the lobes from each other by a single cutting line made by slightly extending the veins, as indicated by dotted lines in the sketch, Fig. 539. The lobes of the leaf *d* are developed with a 10-end weft satin weave, and edged with a double warp line; and the small leaves *e* with an 8-end warp twill weave to give them boldness. These smaller leaves are separated from the lobes of *d* by a neutral weave of plain cloth which will cause both to stand well up. Minor portions of the design are treated in such a manner as will prevent too long floats of yarn; and the whole stands upon a neutral ground weave of the broken "Harvard" ($^2—_2$) twill.

§ 176. In addition to binding both the figure and ground portions of a brocade fabric for the purpose of preventing too long floats of warp and weft, it is essential to properly "lock" or "check" the binding points which occur on the extreme margin of the figure and ground, especially where the margin lies more or less in either a horizontal or a vertical direction. The object of "checking" or "locking" these marginal binding points in a *horizontal* direction is to prevent picks of weft from sliding along the warp threads where a weft margin lies *horizontally* against a warp margin; and also, in a like manner, to prevent warp threads from sliding along picks of weft where a warp margin lies *vertically* against a weft margin. If this precaution were neglected, warp threads and picks of weft would slide out of their proper straight lines, and thereby cause the parts where this occurs to assume a more or less broken and straggling appearance in the fabric.

The tendency of the warp and weft threads to slide out of their proper place in the manner just described arises, in respect of warp threads, from picks of weft extending beyond their fellows and encroaching upon one or more warp threads which are thereby free to slide underneath those picks of weft and thus assume a more or less wavy and irregular line. Also, in a like manner, picks of weft slide underneath encroaching warp threads from a similar cause. This objectionable tendency, however, may, in a very large measure, be prevented or minimised by the practice of "checking" or "locking" the marginal binding points in the manner indicated in Figs. 541 (A) and 542 (A), which indicate the incorrect and the correct methods of binding a design, and the resultant effects in cloth, at Figs. 541 (B) and 542 (B) respectively.

Thus, Fig. 541 (B) illustrates the effect that would be produced in cloth if the marginal binding points were left unchecked as indicated in the portion of a design, Fig. 541 (A); whilst the superior results obtained by the system of checking,

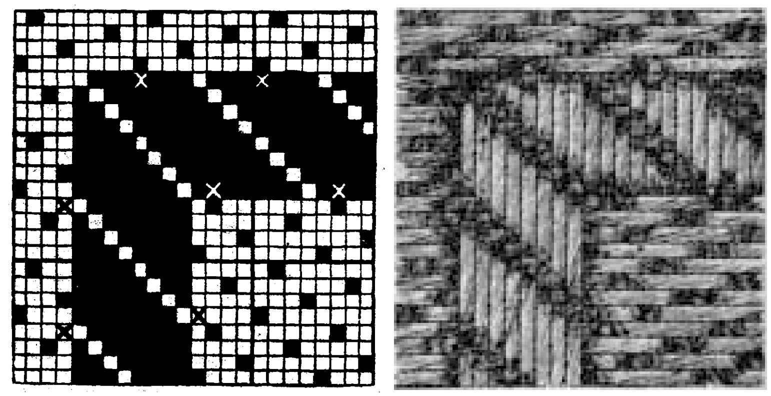


A B

FIG. 541.

by inserting the additional marginal binding points indicated by black and white crosses, in Fig. 542 (A), are illustrated in Fig. 542 (B), to which there is imparted a much smarter appearance by keeping the marginal threads quite straight and in their proper places. The presence of these additional binding points, however, frequently constitute in themselves an objectionable feature in a textile fabric, as they sometimes tend, unless they are employed with discretion, to impair, instead of enhancing, the good appearance of a design by over-binding. Still, of the two evils it is perhaps the least objectionable, and the safer one to adopt, as it conduces to increase the stability of the fabric.

By exercising a little ingenuity in the selection and arrangement of binding weaves, a designer may frequently avoid the necessity of "checking" in many parts of a design, by the simple expedient of causing the marginal binding weaves of the figure and ground portions to check or lock each other automatically. This object is more easily accomplished where the margins of figure and ground are perfectly horizontal and vertical, as in counterchange designs of a geometrical char-



A B

FIG. 542.

acter, than in designs of a foliated character where only short lengths of yarn are exposed at the margins. A good plan to adopt in binding a design, when weaves with single binding points that are all on the same "tab" are used, is to have the weave of the figure portion on the opposite "tab" to that of the weave of the ground portion. By adopting this course the binding points will, in many places, check each other automatically, and fewer additional binding points will be required.

Brocade Figuring with Extra Warp Threads and Extra Picks of Weft.

§ 177 Brocade fabrics may be rendered additionally attractive by the employment of extra warp threads or of extra picks of weft, of a different colour to the ordinary warp and weft. Such extra coloured threads do not replace ordinary threads of the corresponding series, so as to form bands of colour up or across the piece, but are wrought into the fabric as additional threads in such manner as is predetermined in

FIG. 543.—Part of a sketch design for a brocade fabric, with both warp and weft figuring, in which extra warp threads, of a different colour, are introduced in certain parts only, to develop the small berries.

the design. This extra material may either float loosely at the back of the fabric when not required on the face for figuring purposes, and be afterwards sheared off, or it may be interwoven with the ground portion of the fabric.

In the latter event, however, care must be taken to select

such ground weave as will enable the binding points to be properly obscured, so as to prevent them showing through on the face side of the cloth. It is obvious, therefore, that a ground weave of plain cloth would not answer such a requirement, in consequence of that weave exposing the threads on both sides of the cloth for the least possible interval, and thereby not providing any covering for the binding points.

The conventional group of foliage, Fig. 543, is a good motif for a design in which either extra warp or extra weft may be effectively employed. The two bunches of berries could be developed with the extra material, and the remaining portions with the ordinary warp and weft. A neutral weave of some kind should be used for the ground filling, so as to display both warp and weft figure with equal effectiveness.

Extra Warp Figuring.

§ 178. Extra warp threads should be governed, by preference, by spare hooks in the same Jacquard machine as that which governs the ordinary warp threads. By this method only one set of pattern cards is necessary, and less attention is required of the weaver than when an extra machine and set of cards are employed.

Since extra warp threads do not interlace with weft with anything like the same frequency as do the ordinary warp threads their contraction during weaving is considerably less than that of the latter. They should, therefore, be wound upon a separate warp beam, when their delivery can be suitably regulated.

The development of a design for a brocade fabric in which extra warp threads are employed, is little different from that of an ordinary design. The designer must know the number and disposition of extra warp threads at his command, if he is making a design to an existing tie-up; but if he creates a new tie-up, he may dispose the extra warp threads to suit his requirements, and have the Jacquard harness tied up accordingly.

When preparing a design on point paper, the portions of figure to be developed with the extra warp threads should be painted in a different colour from that representing the ordinary warp. Also, if the extra warp threads are to be interwoven to prevent them floating loosely at the back, a third colour should be used to indicate the binding points.

A very simple example that will serve to demonstrate the development of such a design is represented in Fig. 544 which consists of two square cones arranged alternately upon a 4-end basket or matt-weave for ground filling. The centre of each base is developed with the extra warp threads (represented by shaded squares) to form a diamond. This is surrounded by a weft figure (represented by blank squares), and the sides of the cones are developed with the ordinary warp (represented by black squares). Round white dots indicate both warp threads lifted to bind one of them into the fabric at the back.

The design repeats on 48 warp threads and 90 picks of weft, with 22 extra warp threads, *i.e.*, 11 for each figure.

Assuming the design to be woven by means of a 400's Jacquard machine (408 hooks) with a straight-through tie-up on 384 hooks, the card-cutter would repeat the design eight times over on each pattern card, because 384 ÷ 48 = 8. As there are 408 hooks in the machine, this would leave 408 − 384 = 24 spare hooks of which 11 × 2 = 22 are required to operate the extra warp threads, leaving 2 hooks for selvedge warp threads. If the 24 spare hooks are left on the 26-side of the machine, the tie-up will be as follows: 384 hooks (counting from the 1st hook in the 51st bar on the 25-side of the machine) for ordinary warp threads; 22 hooks for extra warp threads; and the last 2 hooks (on the 26-side) for selvedge threads; making a total of 408 hooks.

The design indicated in Fig. 544 is set out for this tie-up, and will be contained in it eight times. The extra warp threads must be indicated in the design at A where they are required to appear in the cloth; and also (in another colour of paint) where they must be lifted for binding purposes. Their order of lifting must then be transferred to the hooks B set apart for them. Selvedge hooks C are working a plain weave.

Harness threads from extra figuring hooks must pass through the comber-board behind the ordinary harness so that their

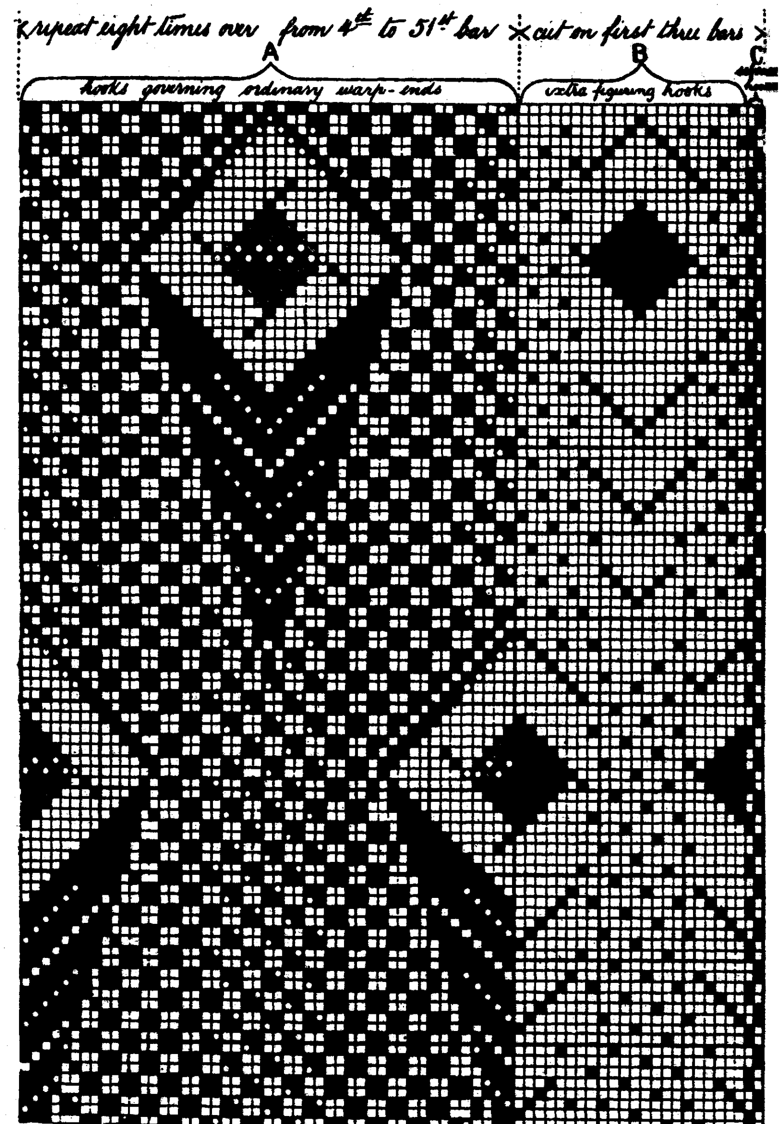


FIG. 544.—Applied design for a brocade fabric illustrating the method of introducing extra figuring warp threads as represented in sketch design, Fig. 543.

mails will fall exactly where the extra warp threads will lie in cloth.

The methods of binding warp and weft are indicated in Figs. 545 to 550 inclusive. The binding of the figure is effected in the usual manner. Thus, the weft figure is bound with the ordinary warp, and both warps are bound with weft where required, in the manner indicated at *a*, a^1, Fig. 545. Warp threads should not be bound in the manner indicated at *b*, b^1, Fig. 546, by sinking one and lifting its fellow on the same pick. This puts undue strain upon those threads, and gives a "pitted" appearance in the cloth, due to their pulling against each other. Although both series of warp threads lie together at the back of the cloth when the weft is on the face, care

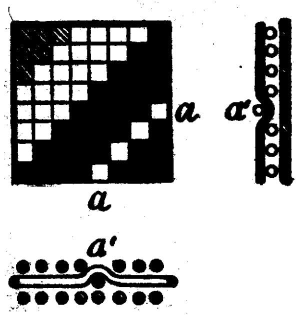


FIG 545.

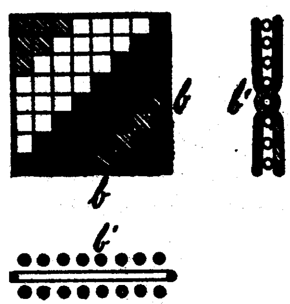


FIG. 546.

must be taken to prevent them being together on the face at the same time: not only to avoid their confusion, but because a warp effect requires a weft foundation, and *vice versâ* The two series of warp threads must, therefore, be separated by picks of weft, as indicated at *c*, c^1, Fig. 547, when one of the two series of warp threads is required on the face. The method of binding the picks of weft when these pass over both series of warp threads is indicated at *d*, d^1, Fig. 548.

The binding points for the extra figuring warp threads must be inserted in such positions as will effectually obscure them when the fabric is viewed obversely. This object may only be effected by raising the extra warp threads over the picks of weft when these are at the back of the cloth, in which case

the binding points will be covered by the regular warp threads, as indicated at *e*, e^1, Fig. 549. Where there is a mass of warp threads on the face of the fabric, as represented on each side of the cones, in the design, Fig. 544, there is no difficulty

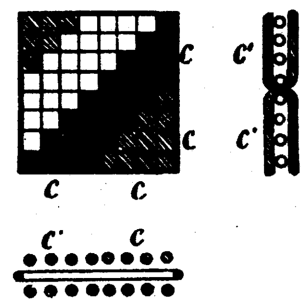


FIG. 547.

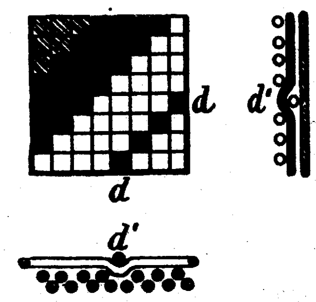


FIG. 548.

in selecting suitable binding points; but in a ground weave similar to that employed, there is greater risk of such points not being effectually obscured.

These observations are also applicable to the binding of ordinary warp threads to prevent their floating too far at the

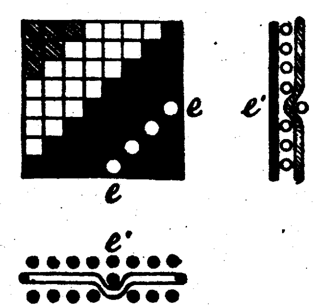


FIG. 549.

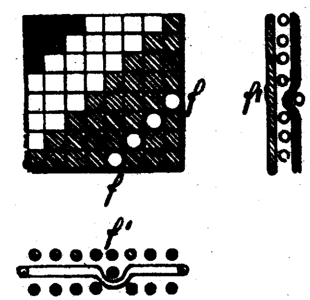


FIG. 550.

back when covered with extra warp threads on the face, as indicated at *f*, f^1, Fig. 550. To ensure the foregoing conditions, the card-cutter must be instructed to punch holes in the pattern cards where there is paint on design paper represented by solid squares and round white dots; and to leave the pattern cards blank where the design paper is bare, and also where