This is effected by the top levers PR and QS, which are centred at O. One end of the griffe is connected to Q, the other end of the griffe is connected to P. This gives firmness and strength to the machine. These Jacquards are usually made very heavy, as they are chiefly for heavy work.

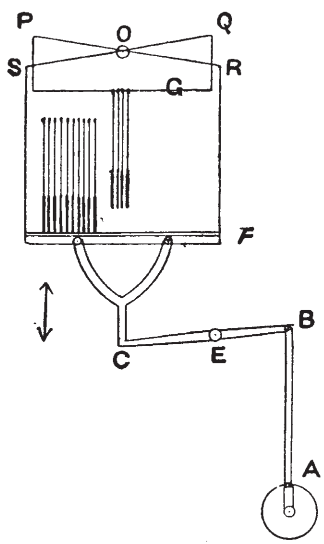


FIG. 121.

Only a few hooks are shown as an example, but the machines can be made any size. When all the hooks are resting on the bottom board, which will be when the bottom plate is at the top of its stroke, the card is pressed against the needles and selects the hooks to be lifted in the usual manner, after which the griffe rises as the bottom board sinks. Thus an extra deep shed is produced without the griffe having so far to lift as would otherwise be the case. The shed produced is a centre shed, all the ends coming to the centre every pick.

"OPEN-SHED" JACQUARD.

Several open-shed Jacquards have been patented. That of Wilkinson's is illustrated at Figs. 122 and 123. A and B are a pair of hooks, which are connected by a cord passing round a pulley, W. This pulley works on a pin at one end of the thin plate C, and at the other end of the plate is another pulley, X. The neck cord E passes round this pulley to the bar D, to which it is fastened. It is obvious that when one hook of the pair is lifted, say, 4 inches, and the other is at the bottom, the pulley W will be lifted 2 inches; and as the cord E is fast to D, the harness threads will be lifted 4 inches, the same as the hook.

If one hook of the pair is lifted and it is required to keep the same ends of warp up for the next picks, the hooks being connected round the pulley W, one hook going up as the other comes down will keep the harness cords stationary, and the hooks A and B can be lifted alternately one up, one down, without moving the cord E, which will all the time be keeping the warp ends up. The shed thus obtained is similar to that in a Keighley dobby; the ends, when once they are lifted, stay in that position until they are required to come down. The principle can be applied to either double-lift single-cylinder or double-lift double-cylinder machines.

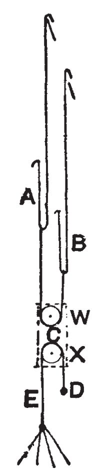


FIG. 122.

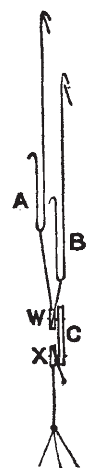


FIG. 123.

Another view of the pulleys is shown at Fig. 123, where the pulleys and other parts are lettered as in the previous figure. Each pair of hooks in the machine has these pulleys attached, and therefore it will be understood that the pulleys must be rather thin in order to enable them to be placed in a space equal to the size of the Jacquard machine. The advantage which a satisfactory machine on this principle would possess lies in the fact that the jerk which occurs in ordinary double-lifts when the weight is passing from one hook to another in each pair is done away with. This jerk causes breakage of the neck cords, and many efforts to overcome the annoyance have been made. This principle of open shed may be applied to dobbies such as the Blackburn dobby.

THE SPLIT HARNESS.

The split harness is an ingenious method of increasing the size of pattern which can be woven on a given Jacquard. What is termed a "double-scale" split harness consists of two adjacent lingoes being connected to each hook in the machine. Thus with a 400s machine there are 800 mails in a pattern. A few lingoes are shown at Fig. 124 tied up in the manner of a double-scale harness. The connections to four hooks are shown. Underneath the comber-board a loop is made in the harness thread, and shafts SS, either wood or metal, are inserted through the loops in each row in the harness. These shafts are worked by the spare hooks in the machine, and in the places where the ends are left down by the Jacquard, the shafts, being lifted to a given ground pattern, will weave the ends singly. In Fig. 124 the shafts are shown lifted to weave a plain or tabby ground, every alternate one being lifted. Hooks No. 1 and No. 2 are lifted by the Jacquard, and hooks 3 and 4 are left down, and it will be seen that where the hooks are down, half the ends will be lifted by the shafts. The ends, when lifted by the Jacquard, cannot be woven separately with this harness, and

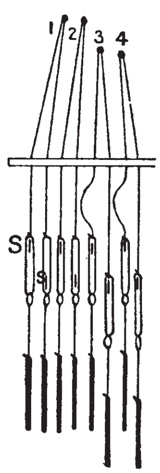


FIG. 124.

therefore the bindings in the figure will show in twos, which, unless the harness is a fine one, has a tendency to make the cloth appear coarse. Satin or twill grounds may be woven. In fact, the ends left down by the Jacquard may be woven singly to any pattern which repeats on the number of shafts used, or into the number of rows which the harness is deep in the comber-board. Of course either the figure or the ground may be woven singly, according to the way the pattern is designed, but not both.

In silk weaving, harnesses are built on this principle to a threefold scale — that is, with three mails attached to each hook—and as in the double-scale a figure repeating on 800 ends can be woven on a 400s machine, so with a threefold scale a 1200 figure can be woven on a 400s machine. In this case the bindings in the figure will be in threes, but the ground ends may be woven quite singly by the shafts.

This principle is only adapted for very fine reeds in cotton goods, but is often used in silk manufacture, where 300 or 400 threads per inch are not uncommon.

THE PRESSURE HARNESS.

The pressure harness was invented with the object of enabling very large figures to be woven on ordinary sized Jacquard machines. In very fine silk damasks—say, with about 400 threads per inch—a very large machine (or machines) is necessary to obtain a figure suitable for damask on the ordinary principle. The pressure harness overcomes this difficulty in a most ingenious manner.

The method originally used consisted in drawing a number of ends in each mail, and then drawing each end separately through a shaft in front of the harness. These shafts had long eyes, as shown in Fig. 125; in fact, the eyes are large enough to permit of the shed being opened without their interfering with it. In Fig. 125 two of the Jacquard lingoes are shown, A, representing those lifted by the Jacquard, and B, those left down. There may be any number of ends in each mail, say

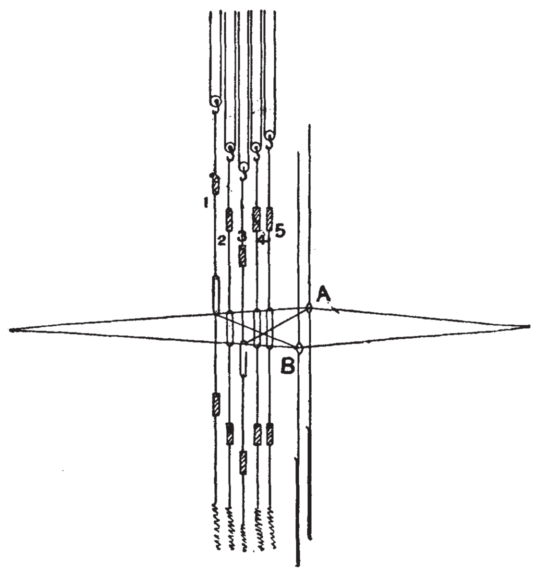


FIG. 125.

five. After being drawn through the Jacquard harness in fives, the ends are drawn singly through the shaft harness in front. These shafts are either worked by treadles or by a Jacquard. In the diagram they are shown worked in the latter manner. A small pulley is placed between the hooks and the shafts, and each shaft is connected to two hooks, a cord from one hook passing round the pulley to the other hook. When both hooks are lifted, the shaft will be lifted to the top, like the shaft 1; when only one hook of the pair is lifted, the shaft will be taken up half way, like the shafts Nos. 2, 4, and 5; and when both hooks are left down, the shaft is left at the bottom, like the shaft No. 3 in the diagram. These shafts require to be worked by a machine with double the lift of the Jacquard machine behind them, as from bottom to top the lift is twice the size of the shed. They may also be worked on the centre shed principle, one shaft going up and another one going down from the centre each pick.

If one of these shafts is lifted to the top, like shaft No. 1, it is obvious that it will take up one end out of every mail left down, and by lifting the shafts in satin order the ends left down by the Jacquard in fives would be woven singly five shaft satin. By leaving one shaft down every pick, the ends lifted by the Jacquard will be split up in the same manner. So that with one shaft at the top, one at the bottom, and the other three lifted half way, a figure repeating on 2000 ends can be woven on a 400s Jacquard, every end being woven singly in both the ground and the figure. Of course only simple weaves can be used, and the figure will move in steps round the edges. If it is required to weave an eight shaft weft satin figure on an eight shaft warp satin ground, eight shafts must be used instead of five. The ends may still remain five in a mail, as it is not necessary that the number of ends in each mail should be the same as the number of shafts used. These shafts are called pressure healds; hence the name given to the harness.

In designing for this class of harness the figure is put on point paper in simple colour, no binding dots being used, as the binding is all done by the pressure healds. The method of putting down the plan for lifting the healds, and of devising a variety of weaves for pressure harness weaving, will be found fully explained in Chapter X.

Another and better kind of pressure harness is illustrated at Fig. 126. Instead of healds with long eyes, two sets

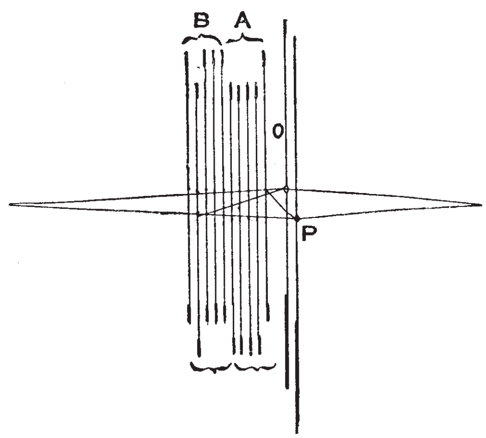


FIG. 126.

without eyes are used, but with a simple clasp in the middle. Fig. 126 shows the mounting for a five end satin figure on a five end satin ground, and two lingoes only of the Jacquard are shown, O representing the lifted hooks, and P the hooks left down.

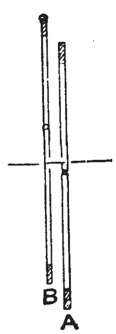


FIG. 127.

There may be five, six, eight, or more ends in each mail, and they are drawn singly into the pressure healds in front in the following manner:—There are two sets of healds with clasps, as shown at Fig. 127. Each end is drawn singly *over* a clasp in the set A, and *under* a clasp in the set B. The clasps in the set A are fixed at the bottom of the shed, and the clasps in B are fixed at the top of the shed. By pulling one of the set B down and lifting one of the set A every pick in satin order, the ends lifted in fives or sixes are woven singly in warp satin, and the ends left down in fives or sixes are woven singly in weft satin.

The method of operating the pressure healds in a hand loom is shown at Fig. 128. The shafts in set B are pulled down by lifting the end E of the levers EF, and the same on the other side. The shafts in the set A are lifted directly by

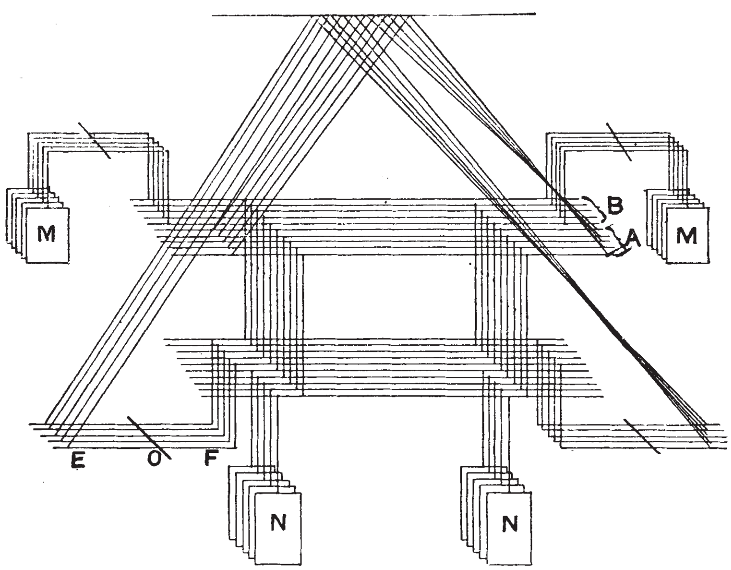


FIG. 128.

the hooks. The shafts are lifted by a few spare hooks in the Jacquard. Sometimes the Jacquards have three or four rows of extra hooks for this purpose, and these hooks are placed a little to one end of the machine, and a small separate cylinder is used. The cards for lifting or pulling the pressure healds are put on this cylinder, and the large cylinder carrying the figure cards is only turned round once every few picks by arranging the catches to do this. The same card is thus brought against the needles several times in succession, and the smaller cylinder being turned every pick, interweaves the threads in satin or the required order. This will form steps at the edges of the figure in the weft way as well as warp way, and is a considerable saving of cards. The weights M are to pull the healds B up, and the weights N to keep the healds A down. Springs may be used in their place, but weights are preferred in the hand loom.

The mails used in the Jacquard harness are made with a separate hole for each end. Sometimes as many as twelve or sixteen ends are drawn in each mail, thus giving in the latter case a 6400 end figure from a 400s machine, so that with 300 ends per inch the figure would measure over 20 inches wide.

EDLESTON HARNESS.

A method of weaving an 800 figure on a 400 double-lift machine has been patented by James Edleston, of Preston. This is a very useful and ingenious idea, as a floated figure can be formed, and the machine remains a double-lift, with all its advantages as regards speed. Certain limits are placed upon the weaves, which can be employed for the ground or for developing the figure, but sufficient scope is afforded for all practical purposes to make the invention a success. An illustration is given of this harness at Fig. 129. The inventor gives no drawing in his specification, but presumably the illustration (Fig. 129) will represent his method; at least, it will effect the same object. One row of hooks of a 400s double-lift single-cylinder machine are shown, and it will be noticed that the hooks are not joined together by a neck cord as in the ordinary machine, but the harness threads are taken singly from each hook as in a single-lift machine. The knives work as in a double-lift, one up, one down. By cutting the cards in a certain manner the whole of the 800 hooks may be operated by the 400 needles so as to produce ordinary brocade or damask figures with a repeat of 800 ends. The same end cannot be lifted for two picks in succession, as the knives have to move up and down and work oppositely; but an end can be *left down* any *odd* number of picks, and a figure can thus be formed. At Fig. 130 the design for eight-end satin ground is given. It must be remembered that for eight ends there are only four needles, and therefore the lifting dots must be put on four ends on the point paper. By carefully comparing this design with the mounting of the harness, the principle will be quite clear. The design shows a dot on the first and fifth ends on the first pick, and therefore a hole will be cut in the card opposite the first and fifth needles.

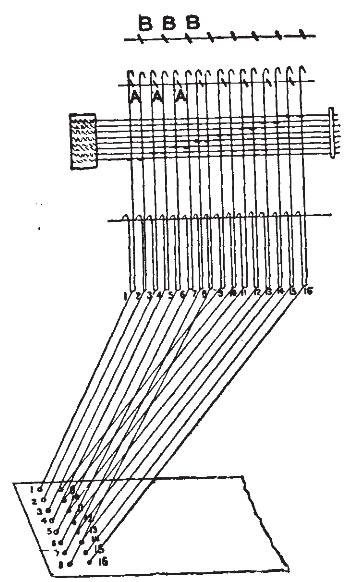


FIG. 129.

Suppose the griffe A to be lifted for the first pick, it will lift the first and ninth ends. The second card has holes opposite the second and sixth needles, and when the griffe B is lifted for the second pick, it will lift the fourth and twelfth ends in the warp or lingoes in the comber-board. The third card has holes opposite the fourth and eighth needles, and as on the odd picks the griffe A lifts, it will lift the seventh and fifteenth ends in the warp. If this is followed out it will be found that the ends are lifted in the order 1 4, 7 2, 5 8, 3 6, or eight end satin is woven. Fig. 131 shows the method of putting the dots on point paper for four end twill (one and three). The principle is the same as in the preceding case, and is very simple when understood. A hole opposite the first needle on the first pick causes the first end to be lifted, and a hole opposite the same needle for the second pick causes the second end to be lifted.

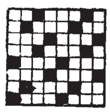


FIG. 130.

FIG. 131.

Any figure can be put upon the cloth, with the following limits as regards the bindings: firstly, an end cannot be lifted for two successive picks; secondly, every end must be left down an odd number of picks.

From this it will be seen that a five end satin cannot be woven, nor can a weft figure be put on a warp ground. Plain grounds can be woven, and cord grounds of various kinds are also suitable for the harness.

DAMASK OR TWILLING JACQUARDS.

These Jacquards are now extensively used for weaving linen, damasks, and similar fabrics, and are used where pressure harnesses were formerly used. The pressure harness puts a great strain on the warp, and requires a longer distance between the cloth and the warp beam than is usually allowed for in power looms; therefore much ingenuity has been expended on these Jacquards with the view of obtaining a large design without using several ordinary Jacquards above each loom, with the accompanying great expense in cards and other attachments.

The principle of damask attachments and twilling Jacquards is entirely different to the principle of the pressure harness, and for fine silk fabrics which require a very large extent of pattern and woven on the hand loom, the pressure harness on the principle shown at Fig. 126 is not likely to be replaced.

In the pressure harness a number of warp threads are

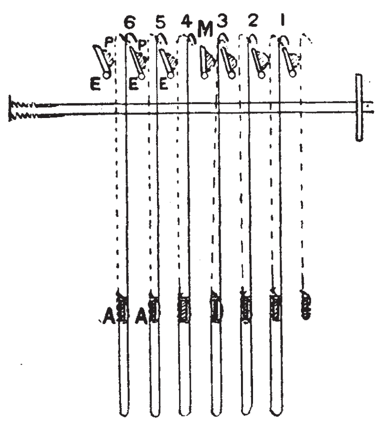


FIG. 132.

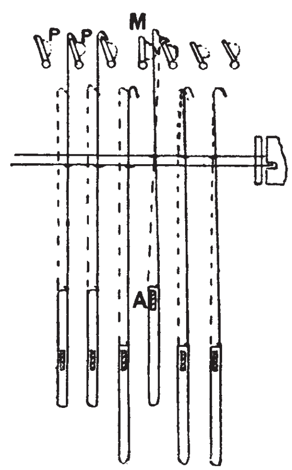


FIG. 133.

placed in each mail, the number of threads varying from five to sixteen; but in the twilling Jacquard only one end is drawn in each mail, and a separate hook is required for every end. The advantage comes in making each needle serve for several hooks and in making one card serve for several picks. One of the first inventors of this kind of Jacquard was Mr. Barcroft, of Newry, Ireland, and it has been improved since by him and others. The principle is illustrated at Figs. 132 and 133. There may be any number of hooks to each needle. In the illustration there are three. The machine is necessarily a single-lift, the griffe goes up and down every pick. Only two needles are shown, operating six hooks. When the top needle is pressed back it will press back the hooks 1, 2, and 3, and when the bottom needle is pressed back it will press back the hooks 4, 5, and 6. These hooks are bent at the bottom as in the diagram, and a bar or rod A is passed through each row of hooks the full length of the machine. These bars A are lifted by the twilling hooks, shown in the diagram in dotted line. These hooks are placed at the sides of the machine: two hooks for each long row of the ordinary hooks, or one for each end of every bar, A. The blades of the griffe are movable about the centres EE, and at each end of the blades and immediately behind each twilling hook (dotted) there is a projecting piece, P, also shown in a dotted line in the diagram.

Now, when the griffe is at the bottom, the blades are operated by a pegged barrel, and by turning the blades one at a time out of the way of the hooks as the blade M is turned, it is obvious that a whole row of hooks can be left down which would otherwise be lifted.

Turning the blade has also another effect. On the front of the blade at each end, as previously pointed out, is a projecting piece, P, and when the blade is turned, this projection pushes the twilling hook in front of it (dotted) on to the next blade of the griffe, and the twilling hook is lifted. The bottom of the twilling hook is fastened to the end of a bar, A, and the bar is lifted, thus lifting a whole row of hooks which would otherwise be left down. In this manner it is obvious that by operating the blades of the griffe in regular order, the figure can be woven warp twill and the ground weft twill, or *vice versâ*. At Fig. 133 the position of the six hooks is shown after the griffe is lifted. It will be seen that the blank opposite the top needle pressed the first, second, and third hooks back, and they would all three have been left down but for the bar A being lifted. The hole opposite the bottom needle leaves the fourth, fifth, and sixth hooks over the griffe, and they would all have been lifted but for the blade M being turned, which also caused the bar A to be lifted. It will be obvious that the twill must repeat on the number of bars A, or on the number of rows of hooks, in the machine, exactly as in a split harness the ground weave must repeat on the number of shafts or rods used under the comber board. In these machines, as in the pressure harness, the same card is pressed against the needles two, three, or more times in succession, so as to give a great extent of pattern with a small number of cards. The number of times a card is pressed against the needles depends on the number of hooks there are to each needle, and on the relative amount of warp and weft in the fabric. If there are three hooks to a needle and the same number of picks as ends per inch, the card should be used three times in succession, but sometimes there are more picks per inch than ends, in which case each card should be used oftener; and sometimes, as in silk damasks, there are 400 or more warp threads per inch and 100 picks, and supposing there were eight threads in a mail, it would make a step of eight ends in the warp; therefore, to make the steps in the weft balance it would be necessary to bring the same card against the needles only twice in succession.

Fig. 134 is another arrangement for weaving damask. It is called a damask attachment, and was patented by Tschorner and Wein a few years ago. Its construction differs from ordinary twilling Jacquards, but the principle is much the same.

Each needle is twisted round several hooks, and the knives are operated separately by cams at the side of the machine. The illustration shows one of the knives left down, leaving down a row of hooks which would in the ordinary course have been lifted, and one of the bottom lifters is taking up a row of hooks which would in the ordinary course have been left down.

The foregoing are the chief kinds of Jacquards and harnesses (except lenos) attached thereto, but there are many com-

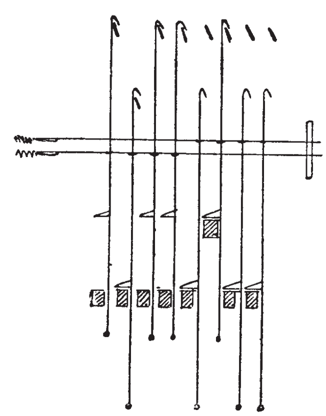


FIG. 134.

binations of shaft and Jacquard or mail harness which need not be mentioned in a book of this size. We may mention a system, sometimes called half harness, in which only half the ends are drawn through the Jacquard harness, and the other half through shafts in front or behind. A double-sized figure may thus be formed.

CHAPTER VII

LENO WEAVING

THE word "leno" has latterly become a general term given to all classes of cross weaving. Originally it had a different meaning to gauze, but the word is now often applied to gauze as well as other fabrics woven with doups. A pure gauze fabric is one in which the crossing thread is brought up on one side of a standard end, and up the other side of the standard end on the next pick. Fig. 135 shows how the threads are interlaced in gauze weaving. It will be seen that the weave repeats every two picks. The crossing end, and the end round which it crosses, must be placed in one dent, and if an end is made to cross round a number of ends they must all be in the same dent or split in the reed, as it is very obvious that an end cannot be made to cross into another dent with the ordinary doup heald.

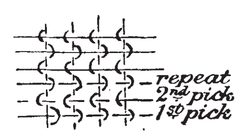


FIG. 135.

The end is made to cross from one side to the other by means of a doup heald. These healds consist of an ordinary heald with an extra half, generally called a "loose half" or slip. The method of knitting the doup heald will be understood from Fig. 136. It is obvious that when the doup is lifted at A, the end contained in the doup will be lifted up on the right-hand side of the end E. In order to bring the same end up on the left-hand side of E, the ends are drawn through the healds, as shown at Fig. 137. There are two ordinary staves, and the ends are drawn through them as for plain cloth with two staves. Then the end which is drawn through the first stave is crossed under the end which is drawn through the second stave, and is then drawn through the doup in the manner shown at Fig. 136. When the doup is lifted it will lift the crossing end A up on the right-hand side of the standard end B; but in order to do this easily the end must be

FIG. 136.

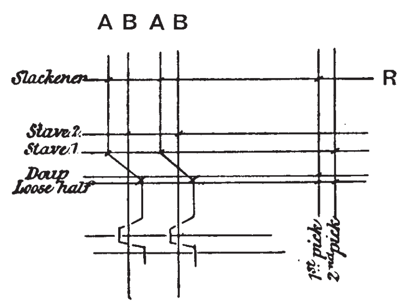


FIG. 137.

slackened. This is done by taking all the crossing ends A from the warp beam over a slackening rod or vibrator, R; the other ends of the warp B are taken over the back rest in the ordinary manner. The slackener is usually in the form of a lever, one end of which can be lifted by the dobby or whatever shedding motion is used, and when the dobby lifts one end of the lever the rod is moved downward, thus slackening the warp which is drawn over the rod. Whenever the doup is lifted the crossing warp must be slackened, or it would cause the standard end B to be lifted, as it is crossed under it. In this manner when the doup is lifted the doup end is brought up on the right of the end B. In order to bring the same end up on the left of B, it is necessary to lift the first stave and the loose half of the doup. The first stave naturally takes the end up on the left-hand side of B, but it is necessary to lift the loose half in order to let the end go up on that side. It is usual to show the doup by a double line in the draft, the front line always representing the loose half. The pegging plan or lifting plan for the healds is for leno fabrics not usually shown on point paper, although it may be, just as easily as any other way. The usual way is to rule horizontal lines representing the staves and perpendicular lines representing the picks, and to put a / on the shafts to be lifted for each pick. It is easy to do this by continuing the lines which represent the shaft in the draft, and to make the pegging plan on the same lines by the side of the draft, as in Fig. 137. The two perpendicular lines one and two represent the picks, and the marks on the first pick are on the loose half, the doup, and the slackener; therefore all these will have to be lifted. (It is usual to peg the dobby to lift the loose half along with the doup to take the strain off the healds.) On the second pick the marks are on the loose half and the first stave, therefore these must be lifted for the second pick.

With the same draft as in Fig. 137, a considerable variety of patterns can be made of a style known as crossover lenos. This style consists in weaving a number of picks plain, and then making a cross with the end. At Fig. 138 the design draft and pegging plan are given for a " five and one " crossover leno. From the design it will be seen that the doup is required to be lifted for the first pick, and the first stave and loose half for the second pick, the second stave for the third pick, and so on. This lifting is shown in the pegging plan at the right of the draft, where on the first pick marks are put on the doup and loose half the slackener, and on the second pick on the loose half and first stave, and so on. There are in this pattern six picks to the round. The appearance of the cloth will be a bar of five picks plain, and then a crank or open space, in the middle of which is a single pick; the crack is caused by the crossing of the ends.

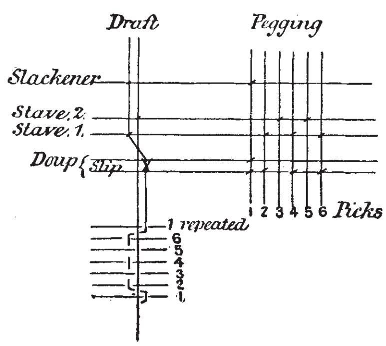


FIG. 138.

In gauzes and fabrics of this description, a thin open fabric in which the ends will not fray or slide is the object. The nature of the weave enables a firmer fabric to be obtained with a smaller number of ends and picks per inch than in ordinary weaving where the threads are not crossed.

Another and quite distinct effect is produced with doups. This is commonly called "lace" or net, and is often combined with gauze or other "open" leno effect in stripes known as "lace and leno stripes." This lace effect is produced by making a thick end form a zigzag on the plain ground. The interlacing of the threads in a simple lace or net stripe is shown at Fig. 139. A thick end, A, is brought up first on one side and then on the other side of two plain or nearly plain ends, B and C. There are ten picks to the round, and by the side of this dent there is another thick end twisting in the opposite direction, first up one side, and then up the other of two more

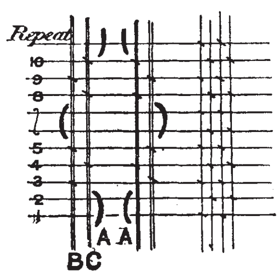


FIG. 139.

plain or nearly plain ends. Each thick end comes up for two picks at one side and then crosses under and comes up on the other side after an interval of three picks, and *vice versâ*. The marks represent the ends lifted. By the side of the lace there are two plain ends shown, which represent the unlimited number of ends used for the ground of the fabric. In weaving this pattern the draft and pegging given at Fig. 140 would be used. By carefully following the design with the draft and pegging plan the principle will be easily mastered. The arrangement of the shafts is rather important. The doup is placed in

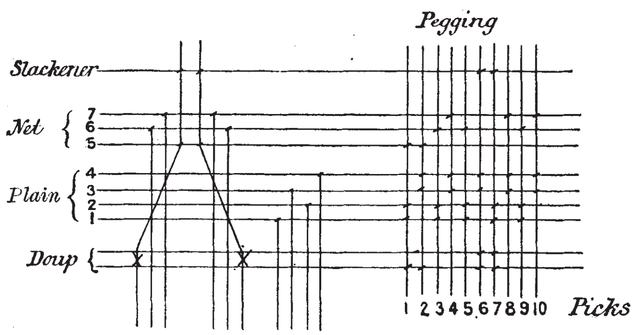


FIG. 140.

front, the ground staves next, and the leno or net staves next. It is immaterial whether the crossing ends be taken through the first stave of the three used for the leno, or the back one—some prefer one way, some another—but it is necessary to get the leno staves as far back as possible to give the thread a better chance of crossing. Four staves are taken for the plain, as in ordinary weaving, to prevent overcrowding. The lifting marks on the pegging plan will be easily followed if the one in Fig. 138 was understood. Where the fifth stave is lifted the loose half is lifted also, and both thick threads come up on the inside. Where the doup is lifted the slackener is lifted also, and the ends are brought up on the outside as on the sixth and seventh picks. More will be said on the arrangement of shafts in the chapter dealing with designs for leno. The explanations on the structure of the fabrics at this point are only for the purpose of enabling the requirements of the looms for weaving them to be understood. Some manufacturers prefer to work with the doups at the top of the loom, especially in weaving net lenos. In this case the crossing end is crossed over the others and slipped downwards.

It used to be considered that gauze and lenos could not be woven on double-lift machines. In other places than Lancashire this idea prevails to-day to a great extent, but of course this is a great mistake. The simpler kinds of lenos, such as pure gauze and crossovers, are sometimes woven on tappets, which are, of course, double-lift. The tappets are of the ordinary kind, drawn on the same principle as described earlier in this book; but the tappet which operates the standard ends is made to lift the staves halfway when the doup end is crossing. Tappets of this kind have been used for some time past, and it is not surprising that the same principle should be applied to double-lift dobbies. Instead of drawing the tappets to lift the standard ends half way or a little way to enable the ends to cross easier, the easing motion usually employed for dobbies is often used, and the tappets are of the ordinary kind.

In a double-lift dobby the healds begin to lift for one pick when the healds which are up for the previous pick begin to come down. In the case of Fig. 137, when the doup is lifted for the first pick and begins tocome down, the same end is being taken up the other side of B by the stave No. 1 being lifted. If the end B were not moved it would very soon be broken by the crossing end being made to act in this saw-like manner upon it. It is necessary, therefore, to lift the end B about halfway up at the moment the crossing end begins to come down and to pass to the other side of B. If the end A has not to cross for the next pick, it would not be necessary to lift the end B at all. In a single-lift machine the doup will get to the bottom before the first stave begins to rise, and therefore there would be no difficulty in the end crossing. In a double-lift dobby the staves containing the ends round which the doup thread crosses are lifted partly up every pick by a lever worked from the crank arm of the loom. This easing motion or "shaker" is shown at Fig. 141. AB is the crank-arm, and the upright CD is connected to the crank-arm at C, and to a lever ED at D. EG is another lever on the rod E, and the healds which are to be lifted half way are connected to this lever at G, as well as to the jacks in the dobby. As the crank revolves the oscillation of the crank arm imparts a similar movement to the lever ED, and to the staves which are connected to EG. This motion commences just at the proper time. Of course, when the crank-arm is lifting the healds, the cords connecting these healds to the dobby will be slack, as indicated at Fig. 141. By thus lifting the standard healds, the crossing is greatly facilitated.

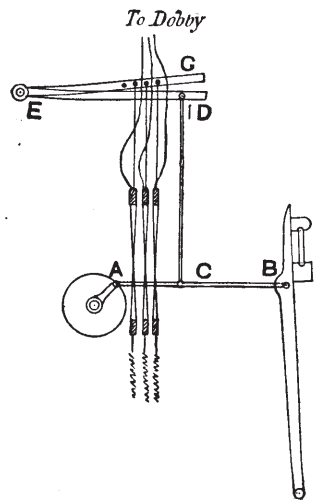


FIG. 141.

This easing motion is not required where there is no crossing of the end immediately, as, for instance, in Fig. 139, the doup end after being brought up on one side is never required up on the other side on the pick immediately succeeding, therefore the end has time to get down before being lifted on the other side and an easing motion is not required.

The method of slackening the warp when the doup lifts is shown at Fig. 142. This diagram shows a two-doup arrangemen. For gauze and similar weaves it is not necessary to have a separate beam for the crossing warp, as one end pulls the other and the take-up is about the same; but for net lenos or laces after the manner of the fabric in Fig. 139 it is necessary to have the crossing ends on a separate beam, as a great deal more in length of this warp is required than for the plain. Sometimes several beams are used, the only limit being the number which can be placed in a given space.

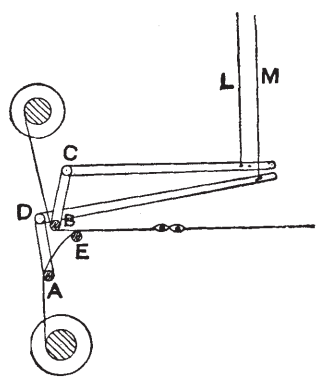


FIG. 142.

At Fig. 142 the crossing warp from the bottom beam is taken over the slackening rod A, and over the carrier E. The crossing warp from the top beam is taken under the slackening rod B. A moves about a centre D, and B moves about a centre C.

The slackener B is connected to a jack in the dobby by the cord L, and the slackener A is connected to another jack by the cord M. When either L or M is lifted, the warp over its rod will be slackened.

FULL CROSS LENO.

A full cross may be made by taking the doup completely round the standard end, as in Fig. 143, and alternately lifting the doup and the other end. This is a much more difficult weave than ordinary leno, and is not much used, although it gives a very pleasing effect when woven with thick yarns. The weave repeats on two picks as in gauze, but it is necessary to use very strong twist in order to bear the strain and friction unavoidable in this crossing.

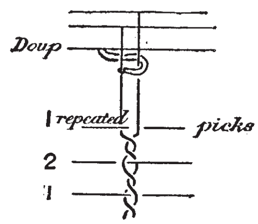


FIG. 143.

THE LENO JACQUARD.

Where figures are required to be thrown up on a leno ground a Jacquard mounting is required. It is possible to weave a plain figure on a gauze ground with an ordinary Jacquard harness and an ordinary doup stave in front, but this can only be done on a pure gauze ground—that is, one end crossing one. A plain figure on a ground of this kind does not afford a sufficiently powerful contrast to the ground. It is necessary in order to produce a really efficient contrast to have two ends crossing two and weaving separately in the plain. A fabric of this kind is one of the most beautiful of all fabrics, and is remarkably cheap and

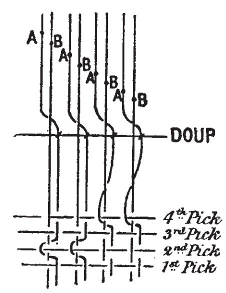


FIG. 144.

serviceable in wear. The method of producing a plain figure on a gauze ground with one doup in front of any ordinary Jacquard harness is illustrated at Fig. 144. The ends are drawn through the Jacquard as usual, and are then taken in pairs and one crossed under the other, the crossing end being taken through the doup, as shown in the diagram. The crossing end in each pair is marked A. We can now see how either plain or gauze can be woven at will. The doup is lifted for the first pick, and this brings all the ends A up at the right hand side of ends B (see first pick). In the first two dents the ends A are lifted again by the harness, and the loose half of the doup being lifted will enable the ends A to cross to the left side of the ends B. The doup is lifted for the third pick, and it is obvious that this will weave gauze with the first two dents. After the doup is lifted, if the end B is lifted on the next pick, it will cause plain to be woven, as will be seen from the diagram, where the third and fourth dents are weaving plain when the first and second dents are weaving gauze, and *vice versâ*.

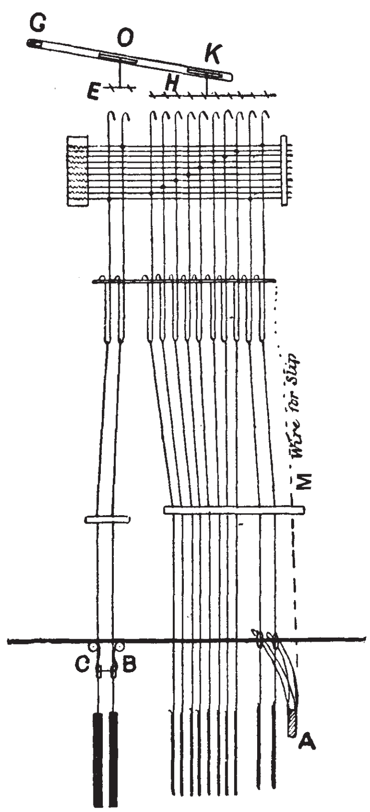


FIG. 145.

A proper leno harness is illustrated at Fig. 145. It is obviously impossible with the arrangement given at Fig. 144 to weave a leno with two ends crossing two in conjunction with plain, as there would require to be two ends in each eye in the doup, and as the doup is lifted every other pick, it is impossible to change to plain from the leno. To obtain a figured leno of this description, each dent must have a doup to itself, and the doups must be lifted by the hooks. At Fig. 145 the arrangement of the harness is shown. The machine is a single lift, and in order to obtain a 400 end figure 600 hooks are required. These are arranged in twelve rows, the two front rows being used for the doup harness, the two back rows for the slackening harness, and the eight middle rows for the ground or figure harness. For the 600 hooks only 500 needles are used, the doup hook and its slackening hook being connected with the same needle. The top and bottom needles are used for the doups and slackeners, as shown in the diagram, and the eight middle rows of needles for the ground or figure harness. The method of drawing the warp through the harness is shown at Fig. 146. The two crossing ends are drawn through the slackening harness, and all the ends are drawn through the ground harness. It is immaterial whether the draft is from back to front or front to back; some manufacturers of these goods draw the ends from front to back. Of course, this must be borne in mind in designing and cutting the cards. After being drawn through the ground harness the two crossing ends are crossed under the other two and drawn through a doup. The mails in the doup lingoes are specially made to allow the thread from the slip to pass through and

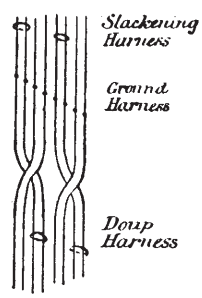


FIG. 146.

back again. The shaft A (Fig. 145) is the slip or loose half, and serves for all the doups. The mails in the slackening harness are placed lower down than the other warp, and these mails hang between two rods, B and C, which are called the "bridge." Sometimes only one rod is used, and this serves equally well.

A better shed is formed by only lifting the slackening hooks half as much as the other hooks, and therefore a special device is required for giving only half the lift to these hooks. In the illustration, Fig. 145, there are two griffes, E and H, and the griffe E is connected to the lever GK at a point, O, about midway between the fulcrum G and the point where the griffe H is connected to the lever. The fulcrum G is movable in a slot made for that purpose, so that the lift of E can be altered a little if desired. When the griffe H is lifted in the ordinary manner, it is obvious that the griffe E will only be lifted about half way.

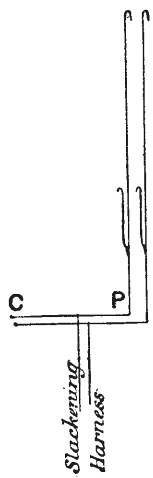


FIG. 147.

The usual method of obtaining the half-lift, which this invention is intended to supplant, is illustrated at Fig. 147. This method was invented by the late Mr. Tootal Broadhurst, and has been in regular use a long time. Each of the slackening hooks lifts a lever CP, centred at C, the slackening harness is tied to these levers about midway between C and P, and thus the mails are lifted only about half as much as the hooks. Of course, in this case all the hooks in the machine are lifted by one griffe, and therefore the slackening hooks are lifted as far as the others.

This method serves its purpose very well, but if any alteration is required in the lift of the slackening harness all the levers have to be gone through and altered separately, whereas in the Devoge machine the lift can be regulated to a nicety by moving the fulcrum G and the point O. The slackening harness should be placed from nine inches to a foot behind the ground harness.

The wire M, in Fig. 145, is for lifting the shaft A, which is required to be lifted every pick. The advantage of using only one needle for the doup and slackening hooks is that it prevents the possibility of the slackener being missed when the doup lifts, as well as being a saving in cards.

By lifting the crossing ends with the ground harness for two or more picks, followed by lifting the same ends in the doup harness for a similar number of picks, an open leno fabric is

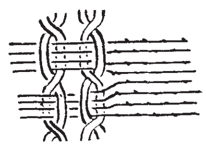


FIG. 148

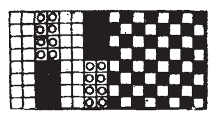


FIG. 149.

produced, and a plain figure can be woven by lifting the ground harness plain, or a floated figure can be formed exactly as with an ordinary Jacquard.

The usual method of putting the design on point paper for these Jacquards is illustrated at Fig. 148. In the plan eight ends of leno are shown with four picks in a shed; and eight ends of plain, of which the figure is usually formed, are shown. The design on point paper for this would be as given in Fig. 149. Ordinary 8 × 8 paper is used, although there are ten rows of needles. The card-cutter cuts the black squares opposite the ground harness needle, and where the circles come, he cuts so as to lift the doup in the next dent. Thus in the first four cards for Fig. 149, the card-cutter would cut opposite the third and fourth needles in the ground harness, and opposite the doup needle for the next four ends. The plain would be cut in the ordinary manner opposite the ground harness needles. A larger design for this harness will be found in Chapter X.

Double-lift Jacquards are not yet used beyond the experimental form, as the shaking cannot be done as easily as in a dobby with shafts, but we have heard of the thing being done by knotting the harness above the comber board and lifting the board a little when the cross is being made. Messrs. Eccles, of Preston, some years ago obtained a patent for lifting the standard ends by means of a third knife or griffe. The additional knife was given half the lift of the other two, and its function was to lift the standard ends half way when the doup ends were crossing to the other side. This would, no doubt, enable the cross to be made with ease in a double-lift Jacquard, but the principle is not likely to be a great success.

The doups in leno Jacquards are very liable to wear out unless made of very good material, and some experience is necessary before the harnesses are worked satisfactorily.

An imitation of the fabric usually woven on this harness is sometimes made by making one end cross three ends in the leno, and weave plain in the figure. This can be done with an ordinary harness with a doup heald in front lifted every other pick, on the same principle as in Fig. 144.

CHAPTER VIII

TERRY LOOMS—CARD CUTTING—LAPPETS

TERRY looms are extensively used in the cotton trade, chiefly for weaving towels, but often for striped dress and similar fabrics where terry or loop pile is combined with other weaves. The loops can be formed either on one side or both sides of the fabric, but the loop formed in these looms is not to be compared with real loop pile woven over wires, as the loops cannot be formed with the same regularity. There are numerous terry motions, as they are called, most loom makers having their own speciality. Fig. 150 is the design for a good terry cloth. It will be noticed that the second and fourth ends are the reverse of each other: one is up for four picks and down for one, and the other is down for four picks and up for one, whilst the other two ends are nearly plain. The first and third ends form the ground, and the second and fourth ends the pile or loops. There are five picks to the round.

FIG. 150.

The ground warp is on a separate beam to the pile warp, the latter having a special tension to let off the required quantity to form the pile. At the second pick in the pattern, just where the pile warp is bound, the reed is made to beat further up than on the two preceding picks, thus forming a pile by sending one half the pile ends to the face and the other half to the back. The reed beats up to the front for the second, third, and fourth picks in the pattern, as given at Fig. 150, following which the reed is held back for two picks. Fig. 151 is a good motion for making the reed occupy the two positions when beating up. P represents the slay, and a lever, A, centred at D, is so constructed that when A is pulled down the reed is pushed forward. The rod R is connected to a lever, M, on a shaft, N, placed under the loom. A rocking motion is given to this shaft by a box cam, P, five to the round (Fig 152), so shaped as to lift and depress the lever QS for the required number of picks. This cam is driven from the picking shaft. By pulling the rod R downwards the reed is moved forwards, and the rod will have to be kept down for three picks and moved up for two picks, so as to keep the reed in its front position for three picks and a little way back for two. The effect required is really to lengthen the crank-arm at will, and the principle of the knuckle joint may be used in its simplest form—that is, by having the crank-arm jointed in the middle and fixed a little out of a straight line, and by straightening the arm when the front position of the slay is required.

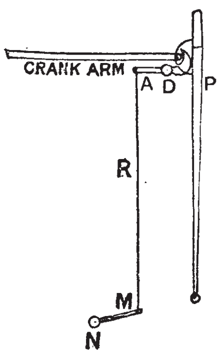


Fig. 151.

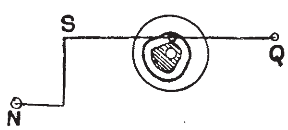


Fig. 152.

The real loop pile is woven over wires. The wires can be inserted and pulled out automatically by a power-loom, but the richest kind of pile is woven on the hand-loom. The structure of the fabric is shown at Fig. 153. The pile end is brought up over a wire every two picks, and when the wire is pulled out the loops form a springy pile, which can be made to give beautiful effects in dress goods. The principle is also used in Brussels carpets, and similar goods. Where figured fabrics are required on this principle, it is necessary to have each pile end on a separate bobbin and weighted separately at the back of the loom, as the take-up of each end would vary so much in the figure.

With cut pile the wires are either grooved, as at Fig. 154, or each wire has a knife at the end, as at Fig. 155, and when

FIG. 153.

FIG. 154.

the wire is pulled out it cuts the pile. The best pile is formed by the grooved wires, as the cutting wires are apt to drag the pile. When cut pile is being made, about four or five wires are constantly in the cloth, for, if the wire were pulled out immediately, the pile ends would fall away from the cloth.

In recent years, looms have been made to weave two pieces of plush (which is a long cut pile, rather longer than

FIG. 155.

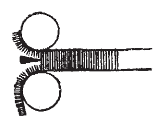


FIG. 156.

velvet pile) in one loom, one piece above the other, after the manner shown at Fig. 156. The principle is not used in cotton manufacture, although it has been tried. It is chiefly used for silk plush.

CARD CUTTING.

The cards are usually cut from the design on a machine called a "piano" card-cutter. This machine consists of a punch-box (Fig. 157), containing thirteen punches, twelve for cutting the smaller holes and one for cutting the peg holes in the cards. There are eight "keys" behind the punch-box, each of which has a small spring round it to spring it back to its original position when the finger is taken off it. These eight keys are used for cutting the eight rows of holes in a 400's card, and for 600's cards, with twelve rows of holes, the

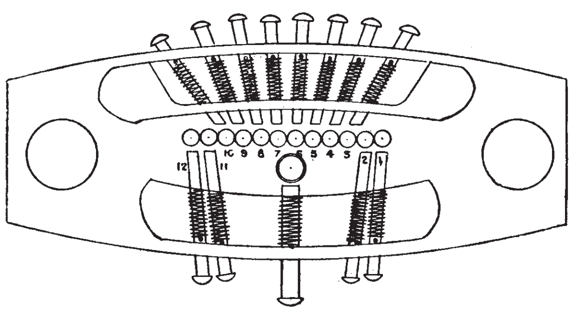


FIG. 157.

four punches in front are used. The two punches in front at the right hand are operated by the thumb on that hand, and the eleventh and twelfth are operated by the thumb on the left hand. The eight keys behind are governed by the four fingers on each hand. Fig. 158 shows the effect of pushing in one of the keys. The key is pushed over the punch K, and as an up-and-down motion is given to the whole punch-box by means of two treadles operated by the card-cutter's feet, the punches that are locked will cut holes in the card. Where the keys are not pressed (see Fig. 159) they do not act upon the punches, and the card is left blank accordingly.

The card is clipped at the numbered end by a clip on the "carriage." This carriage recedes with the card for a space of one row of holes every time the left treadle is pressed down. The method of cutting the cards has already been explained with Figs. 108–110.

If several sets of cards of the same pattern are required, a repeating machine is used. In the hand repeater the

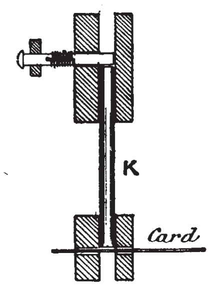


FIG. 158.

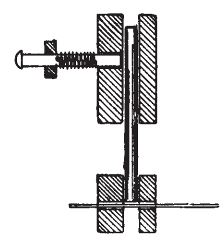


FIG. 159.

cards are made to leave punches in a plate where there are holes in the card, and the plate is then taken to a repeating press, where any number of cards can be cut like the first by applying pressure to the plate, which is done by passing it under a roller or wheel.

Some repeating machines are capable of repeating direct from one set of cards to the other, at the rate of thirty or forty cards per minute. The cards may be laced blank, and kept in stock ready for use when required, which is a great advantage. The machine is built on the Jacquard principle, and the punches required to cut are fastened, whilst those which are not required to cut are taken out of the way of the card.

These machines are rather costly, but in large fancy weaving establishments they soon repay their cost.

LAPPETS.

Lappet figures are formed by giving a horizontal motion to a thick end, and making it interweave in the manner shown at Fig. 160. The system has long been used in hand-looms, and it is now extensively used in power-looms, especially in Scotland. The figures are usually produced with a very thick end upon a fine muslin ground, and the advantage it possesses over figuring with extra weft is that the figuring material does not require cutting off every pick, and therefore there is not the same amount of waste, and in addition the figures are more firmly bound into the cloth.

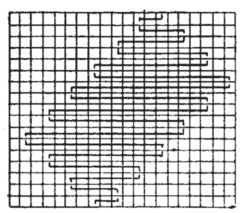


FIG. 160.

Only small solid spot figures can be woven, as the figuring thread cannot be bound between the extreme edges of the figure. This is the chief disadvantage of the principle, and it is not to be compared with swivels for the purpose of producing intricate designs. In swivel weaving each figuring thread is placed in a small shuttle, which receives a horizontal motion by means of a rack. The small shuttles can be lifted out of, and dropped into, the warp, so as to allow the figuring thread to be passed through the shed where the spot is formed, and therefore twill or satin, and shaded effects, can be formed in the spot. In lappet weaving the floats cannot be bound in the middle.

The chief advantage of lappet weaving is that it can easily and satisfactorily be applied to a power-loom. Swivels have been applied to power-looms, but not yet with entirely satisfactory results, taking into consideration the question of cost.

The principle of the lappet power loom will be understood from Fig. 161. In front of the slay cap the needle rack A is placed, the ends resting in the slots BB, and this is moved downwards by the hook C being lifted by the treadle F at the side of the loom. The figuring threads are taken from a separate beam through the needles in the rack, and it will thus be seen that when the rack is pulled down the figuring threads will be at the bottom of the shed. When the treadle F is

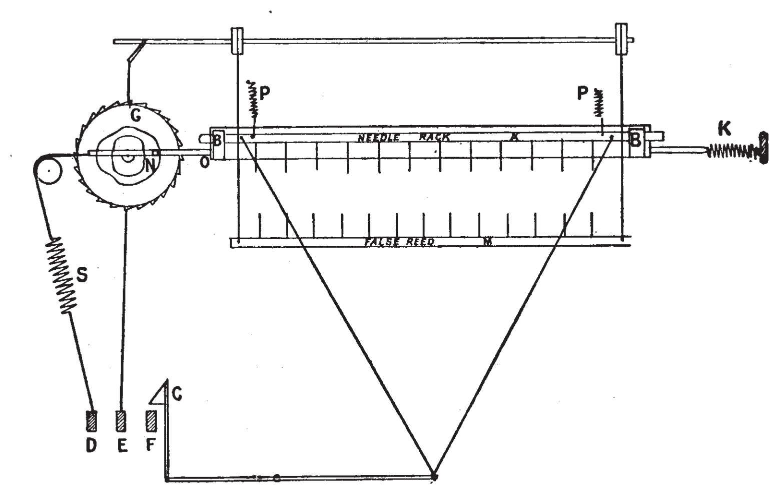


Fig. 161.

forced down, the springs PP pull the rack back to its topmost position, and when in this position the rack is pulled to the left by pressing down the treadle D, the distance which the rack can be moved being regulated by the size of the groove in the lappet wheel at that point.

The lappet wheel G is a wheel with ratchet teeth, and is turned one tooth at a time. The groove in the wheel is so shaped that the rack can be pulled sideways a greater or a less distance as desired, to form a spot or figure. The pin N fits in the groove, and when the treadle D is pressed down the rack is pulled to the left as far as the groove will allow, when the spring S gives way until the treadle reaches the bottom of its stroke. When the treadle is released the spring K pulls back the rack and treadle as far as the groove in the wheel will allow it. The spring K is much weaker than S, so that when the treadle D is pressed down the spring K gives way the first.

The needle rack being in front of the ordinary reed, a "false" reed is required to guide the shuttle across the shed. This false reed M is placed immediately behind the shuttle race, and it is lifted every pick when the shuttle is going across, and dropped to make room for the proper reed to beat up. The treadle E is used for operating the false reed; the connection is shown in the diagram, and when the treadle is pressed down the reed is lifted.

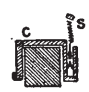


FIG. 162.

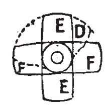


FIG. 163.

At Fig. 162 a section is given showing how the needle rack receives a lateral as well as a perpendicular motion. The slay-cap is cut square, and the cover C works loosely upon it. The needle rack A is pulled down against the spring S, and the cover is pulled sideways by the bar attached to the cover at O, carrying the needle rack along with it.

The treadles are operated by tappets, and those operating treadles E and F must do so every pick, whilst the treadle D only requires to be pressed down once every two picks, because the spring K pulls the needle rack to the right. The tappets are shown at Fig. 163, where it will be seen that when the treadle E is down, F is up, and the rack will be dropped and the false reed lifted; and when thetreadle F is pressed down —letting the rack be pulled up by the springs, the treadle D is pressed down, which pulls the rack to the left as far as the groove in the wheel will allow it to move.

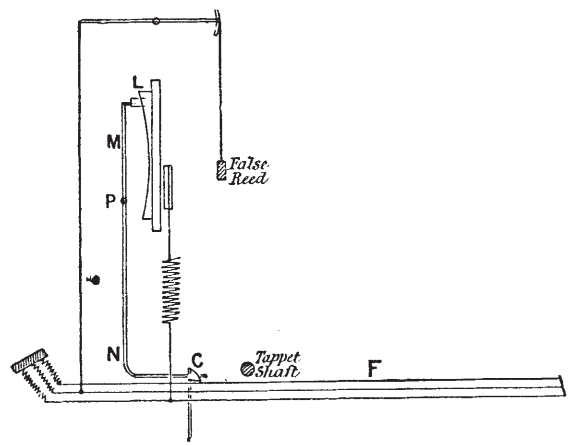


FIG. 164.

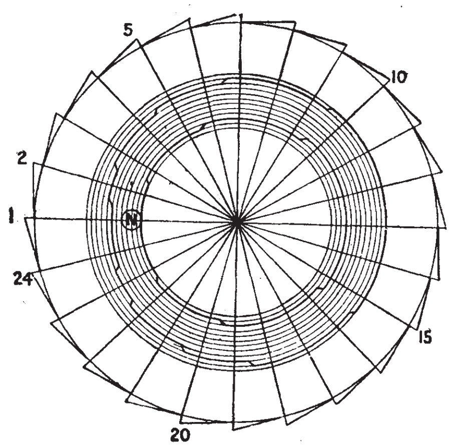


FIG. 165.

At the back of the lappet wheel a face cam L (Fig. 164) acts upon a lever, MN, centred at P, and the bent arm of the lever N pushes the hook C on to the treadle F when the spot figure is being formed, and when there is no figuring going on the hook is pulled out of the way of the treadle, and so the motion of the rack is stopped.

The pattern is formed by the groove in the lappet wheel (Fig. 165), and in drawing this the wheel is divided into as many teeth as there are picks in the pattern. The wheel is usually made of hard wood, and after being smoothed off a number of circles are described, the distance between each being equal to one dent in the reed. Suppose the pattern is a continuous one, as at Fig. 166, the picks shown on paper being in addition to the ground picks. In drawing a wheel for this pattern the number of teeth required will be twenty-four, as there are this number of picks in the pattern.

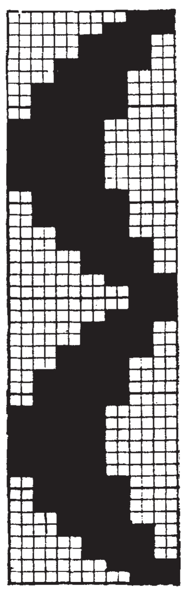


Fig. 166.

The pattern extends to seven dents, and as the pin N (Fig. 165) occupies four dents, it will be necessary to have eleven spaces, each equal to a dent, in the groove. The first pick in the pattern floats over two dents or four ends, and therefore the groove at this point must be six spaces wide—four for the pin, and two for the space it has to move through. Before the next movement of the rack, the wheel will have been turned one tooth, and at this point the groove moves one space further to the left. For the third pick both sides of the groove are moved one space to the left, and the size of the float will remain the same as in the second pick, but it will float over different ends. The groove gradually gets wider until the tenth pick is reached, when it narrows down again until it repeats on the twenty-fourth pick.

If there are two spots set "one and one" in the pattern, the wheel requires one tooth more than the picks in a repeat, in consequence of changing from one spot to the other.

CHAPTER IX

THE PRINCIPLES OF DESIGNING

THE simplest form of interlacing the threads is the plain or tabby weave. In this weave the threads intersect as often as possible, and thus the greatest possible amount of firmness and strength is obtained from a given quantity of material by this weave, with the exception of leno or cross weaving, where additional firmness and strength is obtained by the warp threads being partly twisted round each other in weaving. Plain cloths may be ornamented by using threads of different colours and of different thicknesses, as, for instance, if four picks of blue and four picks of white are alternately put into a cloth, the warp of which is composed of four ends blue and four ends white alternately, a check is formed although the weave is quite plain. A check may also be formed on a plain cloth by using one or more thick threads at intervals in both warp and weft.

There is, of course, a limit to the number of threads of a certain count which can be put into a plain cloth. Assuming that the counts of warp and weft are equal, and that the number of picks per inch required is the same as the ends, the number of threads per inch which can be satisfactorily put into the cloth would not much exceed half the number which could be placed side by side in one inch. Some allowance must be made for the threads being bent out of a straight line and for compression. This branch of design will be treated of more fully in a subsequent chapter, but it will be obvious that this limit to the number of threads of a given count which can be used in a plain cloth renders the weave unsuitable for heavy fabrics. If a plain cloth is very heavy and thick, it must of necessity be coarse.

Plain cloth can be made by using two shafts, but four are

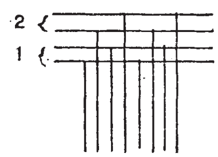


FIG. 167.

FIG. 168.

usually taken with the draft, as shown at Fig. 167. This prevents overcrowding the healds. By tying the first and second together and the third and fourth together, the effect is the same as by using only two staves, only two lifts being required.

Twills.—The simplest twill is the " 2 and 1 " twill, which is woven with three shafts. A section through this twill is

FIG. 169.

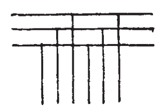


FIG. 170.

given at Fig. 168, where it will be seen the weft passes under one end and over two. The structure of the fabric is better shown on "point paper," as at Fig. 169. The spaces between the perpendicular lines represent the warp threads or " ends," and the spaces between the horizontal lines represent the weft threads or " picks." By filling in the first square on the first pick, it is shown that the first end is lifted for that pick;

and by filling in the second end on the second pick, it is shown that the second end is lifted on the second pick, and so on. It is not always advisable to take a filled-in square as representing a lifted end, as it is often more convenient to fill in the weft squares or those which are left down in weaving. If necessary, it can be stated along with the design whether the marks represent warp or weft up.

Twilled weaves enable a larger number of threads of a given count to be put into a fabric than in a plain cloth, and therefore these weaves are employed in the production of the heavier kinds of cloths where closeness of the threads is also desired.

With three staves the twill given at Fig. 169 is the only one which can be woven. The same twill may be woven with the warp predominating on the face, and this would be represented on paper as at Fig. 171, where two ends are shown to be lifted on each of the three picks.

FIG. 171.

In weaving this pattern three staves would be taken with the draft, as given for Fig. 169 (see Fig. 170). The first stave will be lifted for the first pick, the second stave for the second pick, and the third stave for the third pick. These three lifts being repeated over an indefinite number of times will produce small diagonal lines running at an angle of 45 degrees across the piece, if the number of warp and weft threads in a given space are equal. This twill is sometimes called a "Jean," and is used in the production of a fabric of that name, as well as in "Jeannettes," the latter with warp predominating on the face of the cloth. In all these fabrics a large range of qualities is made.

With four staves the following twills can be made:—

1. One up, three down;
2. Two up, two down;
3. Three up, one down.

These are shown on point paper at Figs. 172, 173, and 174 respectively. The third pattern is really the same as the first, being the reverse of that pattern. It is advisable, however,

FIG. 172.

FIG. 173.

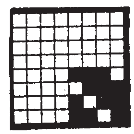


FIG. 174.

to consider them as two distinct patterns, since they give different effects when used for purposes of combination, as will be seen later.

Five-shaft Twills.—With five shafts of staves the possible twills are—

1. One up, four down;
2. Two up, three down;
3. Three up, two down;
4. Four up, one down;
5. Two up, one down, one up, one down;
6. Two down, one up, one down, one up.

These are shown on point paper at Figs. 175 to 180

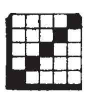


FIG. 175.

FIG. 176.

FIG. 177.

FIG. 178.

FIG. 179.

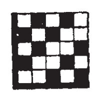


FIG. 180.

inclusive. There are really only three different methods of interlacing the threads in these six patterns; but, as stated previously, different effects are produced in combination twills by all of them.

Six-shaft Twills.—With the increase in the number of shafts the number of twills increases very quickly, as with a "repeat" of six ends the following simple twill can be woven :—

1. One up, five down ;
2. Two up, four down ;
3. Three up, three down ;
4. Four up, two down ;
5. Five up, one down ;
6. Three up, one down, one up, one down ;
7. Three down, one up, one down, one up ;
8. Two up, two down, one up, one down ;
9. Two down, two up, one down, one up.

There are here five distinct methods of intersection, the remaining four patterns being reverses. The patterns are shown on point paper at Figs. 181 to 189.

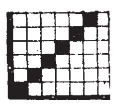


FIG. 181.

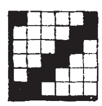


FIG. 182.


FIG. 183.


FIG. 184.


FIG. 185.

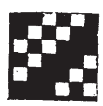


FIG. 186.

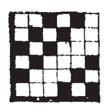


FIG. 187.

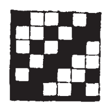


FIG. 188.

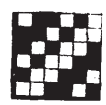


FIG. 189.

Eight-shaft Twills.—With a "repeat" of eight ends and picks the number of changes which can be made in the basis of the twill is much larger, and as the size of the repeat increases the possible twills increase enormously. A selection of eight-end twills is given at Figs. 190 to 199 inclusive.

Satin Weaves.—In simple twills every pick is interlaced with the warp in the same manner, but each successive pick commences, as it were, one end further to the right or to the left, thus enabling every end to be bound into the cloth in regular order. In satins the picks are arranged differently. The object in a satin cloth is to obtain an even surface, free from the bold lines of a twill; and thus it is necessary to distribute the points of intersection of the warp and weft as evenly over the surface of the fabric as possible.

The commonest form of satin is the five shaft, and this can be woven with five shafts with a straight draft lifted in the

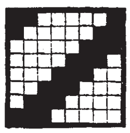


FIG. 190.

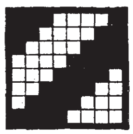


FIG. 191.


FIG. 192.


FIG. 193.

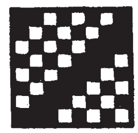


FIG. 194.


FIG. 195.

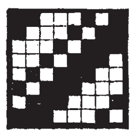


FIG. 196.


FIG. 197.

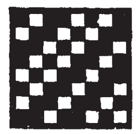


FIG. 198.

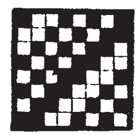


FIG. 199.

order 1, 3, 5, 2, 4. The relation between this satin and a five-end twill is shown at Fig. 175, where it will be seen that on the second pick of the satin the third end is lifted, on the third pick the fifth end is lifted, then the second is lifted, and lastly the fourth. This distribution of the points of intersection produces a satin. A slight twill effect is given by most of these weaves, but it is nothing like so decided as where the adjacent ends are lifted on successive picks, as in twilled cloths. The direction of the twill in the satin at Fig. 200 is from right to left.

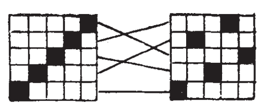


FIG. 200.

This five-shaft satin weave is used with weft preponderating over warp, and also the reverse. Immense quantities of cloth are made on both principles, and in all qualities. A regular make with weft predominating is made with about 72 ends per inch of 32's twist, and picks ranging from 100 to 200 per inch of 40's weft. A finer make is used in large quantities for printing upon. This cloth counts about 26 ends × 45 picks per quarter-inch, and the yarns used are 60's twist, 70's weft. These are two of the standard makes of satins, but for special purposes all qualities are made in cotton.

With the warp predominating a cheaper fabric is produced, as less time is required to weave a given length. "Drills" are woven on this principle, the proportion of warp to weft being about two to one.

Satins may be produced on any number of shafts from five upwards. Fig. 201 is commonly called a four-shaft satin, but this is better classed as a broken twill. The principle of its structure is essentially different to that of a true satin.

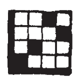


FIG. 201.

A simple method of making a satin weave on any number of ends is to find the first number which is not a measure of the number of staves used, and take this as the basis of constructing the satin, as follows: The first number which is not a measure of five is 2. Then, taking this as the basis of the satin, assuming that the first stave is lifted for the first pick, the third stave must be lifted for the second pick. This gives the number of ends to be "skipped" over, and thus we can obtain the satin by skipping over one each time, viz. 1, 3, 5, 2, 4.

It is advisable to put the numbers in a line or in a circle, and re-arrange them underneath.

The order of lifting the staves for an eight-end satin can be obtained as follows:—The first number which is not a measure of eight is 3. Then, taking this as the basis, we lift the first stave for the first pick and the fourth stave for the second pick, and "skipping" over two each time we get the order, 1, 4, 7, 2, 5, 8, 3, 6. This is shown on point paper at Fig. 202.

A six-stave satin is irregular. It is impossible to form a satin with six staves by "skipping" over a regular number of staves each pick, but the points of intersection can be separated

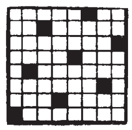


Fig. 202.

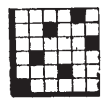


Fig. 203.

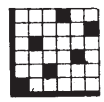


Fig. 204.

and a satisfactory satin formed by lifting the staves in the order, 1, 3, 5, 2, 6, 4, or 1, 4, 2, 6, 3, 5. These are shown on point paper at Figs. 203 and 204.

A six-end satin weave is extremely useful, as it takes rather more material than a five, and its irregular appearance is an advantage for some purposes.

Fig. 205 is a seven-end satin.

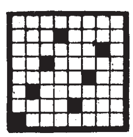


Fig. 205.

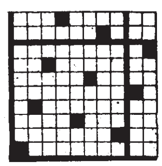


Fig. 206.

Fig. 206 is a ten-end satin. Three is the first number which is not a measure of ten, therefore three is taken as a basis in constructing the satin, and the fourth stave is lifted for the second pick, and the others in regular order.

Fig. 207 is a twelve-end satin. The basis in this case is five, as five is the first number which is not a measure of twelve.

Combined Twills.—A useful class of pattern is obtained by combining pick and pick two simple twills. If two eight-end twills are combined in this manner, a pattern repeating on eight ends and sixteen picks is produced. At Fig. 208 a "three and five plain" twill is combined with a "three, two, one, two,"

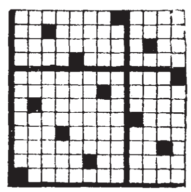


FIG. 207.

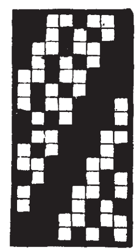


FIG. 208.

twill, and different effects may be obtained by combining the same twills in all the possible positions.

Figs. 209 to 215 show the effect produced by all the changes in the relative position of the two twills. An immense number of patterns can be made on this principle, as all the simple twills may be combined in every position, and in each case a different pattern results.

On six ends we have seen that nine simple twills can be made, and as each may be combined with the others in six different positions, the number of patterns which can be obtained from this system of combination is as follows:—Fig. 181 combined with each of the others in one position each gives eight patterns, and as there are six positions in which they can be combined, this gives forty-eight patterns. Fig. 182 combined with Figs. 183 to 189 gives seven patterns, and these in six positions give forty-two patterns. Fig. 183 combined with Figs. 184 to 189 gives six patterns, and in the six positions give thirty-six patterns. By going through all the changes in this manner we get successively 48, 42, 36, 30, 24, 18, 12, and 6, or a total of 216 patterns. In addition to these, each twill may be combined pick and pick with itself in four different positions without giving double picks.

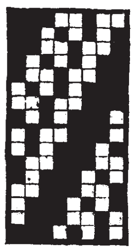


FIG. 209.

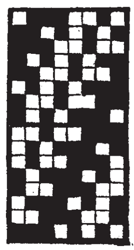


FIG. 210.

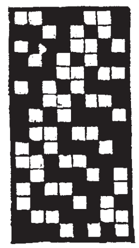


FIG. 211.

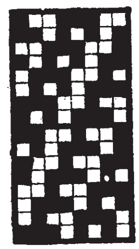


FIG. 212.

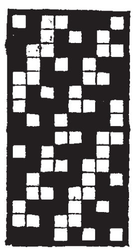


FIG. 213.

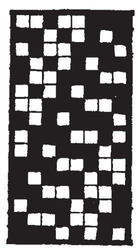


FIG. 214.

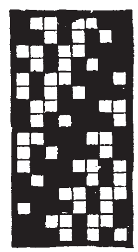


FIG. 215.

Drafting.—The arrangement of the draft is a very important matter in connection with dobby or tappet weaving. In the case of simple twills, satins, and other regular weaves, as each end, or warp thread, in the design is required to be lifted differently, a separate stave is required for each end in the design, but in some patterns this is not the case.

Fig. 216 is a stripe design composed of twenty ends of five-shaft satin and sixteen ends plain. The least number of shafts on which this could be woven is seven, five for the satin and two for the plain. The number of picks to the round, or the number of picks on which the pattern repeats is ten, ten being the least common multiple of two and five. The draft may be shown either by ruling lines to represent the staves as at

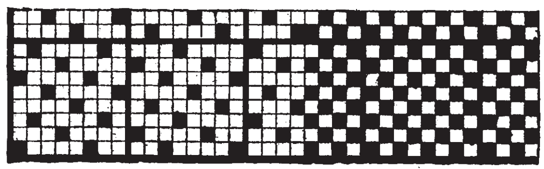


Fig. 216.

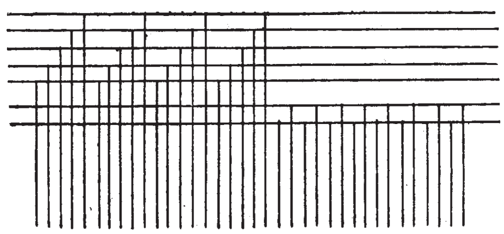


Fig. 217.

Fig. 217, or on point paper as at Fig. 218. The latter is the readier way, and is the way usually practised. The order of lifting the staves is shown in the "pegging plan" (Fig. 219).

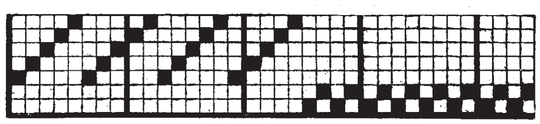


Fig. 218.

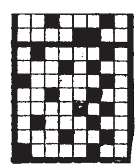


Fig. 219.

The term "pegging" refers, of course, to the dobby loom; if the design is woven on a tappet loom, "tappet plan" would be a more correct term to use.

When two weaves which consist of different arrangements of the same ends are combined in stripe form, the same shafts

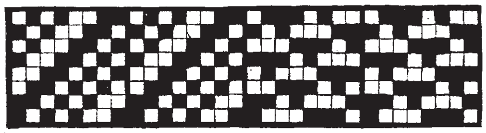


FIG. 220.

will do for both weaves. Fig. 220 illustrates this principle. In the design there are sixteen ends of an eight-end twill, "2

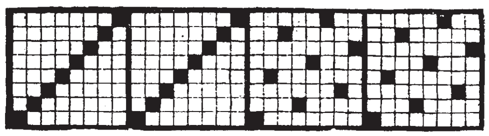


FIG. 221.

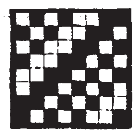


FIG. 222.

up 2 down, 1 up 1 down, 1 up 1 down," and sixteen ends of a mixed effect, which is simply a re-arrangement of the ends of the twill. Each of the ends in the crape or mixed weave can be drawn through the same stave as one of the ends in the twill, as will be seen from the draft (Fig. 221) given with this design, and thus the whole design can be woven with eight staves. If the staves are lifted to form the twill with the first sixteen ends, the different order of drawing the ends in the second part of the draft causes the desired change in the pattern. The pegging or lifting plan (Fig. 222) will therefore be the first eight ends of the twill.

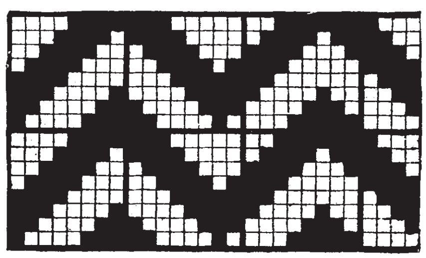


FIG. 223.

One of the most useful principles of drafting is the V draft, or point draft. Fig. 223 is a design based upon this principle;

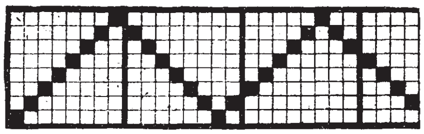


FIG. 224.

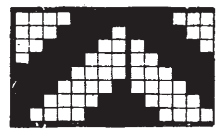


FIG. 225.

the design is repeated twice over in order to show the effect better, and it will be seen that the basis of the pattern is a "four and four" twill. The first eight ends are drawn from right to left, and by reversing the draft, as in Fig. 224, the pattern is made to repeat on fourteen ends. The pegging

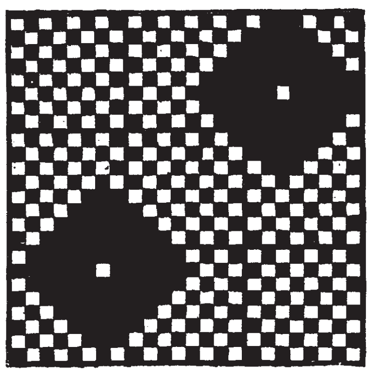


FIG. 226.

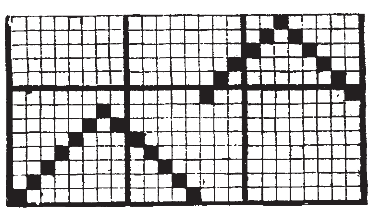


FIG. 227.

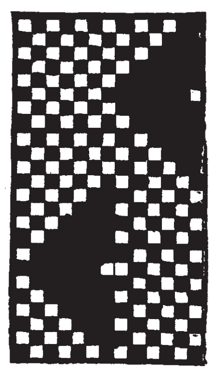


FIG. 228.

plan (Fig. 225) will be the first eight ends and picks of the design. The first and eighth staves have each only one end

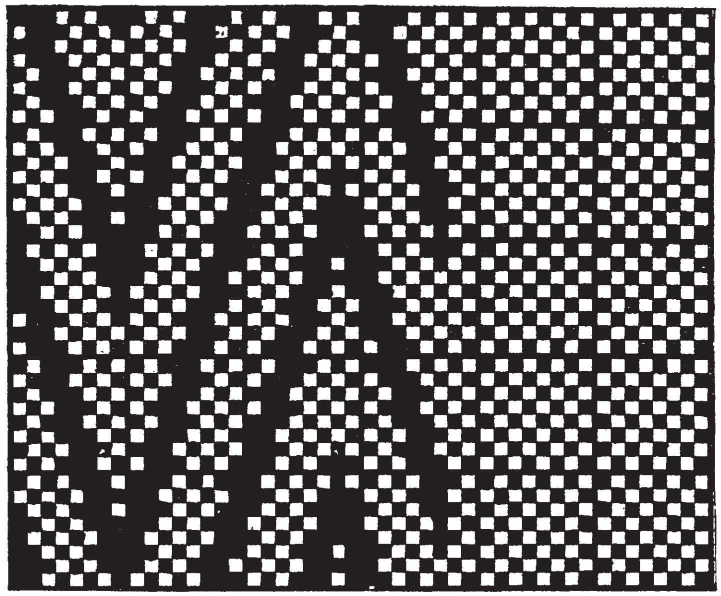


Fig. 229.

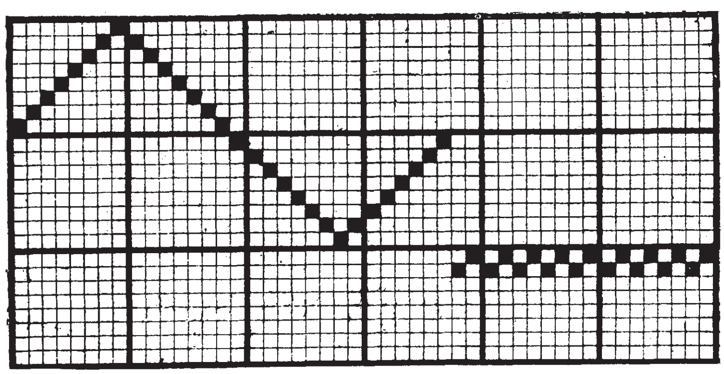


Fig. 230.

out of the fourteen drawn through them, whilst all the other staves have two ends in each pattern. The number on each stave could be made equal by making the pattern repeat on sixteen ends and reversing the draft from the ninth stave, with an eight-end twill basis.

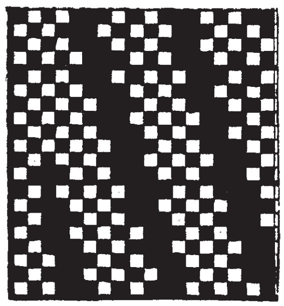


FIG. 231.

The V draft is used in a great variety of forms. It is not only in stripes that it is used. It is very often employed in weaving all-over spot effects and diamond patterns.

Fig. 226 shows the principle applied to an all-over design.

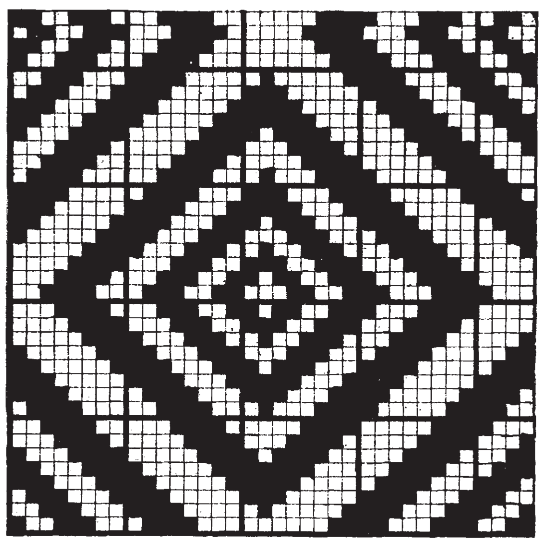


FIG. 232.

The draft (Fig. 227) is given, showing how the ends are drawn through the thirteen staves required to weave the pattern, and the "pegging plan" (Fig. 228) shows the order of lifting the staves.

A very effective method of employing this draft is illustrated

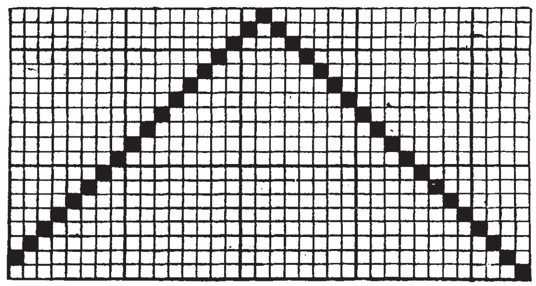


Fig. 233.

at Fig. 229. This is a stripe design, and the general appearance would lead one to suppose that a larger number of staves are

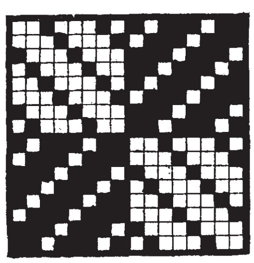


Fig. 234.

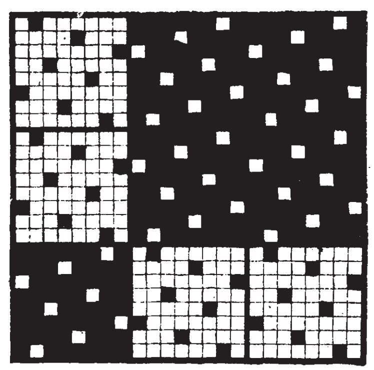


Fig. 235.

required to weave it than the eighteen actually required. Fig. 230 is the draft and Fig. 231 the pegging plan for this design.

Another class of pattern produced by the V draft is the "diaper" style. Fig. 232 is a small design of this kind, and it will be noticed that the draft (Fig. 233) plays a very important part in increasing the size of the pattern. The draft given shows how the pattern would be made on nineteen staves.

It is not always advisable to draft a pattern to its lowest

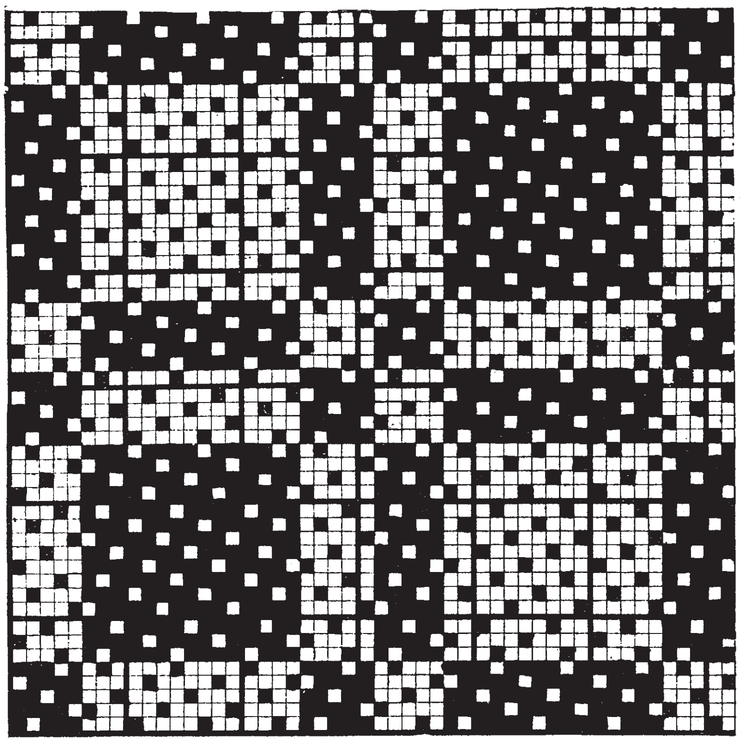


Fig. 236.

number of staves, as it is not worth while saving one or two staves at the expense of an irregular draft.

Dice Checks.—Fig. 234 is a simple dice check pattern. Alternate squares of warp and weft twill form the check effect, and it is necessary to arrange the bindings so as to cross each other at the edges of the squares, as otherwise the ends would "slip." Fancy dice patterns are produced by employing squares of different dimensions. Fig. 235 is a pattern of this description. The bindings are here those of an eight-end satin. To obtain the crossing of the binding dots at the edges of the squares it is necessary to run the satin in opposite directions in the warp and weft squares.

A still more fancy dice effect is given at Fig. 236. The bindings are on the five-end satin basis, and the blocks of warp and weft satin are arranged so that the design repeats on fifty

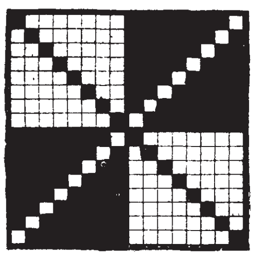


FIG. 237.

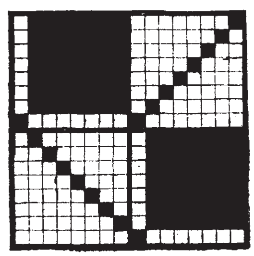


FIG. 238.

ends and picks. It is necessary in this class of binding to commence the satin in the position indicated in the design. By a judicious arrangement of the warp and weft blocks a large variety of patterns can be produced. The principle is extensively employed in the production of fabrics for both the home and shipping trades.

"Barley corn" patterns are a related style. The structure of these cloths is shown at Figs. 237 and 238. The former pattern is manufactured on an extensive scale, as it is a fabric in regular use for making-up purposes. Fig. 238 has the weft square rather larger than the warp, and is usually made in rather a better quality than Fig. 237. In fine makes the size of the squares is often increased.

Patterns produced by Re-arrangements of Twills.—If the ends of any twill be re-arranged in some *regular* order, another pattern of a different character is produced. For example, by re-arranging the eight-end twill given at Fig. 239 in


FIG. 239.

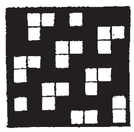


FIG. 240.

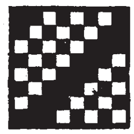


FIG. 241.

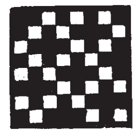
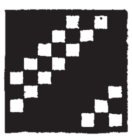
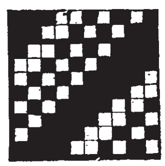


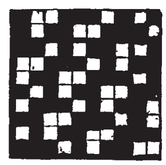
FIG. 242.

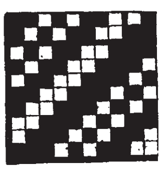
"satin order" the effect at Fig. 240 is produced. The method of re-arrangement is to take the first end of the twill design and place it in the first place in the re-arrangement. The fourth end of the twill is then placed in the second end of the re-

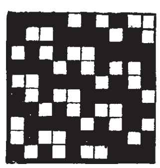

Twill.
FIG. 243.

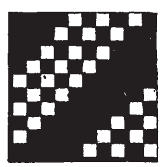

Re-arrangement.
FIG. 244.

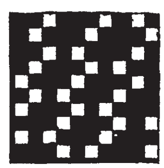

Twill.
FIG. 245.


Re-arrangement.
FIG. 246.


Twill.
FIG. 247.


Re-arrangement.
FIG. 248.


Twill.
FIG. 249.


Re-arrangement.
FIG. 250.

arrangement, the seventh end of the twill in the third place, and so on, the satin order used being 1 4, 7 2, 5 8, 3 6. Fig. 241 re-arranged in this manner gives the effect at Fig. 242, and, as will be seen from the remaining figures (Figs. 243–250), the effects produced by the re-arrangement are all good serviceable effects which are useful for a great many purposes. With

FIG. 251.

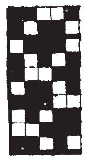


FIG. 252.

FIG. 253

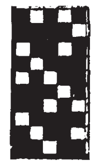


FIG. 254.

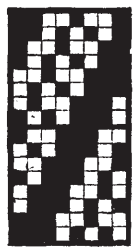


FIG. 255.

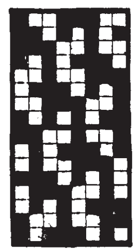


FIG. 256.

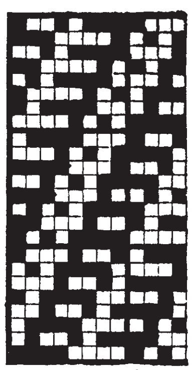


FIG. 257.

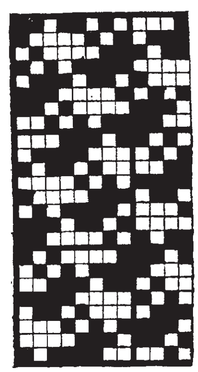


FIG. 258.

larger twills the effects produced are more elaborate and varied, and the principle is distinctly useful for the production of new woven effects.

Combined twills may also be re-arranged in this manner for the production of new effects. Figs. 251 and 253 are two five-end combined twills, and the effect produced by re-arranging

FIG. 259.

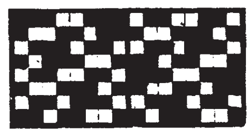


FIG. 260.

the ends in five-end satin order is shown at Figs. 252 and 254, respectively.

Fig. 255 is an eight-end combined twill, and Fig. 256 shows

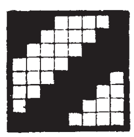


FIG. 261.

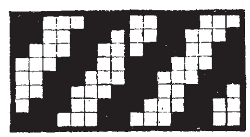


FIG. 262.

the effect produced by its re-arrangement in eight-end satin order.

Fig. 257 is a twelve-end combined twill, and when re-arranged in twelve-end satin order Fig. 258 is produced.

The effects produced by re-arrangement in satin order are,

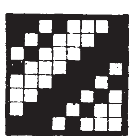


FIG. 263.

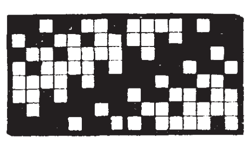


FIG. 264.

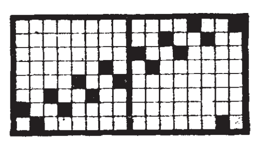


FIG. 265.

as a rule, mixed effects of a less decided character than the original twill. There are many other useful systems of drafting or re-arranging patterns.

Fig. 260 is the re-arrangement of Fig. 259 in the order 1 2, 6 7, 3 4, 8 1, 5 6, 2 3, 7 8, 4 5. This is a regular draft obtained by skipping three shafts between each two ends. Another draft is obtained by skipping one end between each two ends drawn through the healds.

Fig. 262 is obtained by re-arranging Fig. 261 in the order of the draft 1 2, 4 5, 7 8, 2 3, and so on, the draft repeating on sixteen ends.

Another useful draft (Fig. 265) as a basis for re-arrangement is the one employed in producing Fig. 264 from Fig. 263. The order of the draft is shown along with the design; the order runs, 2 1, 3 2, 4 3, and so on, repeating on sixteen ends.

Some novel effects are obtained by re-arranging the ends of

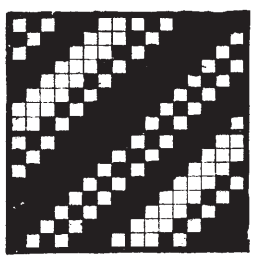


FIG. 266.

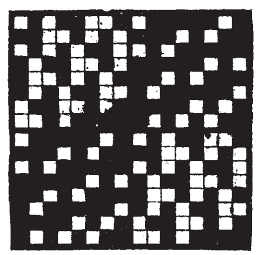


FIG. 267.

a sixteen-end twill in the order 1 4, 7 2, 5 8, 3 6, 9 12, 15 10, 13 16, 11 14. The effect of this system is shown at Fig. 267, which is the result of re-arranging Fig. 266 in the above order. The system is of course applicable to other twills than those on sixteen ends.

Twills combined to form Square Patterns.— Simple twills may be combined to form "square" patterns by taking alternate picks of each. If two eight-end twills are combined in this manner only four picks of each twill will be used in the combination. The principle will be understood from Fig. 268.

This is a pattern composed of alternate picks of two ten-end twills making an effect repeating on ten ends and ten picks. The effect given by re-arranging this in satin order is shown at Fig. 269.

Fig. 270 is a twelve-end pattern made on the same principle,

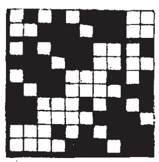


FIG. 268.

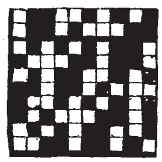


FIG. 269.

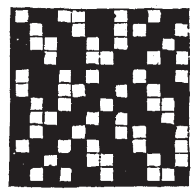


FIG. 270.

and if this is re-arranged in satin order, another effect is obtained.

Fig. 271 is a sixteen-thread pattern, and when re-arranged this produces the rather peculiar pattern Fig. 272.

An immense variety of useful weaves may be obtained

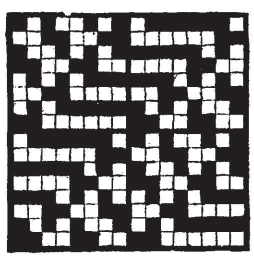


FIG. 271.

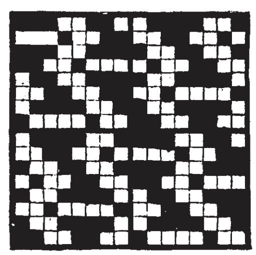


FIG. 272.

on this system of combination, the effects being perhaps more useful than when the patterns occupy twice as many picks as ends.

Unequal Twills combined.—Some useful fancy effects are obtained by combining two unequal twills "end and end," or "pick and pick." Fig. 273 shows the effect produced by combining "end and end," a "three and two" twill, and "two and two" twill. As one twill repeats on five picks and the other on four, the combined pattern will occupy twenty picks—twenty being the L.C.M. of five and four. There will require to be twenty ends of each twill used to make up a complete pattern, therefore the combined design will repeat on forty ends and twenty picks. If a four-end twill is combined with a three-end twill in this manner, the complete pattern would occupy twenty-four ends and twelve picks, as twelve is

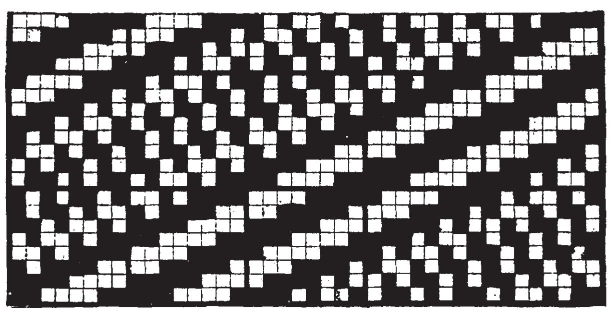


FIG. 273.

the least number of picks on which both the four-end and three-end twills repeat.

Check Patterns produced by Re-arrangement of Twills.—If an eight-end twill "three and five plain" is re-arranged in the order 1 4, 7 2, 5 8, 3 6, the effect shown in the square A (Fig. 274), and if this be again re-arranged in the same order, the original twill results. It follows, therefore, that by placing the pattern A above the twill and drawing the ends through eight staves as indicated in the draft (Fig. 275), a check pattern will be formed. The draft which produces the crape from the twill also produces the twill from the crape. The first eight ends and sixteen picks of the design is the pegging plan. By the addition of two extra staves the floats may be prevented from passing from one square to another. To produce the check effect properly, the satin draft must be such a one that if the fourth end is drawn on the second stave, the second end must be drawn on the fourth stave. If a sixteen-end satin draft is used for making a check pattern on this principle from a sixteen-end twill, the satin draft must be selected from those which can be made on sixteen shafts, and must be such a one that exactly the same pattern will be produced in the opposite squares of the check. The sixteen-end satin which gives this effect is the one made by skipping eight ends between each lift.

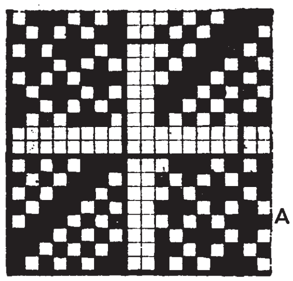


FIG. 274.

Honeycomb Cloth.—In this style of cloth the threads are interlaced so as to form squares, the centres of which are lower than the ridges which form the sides. Fig. 276 is a honeycomb pattern on ten ends and ten picks. It will be noticed that the ridges or raised portions of the honeycomb are formed by the gradually increasing floats of the weft and warp threads. The hollows are formed by the threads weaving plain for a few ends and picks. Any size of pattern, within reasonable limits, may be formed on this principle. Fig. 277 is a 16 × 16 honeycomb on the same principle.

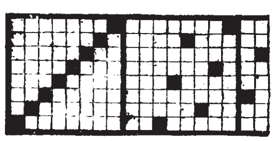


FIG. 275.

For smaller sizes the principle requires a little alteration. Fig. 278 is a good 8 × 8 honeycomb, and gives a fairly good effect even in low makes of cloth. These honeycomb weaves are used for quiltings, towellings, and for fancy goods of all kinds. Some excellent effects can be produced by combining

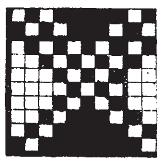


FIG. 276.

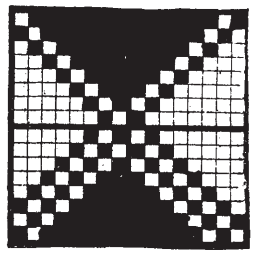


FIG. 277.

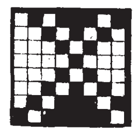


FIG. 278.

honeycomb with satin or other weaves for striped dress goods, and similar fabrics. A good effect is given by the pattern, Fig. 279. The weave requires very thick yarns for giving the best effect. The pattern is reversible, both sides of the cloth being exactly alike.

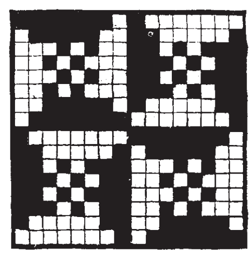


FIG. 279.

Mock Lenos, or Lace Weaves.—These weaves are very extensively used in cotton manufacture. The imitation of leno fabrics can be made extremely close, often so close as to deceive even experienced buyers. The simplest kind is the pattern at Fig. 280, a "three and three" pattern. The threads are interlaced in such a manner that the first ends are pulled together by the second and fifth picks, and the picks are pulled together in threes by the second and fifth ends, and as the shed is crossed between the third and fourth picks, the crack in the cloth appears there. The open effect is greatly increased if the ends are reeded "three in a dent," the first three ends in the pattern being together in one dent, so that the reed assists in forming the open effect. Sometimes the ends are reeded in threes with a dent "skipped" between each full one, and this greatly augments the open effect. A "four and four" mock leno is the weave shown at Fig. 281. To produce the best effect this requires to be reeded four ends in a dent, commencing with the first four ends in the pattern. In this weave the crack is made between the fourth and fifth ends and fourth and fifth picks. The principle of the weave is exactly the same as in the "three and three" pattern, but a slightly more open effect can be obtained with the "four and four" pattern. It is also suitable for a finer make of cloth, as the open effect can be made with a larger number of threads per inch.

FIG. 280.

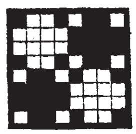


FIG. 281.

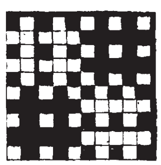


FIG. 282.

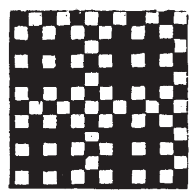


FIG. 283.

A "five and five" pattern is given at Fig. 282. The second, fourth, seventh, and ninth ends serve to pull the picks together in fives, and to make a decided crack in the cloth between the fifth and sixth picks in the pattern. The same thing takes place with the ends, they are pulled together in fives, by the second, fourth, seventh, and ninth picks.

Probably the best open effect is produced by Fig. 283. This is called a "five and one" mock leno or lace. To produce the best effect, the pattern should be reeded as follows :—

Five ends one dent,
Skip a dent,
One end one dent,
Skip a dent.

Two repeats of the pattern are shown at Fig. 283, only six ends and six picks being required to weave it. The first five picks are pulled together by the second and fourth ends, and as the shed is crossed between the fifth and sixth picks and between the sixth and the succeeding pick, the single pick No. 6 is shown in the middle of the crack between the bars of five picks. The same thing takes place with the ends.

It is not absolutely necessary to reed the pattern other than two in a dent; an open effect is produced with the ordinary reeding, but the special reeding greatly increases it.

Cords.—Cords can be formed in cloth by simply making a number of threads lift together, as in Fig. 284. The cord may be made across the piece by putting a number of picks in a shed, as shown at Fig. 285. This principle of forming cords has its

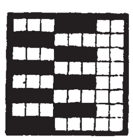


FIG. 284.

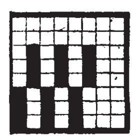


FIG. 285.

disadvantages. If the cord is going lengthwise of the piece a large number of picks per inch is required to give a good and fine effect, and there is always a tendency to show a perforated appearance in cords made on this principle, owing to the threads being pulled together in threes or fours, or whatever number of threads go to form a cord.

A good cord up the piece may be made by taking six or eight ends of six-end satin and two plain ends. Fig. 286 is a pattern of this kind. The six-end satin is used because the plain ends would make wrong bindings with a five-end satin and the ends would slip. This principle of making cords is very

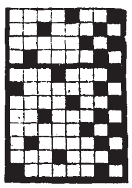


FIG. 286.

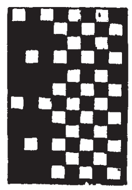


FIG. 287.

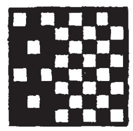


FIG. 288.

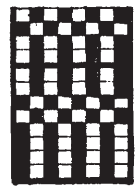


FIG. 289.

useful, as the effect being produced from the warp, the cost is less than if produced from the weft.

For dobby patterns it is necessary to keep the number of shafts as low as possible, and cords requiring only two shafts above the plain are made as in Figs. 287 and 288. Fig. 289 gives a cord across the piece, and is of rather a firmer character

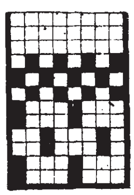


FIG. 290.

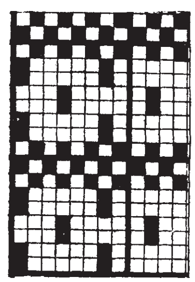


FIG. 291.

than an ordinary four and four cord. Fig. 290 shows a useful principle of making cords across the piece. Two picks are taken together, and three double picks from a cord. The three plain picks serve to define the cord. A better effect is obtained from Fig. 291, in which the double picks have a float of five ends. This cord is very suitable for stripes, as it combines extremely well with warp satin.

Fig. 292 gives a cord up the piece. The back of the cloth

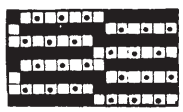


FIG. 292.

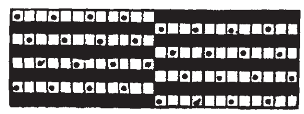


FIG. 293.

is plain, each pick taking an equal part in forming the back. The plain also serves to spread the ends, and so produces a firmer cloth than would be obtained if the cord were formed on the principle of Fig. 294. Sometimes the back of the cord is required to be rather looser, and is woven to a small twill. At Fig. 293 a twelve-end cord is shown on this principle, with a 2 and 1 twill pattern at the back.

Another form of cord is illustrated at Fig. 294. This shows a cord up the piece caused by every pick interweaving with the first and second ends, and only half the picks interweaving

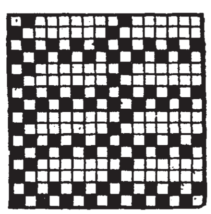


FIG. 294.

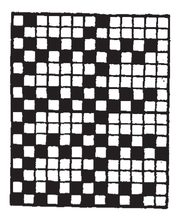


FIG. 295.

with the remaining six ends. The ends interweaving with half the picks are looser than the other two ends, and therefore have a raised appearance. The face of the cloth is plain, with the lines formed by the two ends running up the piece. A smaller cord is shown at Fig. 295, which repeats on six ends and four picks. Fig. 296 is a pattern composed of crossed cords. Excellent

FIG. 296.

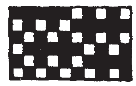


FIG. 297.

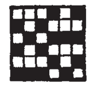


FIG. 298.

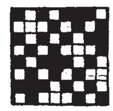


FIG. 299.

effects are obtained by combining larger cords in the same manner.

Crapes.—This is a name given to weaves of a small "seedy" effect. Good effects of this kind are produced by Figs. 297 and 298, which repeat on ten ends and six picks, and six ends and six picks, respectively. Another very largely used pattern is that at Fig. 299. This is a pattern of rather peculiar construction, as both sides of the cloth are alike, and the small floats of three are bent somewhat out of

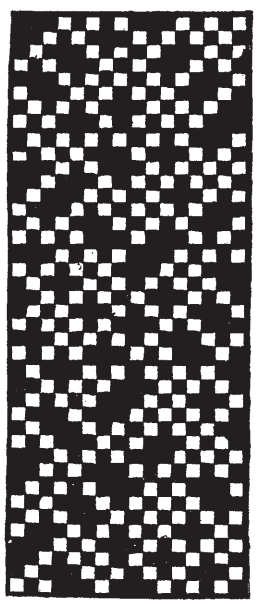


FIG. 300.

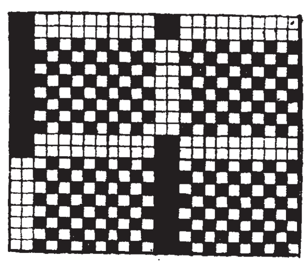


FIG. 301.

a straight line. The reason for this can be seen by a careful examination of the pattern. Patterns of the same character, but with very large repeats, are often used. In many of these there is no regularity in the construction of the pattern. The chief object is to get a perfect all-over effect free from lines or rows. This can be accomplished by keeping about the same amount of float on every pick and distributing the floats as evenly as possible. A pattern of this kind, on forty picks and sixteen ends, is given at Fig. 300. It will be seen that each pick has two floats on it.

Fancy Effects.—Some novel effects can be produced on the principle of Fig. 301. Two picks are floated on the top of a plain cloth every ten picks, and these loose picks are bound only by two ends out of every twelve. The loose picks are pulled in opposite directions by the loose ends, and the result is that small hexagonal figures are formed after the manner shown at Fig. 302. By using coloured ends and picks for the loose ones a still better effect is obtained.

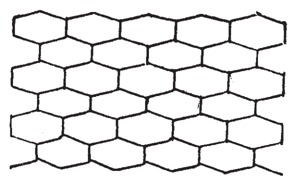


FIG. 302.

Crimp Stripes.—These are usually produced by having two warps at different tensions. The warp to weave the crimp

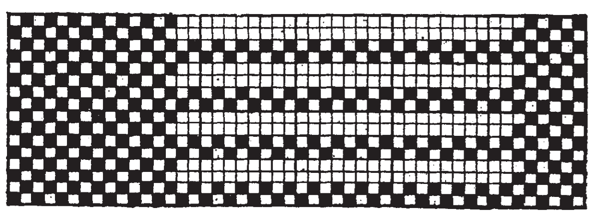


FIG. 303.

is lightly weighted as compared with the warp of the other stripe, which may be plain or satin as desired, and is let off intermittently. If the crimp warp is very hard twisted the effect is increased. Fig. 303 is the design of a crimp stripe of rather a novel character. The ends woven entirely plain are on a beam lightly weighted, whilst the other ends are heavily weighted. The first two picks are of ordinarily twisted weft, and the third and fourth picks are very hard twisted. These picks are thrown to the back, and take no part in forming the cloth in one portion of it. The consequence is that these picks, loose at the back of the cloth, and being very hard twisted, pull the two edges of the stripe closer together, and thus form a crimp or "tuck" the length of the piece. The plain ends form a crimp in the ordinary manner, owing to being lightly weighted.

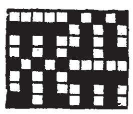


Fig. 304.

Huck Patterns.—This is the name given to a class of patterns used for towellings. The object is to get a firm cloth with a rough surface. Fig. 304 is a weave of this description, but there are many others in use. The pattern repeats on ten ends and eight picks, and can be drafted down to be woven on five shafts.

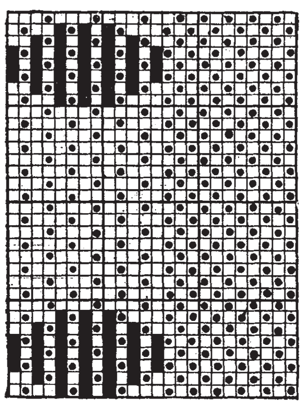


Fig. 305.

Extra Warp.—When some warp ends are used for figuring without taking any part in forming the ground or body of the fabric, they are termed "extra warp" threads. The principle is much used for putting coloured spots or figures on grounds of a different colour or material. In Fig. 305 the ends on which the black squares occur are "extra ends," as they take no part in forming the ground of the fabric. In this figure the black squares represent the warp lifted. Where the extra warp is not forming the figure it is thrown to the back of the cloth, where it hangs loosely unless it can be bound into

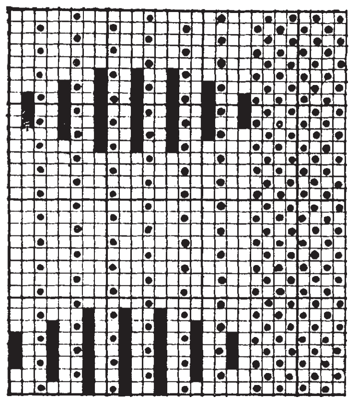


FIG. 306.

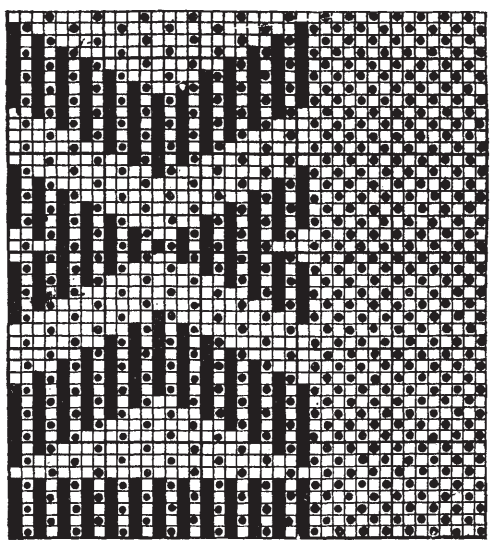


FIG. 307.

the ground cloth or cut off. Two or three differently coloured spots may be formed one above the other. Fig. 306 will show the principle of this. The ground of the cloth is plain, and these ends are distinguished by the small dots in the design. The first and second ends in the design are supposed to be of different colours. This design will repeat on forty picks, and any desired number of ends may be used between each stripe for the ground. The extra warp must be put "extra" in the reed, so that, supposing there are two ends in a dent in the ground, there would be six in a dent where the two extra warps occur. The principle is useful for obtaining a large width of pattern.

The extra ends may be of the same colour as the ground, but of thicker material, and may be used with the object of increasing the width of the pattern. Fig. 307 is a small striped design illustrating this principle. The ground is plain, and the extra warp threads, if of sufficient thickness, give a bold well-covered figure, which enables the design to be woven on nine shafts.

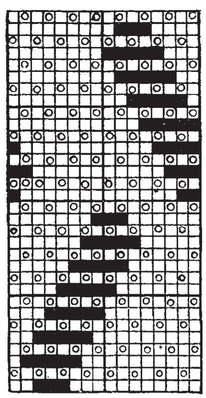


FIG. 308.

Extra Weft.—Extra weft spots may be woven on exactly the same principle by taking the weft "extra" instead of the warp. Fig. 308 is a small spot design on the "extra weft" principle. The cloth would require to have twice as many picks per inch as there are ends per inch.

The ground may be either plain, twill, or satin, but if it is required to bind the extra material a twill is preferable.

Fig. 309 is the commencement of a small design for an extra weft figure on a "two and two" twill ground, showing how the extra weft may be bound to the ground of the fabric without showing through to the face. The extra weft may be brought up under the weft floats of the twill, and if a fair quantity of material is used the binding will not be visible on the face of the cloth.

It is impossible to bind extra weft to a plain ground or to a

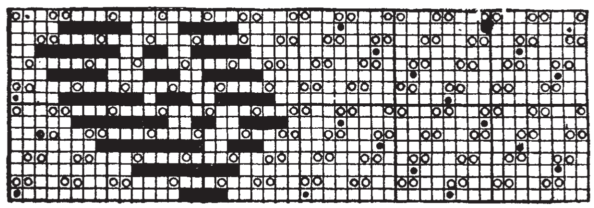


FIG. 309.

warp satin ground in the ordinary manner, as there is no float to hide the binding under. It may, however, be bound to a warp satin ground by means of stitching threads, after the manner shown in Fig. 310. This is an extra weft spot on a warp twill ground, and the loose picks at the back of the cloth

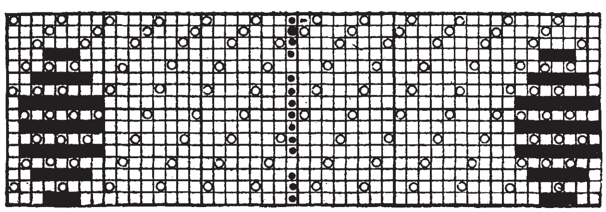


FIG. 310.

are bound by the stitching thread A. This thread is really an extra warp thread, and it is lifted in such a position that the binding is hidden under the warp floats of the twill ground. One of these threads may be used at intervals of an eighth to a quarter of an inch.

In binding extra warp the same principle applies. Extra warp may be bound to a warp ground by lifting it between two warp floats, or it may be bound to a weft ground by using an extra stitching *pick* on the principle illustrated in Fig. 310.

Extra warp or weft is often used to produce a solid figure on a light or open ground. Fig. 311 is a small design of this kind, in which one half the picks are thrown out of the cloth

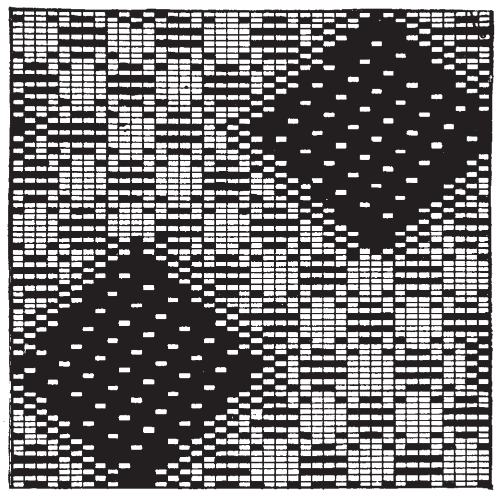


FIG. 311.

in the ground of the pattern. The design gives a very close imitation of a figured leno cloth, if woven with suitable yarns. To obtain a good effect there should be at least twice the number of picks per inch that there are ends or warp threads. When the cloth is taken out of the loom the loose threads are clipped and passed through a shearing machine, where the loose threads are cut off close to the figure.

The extra picks should be bound round the figure by weaving plain for a few ends, to prevent the extra material being pulled out of the figure in clipping or shearing.

Extra Warp and Extra Weft combined.—Where extra warp and extra weft are used together in the same part of the design, the structure is a little more complicated.

A small check pattern of this description is given at Fig. 312. Every alternate end and every alternate pick are extra, and all the even numbered ends and picks belong to the ground cloth, which in this case is woven plain.

In making designs employing both extra warp and weft, it is advisable to put the dots of the ground weave on the point paper first. Then dots may be put on to lift the extra warp where it is required to form the figure, and if it is required to throw the extra weft to the back of the ground cloth when the extra warp is on the face, the ground ends must be lifted on the extra weft picks where required.

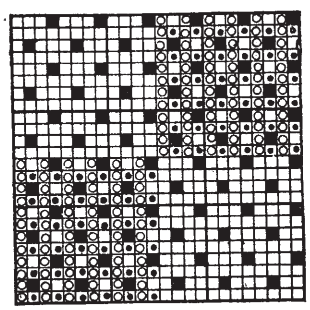


FIG. 312.

In Fig. 312 the ground weave is shown in solid squares; the extra warp is lifted by the small circles, and the extra weft is thrown to the back of the plain cloth by the small dots, which lift all the ground ends on the extra picks where the extra warp is lifted. This design is made for single picks, but in the majority of looms there are only change boxes at one side, and so the design must be arranged for two picks alternately of ground and extra weft.

Double Weft Face.—Double weft-faced cloths are made on the principle shown at Fig. 313. There is a face weft and a backing weft, and both sides of the cloth may be made alike by using only one count of weft.

The pattern is a four and one twill for both face and back, and it is important that the binding should take place under the floats of the twill, after the manner described in binding extra weft.

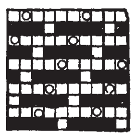


Fig. 313.

The face pattern may be different from the back, but it is not possible to back a cloth with every pattern on this principle, as the binding must not show through to the face, and therefore the back pattern must be selected so as to give this result.

Fig. 314 is an eight-end twill backed with weft, the back pattern in this case being a "seven and one" twill.

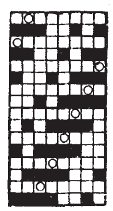


Fig. 314.

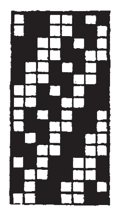


Fig. 315.

Suppose it is desired to put a weft back to the pattern, Fig. 315, and to have two face picks to one back pick. The

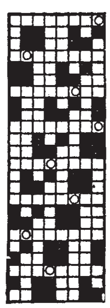


Fig. 316.

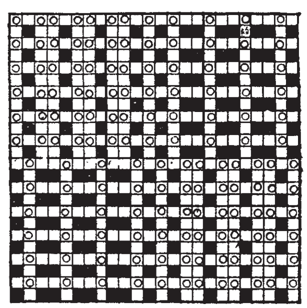


Fig. 317.

face pattern must be put on the face picks as in Fig. 316, and the back pattern must then be put on in such a manner that where the backing weft is passing over one of the warp threads there must be at least one weft dot above and below it, as in Fig. 316.

Two wefts of different colours may be made to form reversible figures by making them change places, first one being on the face, and then the other. The principle is shown at Fig. 317, where the alternate picks are of different colours. The two wefts should be thick enough to cover well, and a fine warp should be used.

Double Warp Face.—This is the same as "double weft face" weaving, with the exception that two warps are used instead of two wefts. A four and one twill backed with warp is

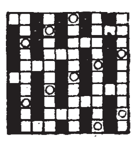


FIG. 318.

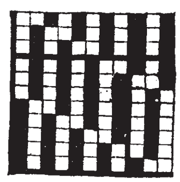


FIG. 319.

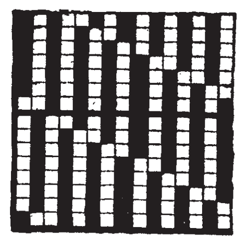


FIG. 320.

shown at Fig. 318. It is necessary to have the warp threads close enough together to hide the bindings. Fancy patterns may be backed with warp by binding the backing warp under warp floats in the face cloth.

Corkscrew twills are those which have a warp face on both sides of the cloth. The weave is chiefly used in the manufacture of worsted coatings, and similar goods, but is often employed in cotton designs. An eleven-thread corkscrew is given at Fig. 319, and a fifteen-thread pattern is given at Fig. 320. The weave requires a large number of warp threads per inch to give a good effect.

Padded Cloths.—To obtain a raised effect on cords or figures, thick weft may be inserted between the face and back cloth, or between the face cloth and backing ends when there is no backing weft used. This thick weft takes no part in forming either the face or back cloth, and is simply held in position by the binding of the backing material to the face cloth.

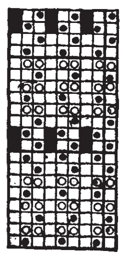


FIG. 321.

A simple example of this principle of weaving is given at Fig. 321. This pattern may be woven with one shuttle, and a fine raised cord across the piece is formed. The backing warp threads, on which the solid squares are placed, should be on a separate beam, and should be heavily weighted as compared with the other ends. All the marks in the design represent the warp lifted, so that the empty squares represent warp left down. It will be noticed that the heavily-weighted ends are only lifted for two picks in every ten, and this forms a cord effect. There are three picks in each cord which do not interweave with either the face or backing ends, but they serve to increase the boldness of the cord by giving it a raised appearance. The three picks which form the padding are the second, fourth, and sixth in the design.

The section at Fig. 322 will better explain the principle of the pattern. There are five plain picks in the cord, two plain picks between the cords, and three padding picks, making altogether ten to the round. These cloths are known as Piqués.

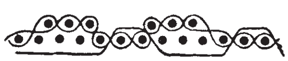


FIG. 322.

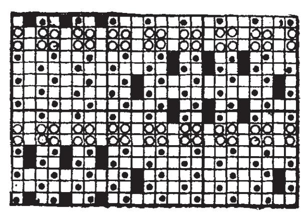


FIG. 323.

Another padded effect is given at Fig. 323. The double pick is the padding weft, and should be of thick material. The plain face cloth is developed in small dots, and the backing ends in solid squares. The padding picks in this pattern are pulled out of a straight line, and a diamond effect is produced on the cloth.

Double Cloths.—Double-warp-face and double-weft-face cloths are usually classed as double cloths, but they are essentially different from double cloths made from two warps and two wefts.

Figs. 324 and 325 will show how two separate cloths, one above the other, can be woven in one loom. The first figure shows one of the face ends only lifted, and a pick being put in

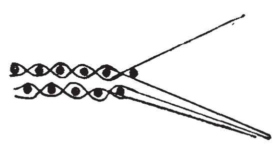


FIG. 324.

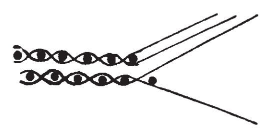


FIG. 325.

the face or top cloth. It will be noticed that both back ends are in this case down along with one of the face ends. The second figure shows both face ends lifted and one of the back ends, whilst a pick is being put in the back cloth.

Two separate cloths of any pattern may be woven by simply lifting the face ends out of the way when a pick is being put in the back cloth.

If a pick is put in the face and back cloth alternately, the cloths will be bound together at both selvedges; but if two picks are put in each cloth alternately, they are only bound at one side. This will be seen from Figs. 326 and 327. In the former the pick passes from the face cloth to the back cloth at one side, and from the back cloth to the face cloth at the other side of the loom. In Fig. 327 two picks are put in each cloth in succession, and the cloth will open out to double the width of the loom. The former principle is used for weaving sacks, meat-bags, and seamless pillow-cases. In putting double

FIGS. 326, 327.

cloths on point paper it is usual to use different colours or marks for the face and back cloths respectively, and also for lifting the face cloth when weaving in the back one. It is also advisable to always take the dotted squares as warp lifted.

The following directions for double cloth designing will be found useful.

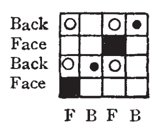


FIG. 328.

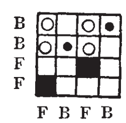


FIG. 329.

First mark off the face and back ends and picks respectively. Then on the face ends and face picks put the face pattern, and on the back ends and back picks put the back pattern. On

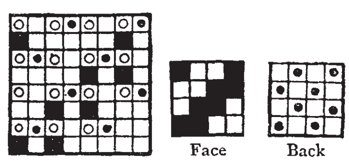


FIG. 330.

every back pick lift every face end. This will make the two cloths separate.

Fig. 328 is the design for two separate plain cloths bound at both sides of the loom, and Fig. 329 is the pattern for the cloths bound only at one side. The face and back cloths may be of different patterns, and bound together to form one thick fabric.

Fig. 330 is a design for a double cloth with a two and two twill face and a plain back. The design is end and end, and pick and pick.

The binding of the two cloths together is a very important matter. It must be done in such a manner that the bindings are not visible on the face of the fabric. To find the best position for binding the two cloths together it is generally advisable to make a section showing the first two picks in the pattern, as at Fig. 331. A position can then be found for passing a *back pick over a face end* where the floats of weft in the face pattern will hide the binding. It will be seen that this can be done effectually by passing the back pick over the fourth face end, and so in the design the fourth face end is not lifted when the first back pick is being put in.

FIG. 331.

Sometimes the face cloth is required to be much finer than

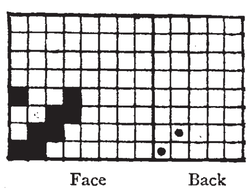


FIG. 332.

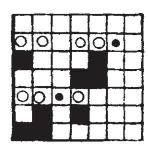


FIG. 333.

the back, and so there may be two face ends and two face picks to one back end and one back pick.

Figs. 332 and 333 show a design for a fabric of this description, the face pattern being a two and two twill, and the back plain. Before commencing to put the design on paper, it is best to make a section showing in what relative positions it is proposed to start the two patterns, and so enable the weaves to be placed in such positions that a satisfactory binding is possible.

Fig. 334 shows how the binding may be effected by placing the two patterns in a certain position in relation to each other. The binding in this, as in the previous case, is made by passing a back pick over a face end.

FIG. 334.

The binding may also be made by lifting a *back end over a face pick* where the warp floats in the face cloth would cover it. A design illustrating this kind of binding is given at Fig. 335. The face pattern is a "four and four" twill and the back a two and two twill, and there are two threads of face to one of back. The two cloths are bound together by lifting

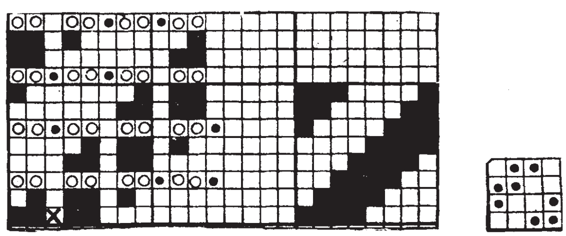


FIG. 335.

the first back end on the first face pick where the binding dot comes between two warp floats. The full squares in the figure represent the face ends lifted; the small dots represent the back ends lifted; and the circles show all the face ends lifted on the back picks, which keep the two cloths quite separate. The cross on the first pick effects the binding.

The question as to which is the better system of binding depends upon the character of the two cloths. If the face weft covers better than the warp, it is the better way to bind by passing the back pick over a face end, whereas if the face warp covers better than the weft, a back end lifted over a face pick is preferable.

Three-, and more ply Cloths.—Any number of cloths may be woven separately, one above the other, or several may be bound together to form a very thick fabric. Fig. 336 is a design for weaving four plain cloths, one above the other, and

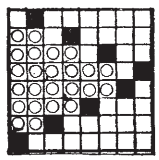


FIG. 336.

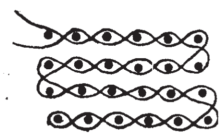


FIG. 337.

if the picks are woven in the order given in the design it will weave a cloth four times the width of the loom when opened out. The passage of the weft from one cloth to the other is shown at Fig. 337.

Figured Double Plain Cloths.—If the warp be taken with alternate ends of two colours and picked in the same manner, figures, checks, or stripes can be formed by weaving two separate cloths of the different coloured yarns, making both cloths solid colour, and making them change places so as to form the desired figure. Fig. 338 is a design for a small check pattern on this principle. The odd ends and picks are, we will

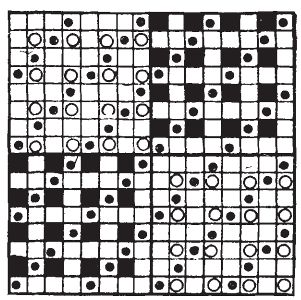


FIG. 338.

suppose, black; and the even numbered ends and picks white. It will be seen that in the bottom left-hand square of eight ends and picks, the lifting marks for lifting the face cloth out of the way when weaving in the back cloth are put on the black ends and white picks, and therefore the black cloth is lifted to the face in this square. On the opposite square of eight ends and picks, the lifting marks for separating the two cloths are put upon the white ends and black picks, and therefore the white cloth is here made the face cloth. By bringing either the black or white cloth to the face, any figure may be formed, and the surface of the fabric

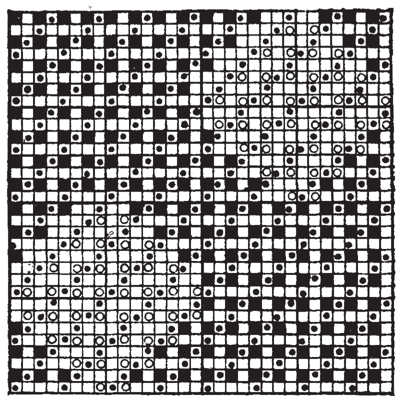


FIG. 339.

is quite plain, which for some purposes is much preferable to floated figures. The weave used may be a twill or satin instead of plain, if desired, or the two cloths may be of different weaves, and one brought through the other to form a figure. Fig. 339 is a design for a small spot pattern on the double plain principle. The threads should be "end and end" and "pick and pick" of different colours, the first end and first pick being, we will suppose, black, and the threads for the second cloth being white. The lifting marks for bringing the back cloth to the face are the solid squares, whilst the white cloth is brought to the top by the circles.

If all the black ends and picks are brought together and all the white ends and picks brought together, the pattern of both sides of the cloth can plainly be seen as well as the ground weave. Fig. 340 will show this. The face pattern is shown on the first sixteen ends and picks, and the back pattern on the second sixteen ends and picks, whilst the ground

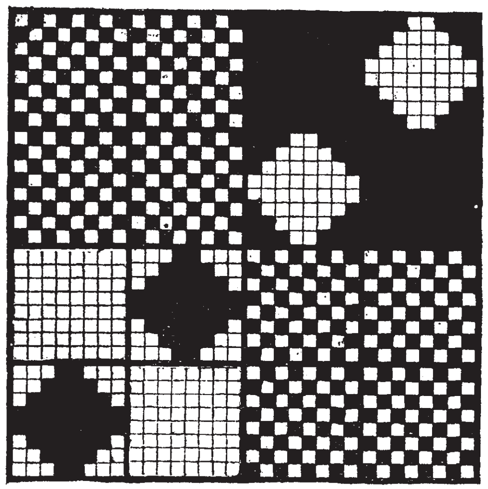


FIG. 340.

weave is shown for both cloths in the opposite corner squares. The patterns may be designed in this manner, and the full effect produced by arranging the draft so as to give the required effect in the cloth.

Some fine effects may be obtained by inserting a thick end in the form of padding between two plain cloths, and binding the cloths together so as to make the thick end form a cord. The cords may run either lengthwise or across the piece.

Fig. 341 is a section showing how the cord is formed by the thick end coming between the two cloths without interweaving with either of them, and Fig. 342 shows how the point paper design is made. The end on which the crosses are placed is the thick thread which is used for padding, and the four ends at each side of this are the two separate plain cloths. At each side of this there are two ends showing where the two cloths change places, and so bind the thick end between the cloths and form the cord.

Double plain cloths may be bound together by using sufficient material to cover well, but the binding is difficult to make

FIG. 341.

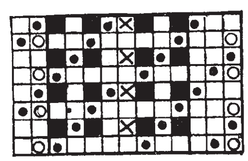


FIG. 342.

without being visible. This principle of binding is shown at Figs. 393 and 394.

Leno Fabrics.—In a previous chapter the method of interlacing the threads in simple gauze has been shown. With the two staves and one doup required to weave gauze a considerable variety of patterns can be woven. A "five and one cross-over" has already been given, but it will be obvious that the number of plain picks in each bar of the cross-over may be any *odd* number. A "seven and one," "eleven and one," and so on, are regular weaves.

Where the crossing thread weaves plain first at one side and then the other of the standard end, a simple crack is made in the cloth between the bars of plain, and there is no single pick in the middle of the crack. The most common pattern of this description is a "five and five cross-over;" a plan, draft, and pegging-plan of this pattern is shown at Fig. 343.

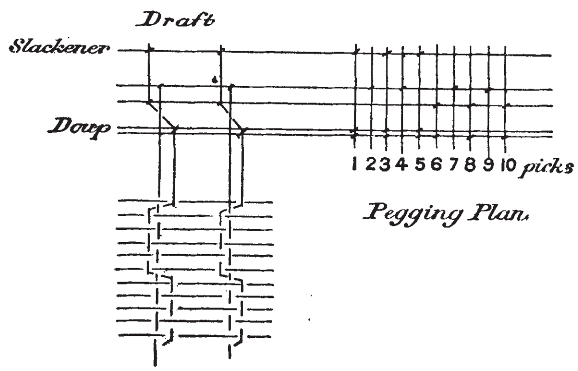


FIG. 343.

In all these fabrics the effect is decidedly of an open or transparent nature.

In some leno fabrics the object is not to get an open effect but to get zigzag effects by crossing a thick end over a few plain ends. A simple pattern of this kind was given at Fig. 139 in dealing with leno weaving, but the effect may be varied by making the crossings at irregular intervals.

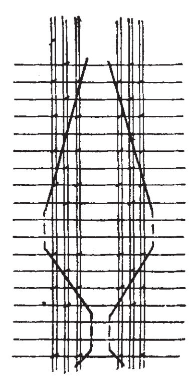


FIG. 344.

Fig. 344 is a fancy crossing in which the thick doup end is crossing over three double plain ends.

Fig. 345 is another fancy effect on the same principle. The marks on the plain ends show when these ends are lifted.

When the thick crossing ends all work in the same direction a "wave" effect is produced, which is often employed in conjunction with the "diamond" or "eye' effect, obtained from the opposite working of the two thick ends.

By using two doups a great variety of effect can be obtained.

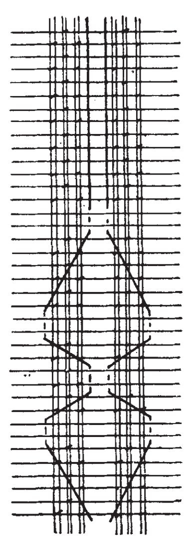


FIG. 345.

Fig. 346 shows a method much practised of making the picks bend out of a straight line. It is obvious that this will require two doups, because one doup thread has to be lifted for the first six picks, and the other doup thread does not lift until the fourth pick in the pattern.

Check Lenos. — Where alternate squares of leno and plain are required

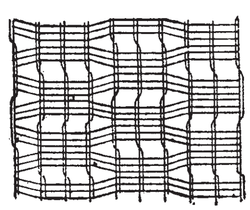


FIG. 346.

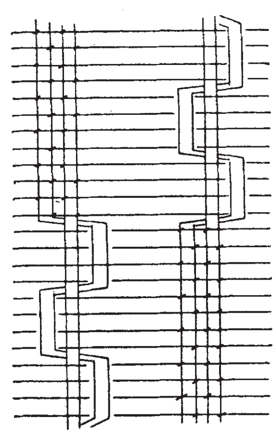


FIG. 347.

to be woven, it is necessary to have two doups if the leno is required to be woven four ends in a dent, with two ends crossing two, as in Fig. 347. It has been shown how a check leno or gauze can be woven with only one doup at

Fig. 144, but the principle only applies to pure gauze, or one end crossing one. The draft and pegging plan for weaving a small check on the principle of Fig. 347 is given at Fig. 348,

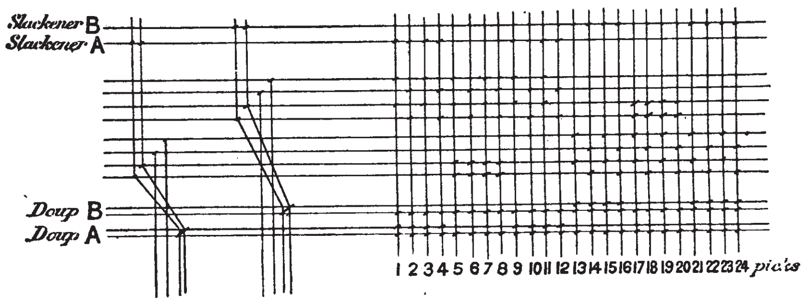


FIG. 348.

where it will be seen that eight shafts or staves are required with two doups and two slackeners.

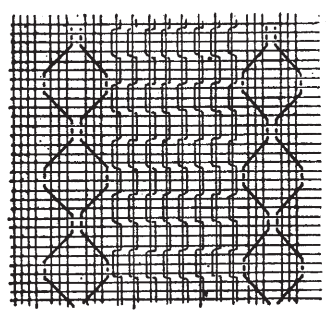


FIG. 349.

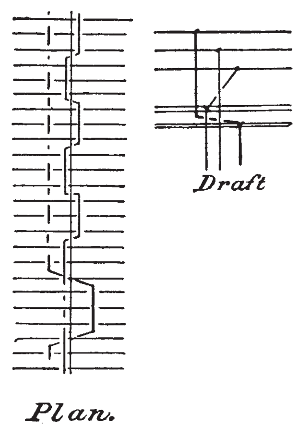


FIG. 350.

For dobby weaving, the leno principle is chiefly used in the production of striped fabrics. One of the most popular classes of fabrics is a combination of the thick zigzag effect with an open leno effect of any kind. Fig. 349 is an example of this combined style, the stripe can either be woven with a satin or plain ground fabric.

With three doups some very elaborate effects can be obtained, but the increased cost is rather prohibitive.

A thick end can be crossed round a pair of ends weaving leno, as in Fig. 350. It is necessary to bring the end from the back stave round the doup B before crossing under the pair of leno ends, as this would make the crossing easier.

Weft Pile Fabrics, Velvets, and Corduroys.—Practically all cotton velvets are woven on the weft pile

FIG. 351.

principle. The intricate nature of the loom required for weaving warp cut-pile prevents its adoption for cotton pile fabrics. There is no doubt that a warp pile woven over wires is superior to any weft pile fabric, all the pile being perfectly even. The principle upon which weft pile is formed is

FIG. 352.

illustrated at Figs. 351 and 352, the former showing the pile uncut, and the latter cut.

In weft pile fabrics the pile weft is usually "extra weft" issuing out of the ground fabric only between every pair of ends. This forms grooves or "races" in the fabric, which allow of the insertion of a "knife and guide" which cuts the pile about the middle of the float. At Fig. 351 the ground fabric is plain, and between each ground pick there are three pile picks. The first pile pick passes under the first end, the second pick under the third end, and the third pick under the fifth end, and if these are repeated there are formed small grooves for the cutter's knife every two ends. The pattern is given on point paper at Fig. 353, extended a little in each direction as the pattern repeats on only six ends and eight picks. The ground picks (plain) are put on in circles. A large number of picks per inch are required; in a common make about 260 picks per inch of 60's weft are used, and about 74 warp threads per inch, the counts of warp being usually 2-70's.

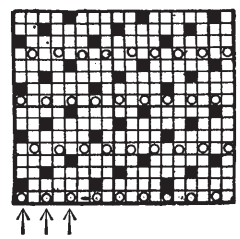


FIG. 353.

If there are 260 picks per inch, and one pick out of every four belongs to the plain ground fabric or "back," as it is sometimes called, there will be sixty-five picks per inch in the plain, and the pile weft is "extra" material forming grooves for the cutter's knife on the face of the cloth.

After the cloth is woven it is stiffened, and stretched in a frame for cutting. Fig. 354 shows the kind of knife used for

FIG. 354.

this purpose. The guide A is selected so as to fit under the float easily and lift the centre of the float to the cutting edge B. The cutter inserts the knife and guide every two ends or "race," and thus in a common velvet, as at Fig. 353, one-third of the pile picks are cut each time the knife is run up the piece. The arrows show the ends where the knife is inserted.

Machine cutting is now adopted to some extent for velvets. The piece is moved backwards and forwards automatically, and so the cutter does not require to walk the length of the frame every time the knife is run up the piece.

The term velvet is used by retailers and the general public as referring to silk velvet, and by them all cotton pile fabrics are termed velveteens; but in the trade the lighter and finer classes of cotton weft pile fabrics are velvets, and the heavier kinds, such as those used for clothing purposes, are called "velveteens." There is no very definite line drawn between the two classes.

Velvets are usually sold by weight when in the grey state. The pattern given at Fig. 324 is made to weigh from 18 lbs. to 30 lbs. for 100 or 110 yards, 24 inches wide, the yarns being as previously stated, and the various weights obtained by altering the number of picks per inch. About 25 lbs. per 110 yards is a medium weight.

The usual width for home trade velvets is 24 inches (grey), but for shipping $22\frac{1}{2}$ inches is a very common width. The pieces are usually woven two or three in a width of the loom, and afterwards torn asunder.

The length of the pile may be increased by increasing the length of the float. Fig. 355 is a pattern with a seven float, and four pile picks to each backing, or ground pick. This is usually called an E1 velvet, a term probably handed down from the origination of the pattern.

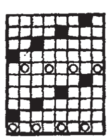


FIG. 355.

Until well into the last century the pattern Fig. 353 was the only weave used in the production of cotton velvets, and a patent was obtained for this E1 velvet, and the term "Patent" is still regularly used when referring to velvets with a longer pile than a five float.

An E1 velvet requires considerably more picks per inch than a "common velvet." A good make will contain 400 or more picks per inch of 60's or 70's weft, woven in a 74 Stockport reed with 2-70's twist.

Sometimes the points where the pile weft intersects are distributed in satin order as in Fig. 356, but this makes no appreciable difference, as the picks are so piled up on the

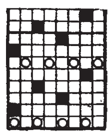


FIG. 356.

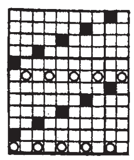


FIG. 357.

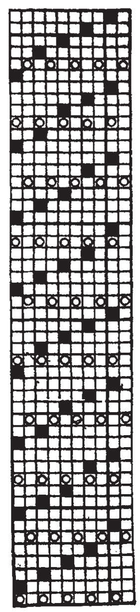


FIG. 358.

top of each other that the bindings of the four pile picks are practically in a horizontal line in either of the methods given.

Fig. 357 is a design for a velvet with a nine float, and five pile picks to one back pick or "binder," as they are sometimes termed. This would require a still larger number of picks, and would easily take 500 picks per inch of 70's weft.

A cloth is made with the same length of pile as the above, but with only four picks of pile to each back pick. This pattern requires fifty picks to complete it, as will be seen from Fig. 358. The pile in this case will be much more firmly bound into the ground cloth than is the case in Fig. 357.

Fast Pile Velvets.—When the pile weft is only bound under one end it is rather liable to wear out, especially by rubbing at the back. To obviate this, the pile weft is bound in the manner shown at Fig. 359, by which it is rendered much faster.

When bound to the ground fabric in this manner it is known as "fast pile."

The method of binding detracts from the richness of the pile obtained from a given quantity of material, but the fabric possesses much better wearing qualities.

Fig. 360 shows the structure of an ordinary fast pile velvet with a plain ground, and four pile picks to each back pick.

FIG. 359.

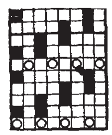


FIG. 360.

FIG. 361.

A regular make of this fabric is as follows:

Width 26 inches, length 104 yards, weight 30 to 34 lbs. 76 reed, 420 picks per inch, 2-70's twist, 50's weft.

Twill Backed Velvets.—Some of the finest kinds of velvet are made with a twill back. The chief advantage of a twill back over a plain is that the bindings of the pile weft into the ground are hidden by the twill floats at the back. This renders the pile much faster than a common velvet; in fact, twill backs are usually sold as fast pile velvets.

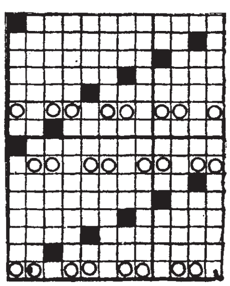


FIG. 362.

Fig. 361 is a section showing the structure of the fabric, and it will be easily understood that the pile cannot be so easily pulled out at the back, owing to the weft covering the bindings. Fig. 362 is the design for a good make of this kind of velvet, the back is a two and one twill, and the pile weft floats over eleven ends.

An important thing to remember about twill backs is, that the pile pick following a back pick must have the dot opposite a blank square in the back pick. If this were not so, the picks would slip about and form an irregular surface.

In the weave under notice, five pile picks are taken between the first two back picks, two between the second and third, and five between the third and first. This enables the proper bindings to be made.

This weave gives one of the best cloths that are made. It is usually woven with about 600 picks per inch of 60's weft, in a 76 reed with a 2-70's twist.

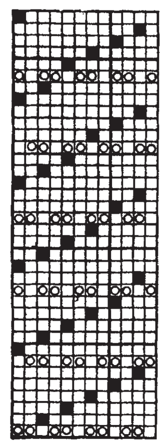


FIG. 363.

Another pattern of the same kind which will take still more weft is given at Fig. 363. In this there are five pile picks to each backing pick, and the pattern repeats on thirty-six picks.

Plushes.—When much longer piles are required the fabric is called "plush." These can be made on exactly the same principles as the foregoing, or the principle embodied in Fig. 364 may be used. In this weave the pile is bound in much oftener than in the shorter piled cloths, as a long pile is much easier to pull out than a short one, and therefore requires more firmly binding. The ground picks also in this weave are all alike, i.e. they all pass under the same ends, and this does not hold the pile weft as firmly as a proper plain back, although it utilizes the binding of the pile weft as forming part of the back pattern. The bindings of the four pile picks together form a plain pick, and the back of the cloth thus appears perfectly plain. To preserve an even surface of pile it is necessary to distribute the points, where the first pick in each four commences, in satin order. As there are in Fig. 364

twelve ends on which the pile picks are bound, the basis upon which the bindings must be distributed is a twelve-end satin, which runs 1, 6, 11, 4, 9, 2, 7, 12, 5, 10, 3, 8. The first pile pick commences to bind on the second warp thread, and therefore the first pile pick in the second set of four (the seventh pick) must commence to bind on the sixth of the ends available for the purpose (the twelfth end). The whole design will be complete on sixty picks.

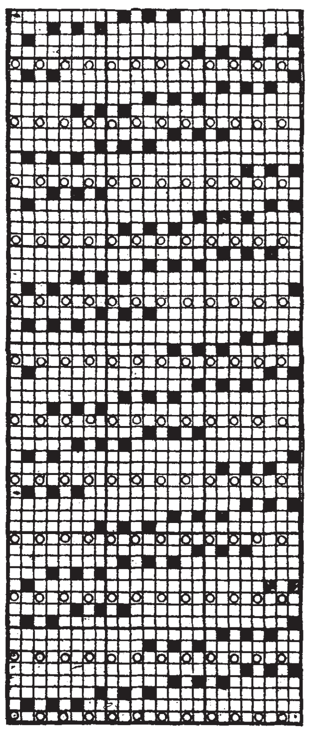


FIG. 364.

For a longer pile the weft would require to be bound under more ends, especially if the backing picks are not crossed.

Cord Velvets.—A simple cord velvet can be made on the principle of Fig. 365. The two plain ends on every six bind all the pile picks in the form of a cord up the piece, and there is one ground pick to four pile picks. The cutter's knife is only run up every cord, and so the cutting operation is much cheaper and more easily done than in the case of velvets. After cutting, the pile is brushed, and the fibres spread out so as to cover the space between the two binding ends as much as possible.

An eight-end cord on the same principle is given at Fig. 366.

Round cords are made by employing floats of two lengths. In the previous cords all the floats are equal, but in Fig. 367 one float is a "thirteen" and the other a "fifteen." When

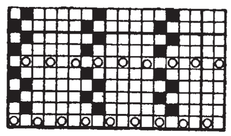


FIG. 365.

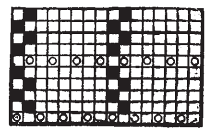


FIG. 366.

these are cut in the middle, the short float forms the outside of a cord, and the long float the inside, which gives the cord a round appearance. Fig. 368 shows the appearance of the two pile picks when cut.

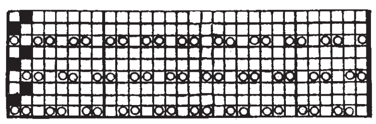


FIG. 367.

FIG. 368.

As a rule, these cords are used for very heavy fabrics, and twill and satin backs are chiefly used, and as the pile weft is usually much thicker than velvet weft, there are not so many

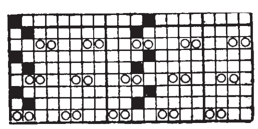


FIG. 369.

pile picks between the ground picks. A smaller cord on the same principle is given at Fig. 369.

CHAPTER X

FIGURED DESIGN

IN figured fabrics it is most important that the distribution of the parts of the figure should be such that the eye is not attracted by lines formed by the unequal distribution of the figure. The objectionable feature is most likely to occur in designs of an all-over character, as it is almost impossible to tell if the distribution is perfect without extending the design to cover a considerable space.

In designs which consist of set or detached figures, it is a comparatively easy matter to cover the surface of the fabric equally by distributing the figures in some pre-arranged order. The simplest method of arranging detached figures is to arrange them "one and one," as in Fig. 370. This is a small spot arranged from two points on twelve ends and twelve picks, and the same principle will apply whatever the size of the figure. The space to be covered, twelve ends and twelve picks, is divided into two, both in warp and weft, and it will be noticed that the central dot in each spot is in the same position in each square of 6×6.

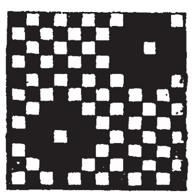


FIG. 370.

In designs of a floral character the two figures are generally turned in different directions, and if the centres of the figures be properly placed they may be turned in any direction, and still preserve the equal distribution. Detached figures may be arranged in the order of any satin, but the regular satins show the figures too much in lines, and the system is not much practised on that account. Irregular satins give much better effects. Fig. 371 is a design consisting of six spots arranged in six-end satin order, on thirty ends and thirty picks; the ground being five-end satin. In making the design the space to be covered is divided into six parts, both in warp and weft, by the crosses at the corners of the squares.

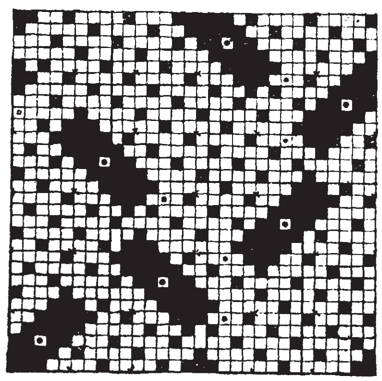


FIG. 371.

The squares are numbered at the side in the order of the satin, viz. 1, 3, 5, 2, 6, 4, and the first spot is placed in the left-hand bottom corner, the central dot of the spot being placed in the centre of its square. The next figure is placed in the third square, on the second five picks, the central dot again being placed in the middle of the square. The third spot is placed in the fifth square, on the third division of the picks; and so on, until the six figures have been placed on the thirty ends and picks.

If the central dot is always placed in the correct position in each division, the figures may be turned round or placed in any direction.

The ground weave is a five-end satin, and care must always be taken, in designing, that the ends and picks in the pattern are a multiple of the ends and picks in the ground weave, or there will occur a broken pattern at the joining of each "repeat."

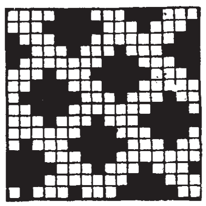


FIG. 372.

Fig. 372 is a small spot arranged in the order of a regular eight-end satin on sixteen ends and sixteen picks. In making this design the sixteen ends and picks divided into eight will give only two ends and picks for each division, so that if the central dot of the first spot is placed

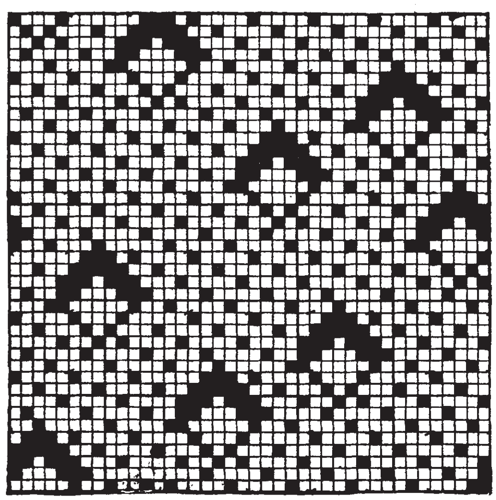


FIG. 373.

on the third pick, the centre of the next spot will come on the fifth pick, and so on.

As previously stated, when set figures are distributed in regular satin order a stiff appearance is given to the design by the figures showing in lines. It is therefore necessary to get some irregular order as a basis to work upon, which will distribute the parts of the figure equally, and give a mixed-up appearance. A design based upon an irregular eight-end plan is given at Fig. 373. The irregular satin upon which it is based is given at Fig. 374. The method of constructing the design is precisely the same as in the previous examples; the space to be covered is divided into eight parts in each direction, and the figures are arranged in the same order as the dots in Fig. 374. If ten spots or figures are to be arranged in a design, an irregular ten-end satin may be used. In arranging the order care must be taken to have the dots evenly distributed.

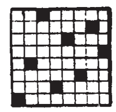


FIG. 374.

Transferring from Sketch to Point Paper.—In transferring a design from the sketch to point paper, it is usual to rule the sketch into small squares, each square to represent sixteen or twenty-four ends and picks, and to mark the point paper into squares of this number of ends and picks. The outline of the sketch is then drawn on the point paper; the squares into which the sketch and point paper have been divided render it a simple matter to enlarge the sketch and preserve the proportions of the various parts of the design. If the sketch measures four inches for one repeat of the pattern, and the design is to be made on 400 ends, and say 500 picks, on 8 × 8 point paper, the sketch may be ruled with lead pencil into twenty-five parts in the warp, and the same number of parts in the direction of the weft. The point paper would then require to be divided into spaces of sixteen ends and twenty picks.

$$\frac{400}{25} = 16 \text{ ends} \qquad \frac{500}{25} = 20 \text{ picks}$$

Development of the Pattern.—When the outline of the figure has been drawn on the point paper, it may be coloured in. This is done by going over the line carefully and filling in all the squares that the outline passes through.

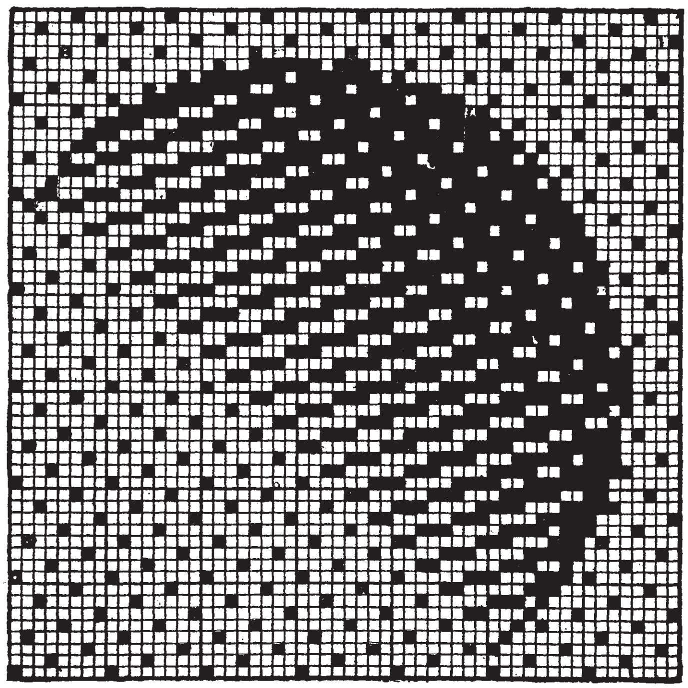


Fig. 375.

If the ground of the fabric is to be plain, the outline of the figure must be kept plain—that is, it must move an odd number of threads each time, so that the plain ground may be carried up to the figure without spoiling it.

If a solid weft figure is required on a warp satin ground the figure may be coloured all over with, say, red paint, and the developing dots be put on in blue or other colour; but if much shading or fancy treatment is required, it is more convenient to develop the figure in one colour, as in Fig. 375. Some designers colour the ground with red, and put the satin or other dots over this in another colour, leaving the figure white, and then develop the figure by putting on the required red dots to lift the warp for shading or binding.

This method is advantageous where there is more figure than ground, which is often the case; but, as a general rule, the figure is coloured with red, and the binding dots of the ground in the same colour, another colour being used for the binding of the figure when required.

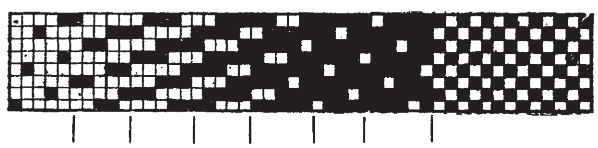


FIG. 376.

Fig. 375 illustrates the principle of developing a weft figure on a warp satin ground by shading from warp to weft.

The outline of the figure is first sketched on the point paper, and then the whole is covered with the satin dots. By adding single dots where required any degree of light and shade can be obtained. It is best to add the dots all to the same side of the float, and, as a rule, it is most convenient to add them singly. The effect is obtained by gradually increasing the float from one to seven, and thus there are seven degrees of light and shade between the two opposite eight-thread satins.

Fig. 376 will illustrate the principle of shading more perfectly. This is a small stripe of shaded eight-end satin.

The space to be shaded is divided into seven equal parts of five threads each, as there are seven changes to be made. The first five ends are left as they are, and a dot is added to each one in the second division, two dots are added to each in the third division, and so on, until the float of seven is reached at the right-hand side of the stripe.

In a five-shaft satin there are only four possible changes, and therefore this is not of much use for figured design in cotton goods. The larger satins, such as eight, ten, and twelve-shaft satins, are most useful for this purpose.

Twills may be shaded in the same manner as satins by gradually adding to the float of a warp twill until a weft twill is reached.

Satin figures are somewhat flat and indistinct when woven with grey warp and weft, and therefore in cotton fabrics the figures are more often developed in twill or fancy weaves of a bold character, unless coloured yarns are used. The best effect is obtained when a number of different weaves are employed in developing a design; the variety in itself prevents any appearance of flatness, which a design developed entirely in satin or twill possesses, and the weaves may be selected so as to suggest the beauties of the flower, leaf, or other object which forms the basis of the design.

The object of the designer need not be to render a direct imitation of nature; but there is no reason why a textile designer should not use the power at his disposal of suggesting the surface appearance, or the beauties, or characteristics of the object which forms the subject of the design.

A portion of a design developed in a variety of weaves is given at Fig. 377. The combination of the solid weft mixed fancy weaves gives a good effect.

In designs of the more conventional kind the outline of the figure may be solid weft float, and the inside any other weave that fancy may suggest.

If the figures are formed from extra warp or weft, the same principles of development will apply. Any variety of light

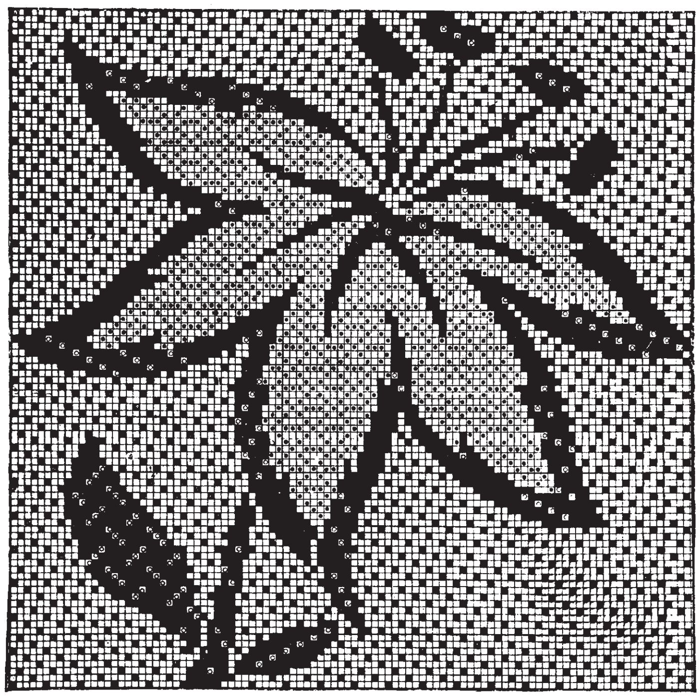


FIG. 377.

and shade can be obtained, and bold effects may be produced by twilling, or subdued effects by interweaving the threads more closely and in satin order.

Sizes of Patterns, and Casting Out.—The Jacquard machine most generally used in the cotton trade is a 400's, which weaves a design made on 400 ends or warp threads in a "repeat." If the harness is tied up to the 400 neck cords, and the warp drawn through every mail in the harness, the designs made for this loom must either be on 400 ends or on a number of ends which is a measure of 400. Thus a 400's harness will weave the following sizes of patterns :—

One pattern to	400,	or	400	end pattern	
Two patterns to	400,	,,	200	,,	
Four ,,	400,	,,	100	,,	
Five ,,	400,	,,	80	,,	
Eight ,,	400,	,,	50	,,	
Ten ,,	400,	,,	40	,,	and so on.

If it is required to make a design with three patterns to the four hundred ends, the design must be made three times over, two patterns occupying 133 ends each, and the other pattern occupying 134 ends to make up the 400 ends.

A design six patterns to the four hundred may be made by designing four patterns on sixty-seven ends each and two patterns on sixty-six ends each, and other sizes not exactly divisible into the four hundred may be made to come in on the same principle.

In designing for Jacquard weaving care must be taken that the ground weave will divide exactly into the number of ends in the harness, otherwise the pattern will be broken. Sometimes the figure will allow of the ground being broken at some point or other without the break being visible. Such opportunity occurs where the ground narrows down to a fine point; but in ordinary cases, where it is necessary to make a design with a ground weave repeating on a number not a measure of 400, some of the mails must be "cast-out."

For example, if the ground weave is required to be a 12×12 honeycomb, as it will not divide equally into 400, but will divide into 396, the design may be made on this number, and four mails in the harness left empty.

Casting out is also resorted to when it is required to reduce

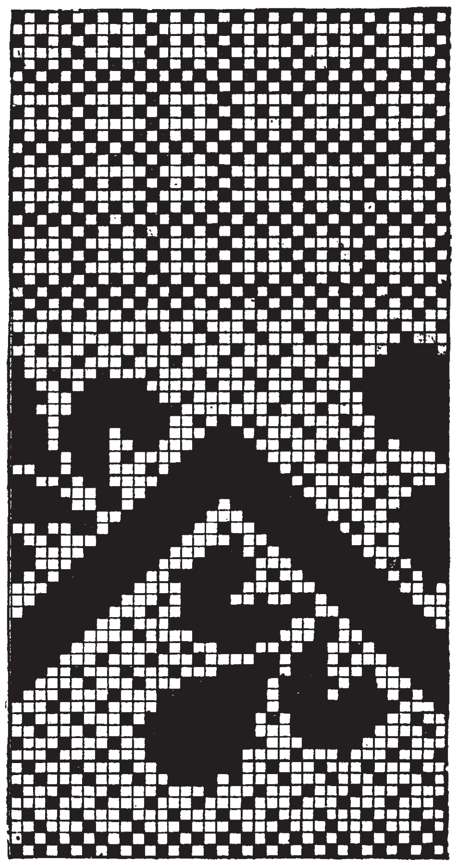


Fig. 378.

the fineness of the reed. For instance, if one-eighth of a 400's harness be cast out, there will be 50 ends less per pattern, and if the pattern measures four inches, the reed would be reduced from a 100's to an 87's.

If several rows are cast out, it is best to leave them out in two places; usually one-half is left out in the first half of the machine, and the remainder in the second half.

In designing for a machine which is "cast out," it is necessary to know in which part of the machine the ends are cast out, so that the design may be made to tie up properly, and that proper instructions may be given to the card-cutter.

Striped Designs.—Striped fabrics are always largely made for dress goods and other purposes. An endless variety of styles may be made by combining stripes of any two contrasting weaves. If the weaves are combined for dobby weaving, care must be taken that too many shafts are not required for the value of the effect obtained, but if intended for Jacquard weaving, the stripes may be figured as desired.

Some of the most effective combined styles are made of satin and leno in various forms and proportions. If for dobby weaving, the designs may be spotted to come in on a reasonable number of shafts, but if for the Jacquard, the satin is figured. The satin stripes are usually crammed—that is, there are more ends in each dent of the reed in the satin than in the other part of the fabric. Fig. 378 is a stripe design, composed of alternate stripes of figured satin and "5 and 1" lace or mock leno. The reeding plan for this fabric will be as follows:—

Reeding Plan for Fig. 378.

48 ends satin, 4 in a dent			=	12 dents
5 ends	1 dent	three times	=	12 dents
Skip	1 dent			
1 end	1 dent			
Skip	1 dent			
5 ends	1 dent		=	1 dent
				25 dents in pattern.

This system of reeding the open work is the best for obtaining an open effect, as pointed out in a previous chapter. Twenty-five dents are occupied in reeding each pattern of seventy-one ends, and assuming the harness to have one hundred threads per inch, the reed required to keep the cloth the same width in the reed as in the harness will be—

$$71 : 100 :: 25 : 35{\cdot}2 \text{ dents per inch.}$$

The reed required is one with 35·2 dents per inch, or a 70's "Stockport" reed would be used. This calculation is for a complete number of patterns, and does not allow anything for balancing the piece by having a satin stripe at both sides, as is often the case.

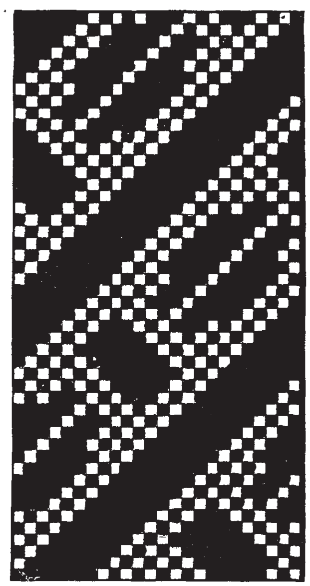


FIG. 379.

In figured stripe designs the general effect is much improved by placing the figure in different positions on each stripe in the 400 ends. If there are four figured stripes in the 400 ends, and the figure repeats on 100 picks, the figure may be placed in four different positions, moving twenty-five picks each time, in which case it would have to be designed on 400 ends; or in two different positions, in which case it would be designed on 200 ends. The object of this distribution is to prevent the figure appearing in rows across the piece.

Figured Diagonals.—As previously explained, striped designs are complete on the lowest number of picks into which all different weaves in the design will divide without remainder. In figured diagonals the design is complete on the first number that the diagonal and figure or figures counted diagonally will divide into without remainder. Thus, in Fig. 379 the design is complete on 48 picks, because the diagonal repeats on 24 picks and the figure repeats on 16 picks, and the L.C.M. of 24 and 16 is 48; therefore this is the number of picks to which the design must be carried before it is complete.

Selection of Point Paper.—Point paper is divided into small squares to represent the ends and picks, and if the designs are for a 300's or 400's Jacquard a thick line is required every eight in the warp direction to mark off the number of rows of eight needles in the machine. In 100's Jacquards the needles are placed in 25 rows of four needles in a row; in 200's the needles are in 25 rows of eight needles, in 400's there are 50 rows of eight needles, and in 600's there are twelve needles in a row. The design on point paper must be divided by a thick line to mark off the number of needles in a row; in a 400's machine this is always eight, in 600's machines it is always twelve.

If the paper has a thick line every eight in the picks as well as in the warp, it is called "8×8," and a design made on this paper will be proportionately the same if woven into cloth with the same number of ends as picks per inch.

If it is desired to make a design for a fabric with 96 ends per inch and 60 picks per inch for a machine with eight needles in a row, the paper required to keep the figure of the same proportions as it will appear in the cloth will be 8×5.

$$96 : 60 :: 8 : 5$$

If the design is intended for a 600's machine, the paper must be $12 \times (x)$. If the cloth is to have 96 ends per inch and 120 picks per inch in a 600's machine, the paper required would be 12 × 15.

$$96 : 120 :: 12 : 15$$

In selecting paper for a figured crammed stripe design, a rather more complicated calculation is necessary. It is necessary to obtain the number of ends per inch in the figured stripe, thus :—If the satin is figured in a stripe

$$\left\{\begin{array}{l}\text{96 ends, 4 in a dent, satin} \\ \text{50 ends, 2 in a dent, plain}\end{array}\right\}$$

woven in a harness 100 ends per inch, and the same width in the reed as in the harness, the ends per inch can be obtained as follows :—

$$\begin{array}{lcl} \text{96 ends, 4 in a dent} & = & \text{24 dents} \\ \text{50 ends, 2 in a dent} & = & \text{25 dents} \\ \hline \text{146 ends.} & & \text{49 dents.} \end{array}$$

If 49 dents are required for 146 ends, the number of dents per inch in the reed will be—

$146 : 100 :: 49 : 33\frac{82}{146}$ dents per inch, or a 67 reed.

If the reed used is one with $33\frac{1}{2}$ dents per inch and the satin is four ends in a dent, there will be $33\frac{1}{2} \times 4 = 134$ ends per inch in the satin; and if there are to be 100 picks per inch in the cloth, the paper required to keep the figure proportionate would be for a 400's machine, $134 : 100 :: 8 : 6$ (nearly).

Therefore the paper required is 8 × 6.

It is not at all necessary to use point paper ruled exactly in proportion to the warp and weft, as the design can easily be elongated or otherwise. It is only necessary to rule the sketch into squares, representing a certain number of ends and picks, and to mark off the point paper accordingly.

Designs for Split Harness.—In designing for the split harness, Fig. 124, no ground dots are required on the design, as the shafts under the comber-board which are lifted by the spare hooks weave the ground pattern. The design is simply coloured in, and the binding dots put on the figure only.

In a double-scale split harness every hook lifted takes up two ends, and thus the bindings in the figure will appear in twos, and will therefore appear rather coarse. In the ground every end is woven separately by the shafts, and these will require to be lifted to give the required ground weave. All that is required, therefore, is to put the lifting dots on the point paper in the position required to operate the hooks which lift the shafts. Except for the limit with regard to the ground weave, designs for the split harness are prepared in the same manner as for an ordinary harness.

Pressure Harness Designs.—In designs for the pressure harness no binding dots are required on the point paper in either the figure or ground, as the shafts or "pressure healds" in front of the harness do all the binding.

This harness is chiefly used in fine goods. Several warp threads are drawn through each mail in the harness, and afterwards woven singly by the pressure healds in front.

The edges of the figure are stepped according to the number of ends in each mail.

The structure of a pressure harness damask fabric, woven six ends in a mail with eight shaft satin bindings, is shown at Fig. 380. Of course it is not necessary to make the design on point paper in this manner; all that is necessary is to sketch the figure and colour it in where the warp satin is required.

All the binding is done by the pressure healds, as explained with Fig. 125.

Designs woven with this harness have always a flat appear-

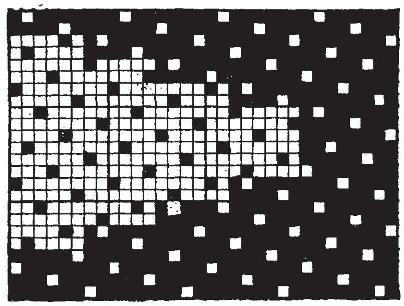


Fig. 380.

ance, but this is suitable for hangings, for which the harness is chiefly used.

A considerable number of weaves may be employed in binding the ground or figure. Any two weaves can be used in conjunction for the ground and figure which do not interfere with each other in the working.

In addition to simple satin and twill weaves, Figs. 381 and 382 can be used in conjunction, the figure being woven to

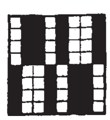


Fig. 381.

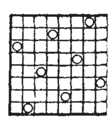


Fig. 382.

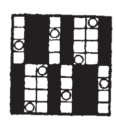


Fig. 383.

either pattern. Fig. 383 will show that the two weaves do not interfere with each other—that is, an end is never required to be lifted and left down at the same time.

Figs. 384 and 385 can be used together, one forming the figure and the other the ground.

The best way of compiling weaves to give variety to pressure

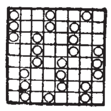


FIG. 384.

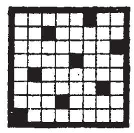


FIG. 385.

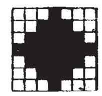


FIG. 386.

harness fabrics is to put the satin dots on paper first, and then to arrange a pattern to fit in the empty squares.

Designing for Edleston's Harness.—When designing for the patent harness, illustrated at Fig. 129, the sketch is put on point paper in the ordinary manner, but it must be remembered in doing so that the figure when woven will be on double the number of ends which it apparently occupies on point paper.

If the spot shown at Fig. 386 is put on point paper and woven in this harness the effect shown at Fig. 387 will be obtained in the cloth.

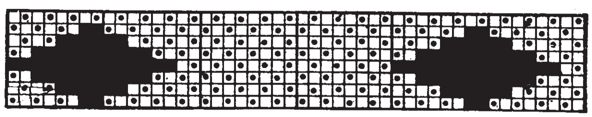


FIG. 387.

The number of ends between the spots would only be nine on paper to give the eighteen in the cloth.

It was pointed out in explaining the structure of this harness that a weft figure could not be put upon a warp ground, as it is obvious that not more than half the warp can be lifted at once, and the figure must therefore be obtained by leaving the warp down. The designs are confined to plain grounds, or weft figures may be thrown on weft satin grounds, and twill or cord grounds may with advantage be used. The method of putting eight-end satin on point paper is given at Fig. 130. The principle of putting on paper any weave possible on this harness will be understood by referring to the explanation given with the illustration of the harness.

Figured Lenos.—Some of the most beautiful of all fabrics are made with the leno harness, the combination of

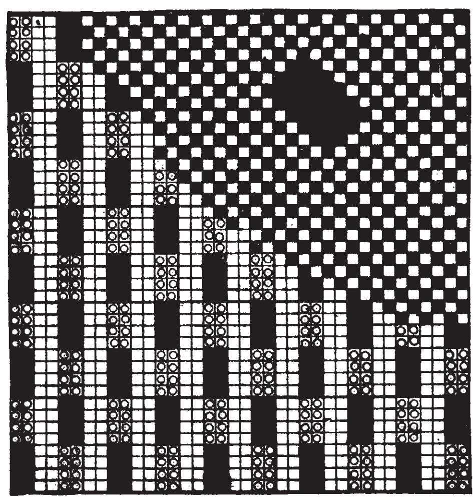


Fig. 388.

plain or floated figures with the open and firm leno ground giving a fabric which is both serviceable and effective. The structure of the harness has already been explained with Fig. 145, and it has been shown how "four and four" leno and a plain or floated weave can be combined.

The method of putting the design on point paper for a figured leno harness with 500 needles and 600 hooks (see Fig. 145) will be understood from Fig. 388. This is a small portion of a design which includes "four and four" leno, plain, and floated weft or warp. The solid squares show the crossing threads lifted by the ground harness, and the circles show the same ends lifted by the doup. There will thus be four ends in a dent and four picks in a shed in the leno, and when these are woven plain the contrast is very effective.

Two colours are necessary for putting the design on paper, and in cutting the cards from the design the solid squares in the leno portion will be cut opposite the third and fourth or seventh and eighth needles in the ground set, whilst the circles in the design which show where the doups are to be lifted will be cut opposite either the first or tenth row of needles. In a ground weave of this kind both doups are never lifted together, as the weave is easier when they are lifted separately.

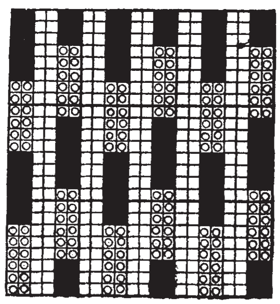


FIG. 389.

Some beautiful striped designs are made by using thick whip threads to give a lace effect, and various fancy leno weaves can be made and employed for giving variety to the effect.

If there are more than four picks in a shed on the leno it is often necessary to lift one of the crossing ends when the standard ends are lifting in order to prevent the threads from "slipping" or "fraying."

Fig. 389 will give a well-known two-doup effect, and other patterns may be devised quite easily, the power of the harness being practically unlimited.

Sometimes leno figures are woven on plain grounds, but the opposite is the general rule. Floated figures are not much used, as the contrast of the plain and leno is very effective, and is more serviceable than a loose figure.

A very fair imitation of a four in a dent figured leno can be made by using one doup stave in front of an ordinary Jacquard harness, and crossing one end under three. By lifting the doup every other pick a plain figure can be woven on the leno ground, one crossing three, on the principle explained with Fig. 144.

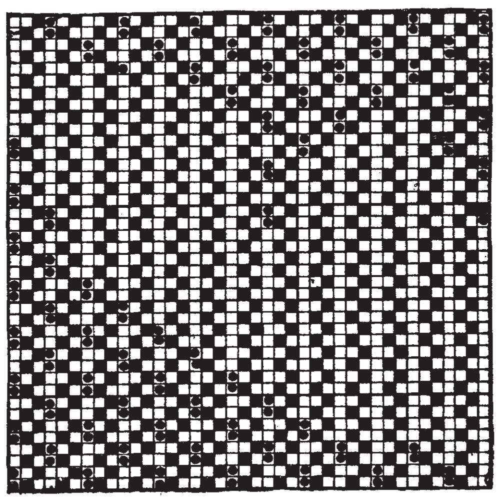


Fig. 390.

Toiletings.—In toilet quilts a raised plain figure is formed by an extra warp from a separate beam interweaving with the plain cloth where the ground of the design is required. Fig. 390 is a portion of a design for a cloth of this kind. Every third end is an "extra" end, and where the raised figure is required these ends are left down, but where the ground of the design is required the extra ends interweave with the plain cloth and bind it down. The tension of the extra warp causes the figure to stick up more than would otherwise be the case. The principle can be made to give innumerable effects by different methods of introducing the extra warp, but the ends must not be left out of the cloth for too long together, or they would be too loose at the back and would be likely to catch. Fig. 391 is a section showing the binding of the extra warp into the plain figuring cloth.

FIG. 391.

The principle is well adapted for the production of large figures such as are required on quilts and similar fabrics, owing to the fact that only one-third of the warp threads are required to pass through the Jacquard harness; the plain ends can be lifted by shafts.

In the better classes of toiletings two shuttles are used, and the extra ends are woven plain at the back instead of hanging loose. The principle is otherwise the same as in a one-shuttle toileting.

In some quilts a padding weft is inserted between the face and back cloth on the principle explained in Figs. 321–323. "Marseilles" quilts are made in this manner. Fig. 392 will

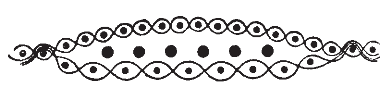


FIG. 392.

show how a padded figure is formed, the dots represent the weft, and the principle of forming the figure is the same as in Figs. 321 and 323.

When the padding picks are being put in, the face cloth is all lifted, and the back cloth left down.

There are various other makes of quilts, of which the "Mitcheline" type is extensively manufactured. These fabrics are characterized by a raised figure of coarse texture upon a

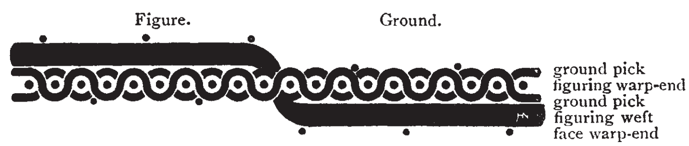


FIG. 393.

ground of comparatively fine texture. Fig. 393 shows how this is effected.

Two systems each of warp and weft are used, the warp being drawn in the harness and reed as follows :—

> one face end fine counts : (say white)
> two figuring ends medium counts : (say brown).

The order of picking is—

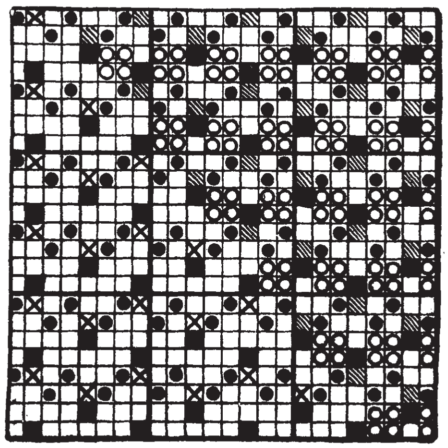
> two coarse figuring picks (white)
> two fine ground picks (brown).

Two plain cloths are woven, one being white and the other brown, and these are made to change places so as to form the desired figure in the manner shown in Fig. 393.

The two cloths are bound together in both the figure and the ground. When the white cloth is at the top, as in the first part of Fig. 393, a ground pick is passed over a white face end under the float which follows, and the binding is perfectly hidden. When the brown cloth is at the top a white end is lifted, and as this is of a fine count and the brown warp threads are rather closely set to the reed, the binding is obscured.

A portion of a design of this weave is given at Fig. 394, the structure of which will repay careful study along with the section at Fig. 393.

Twilled cloths are sometimes used for figuring on this



REFERENCE.

■ = White face warp-ends raised above coarse white figuring picks.

● = Brown figuring warp-ends raised above fine brown ground picks.

☒ = White face warp-ends raised above fine brown ground picks, in the figure.

○ = Brown figuring warp-ends raised above coarse white figuring picks.

▨ = White face warp-ends raised above fine brown ground picks, in the ground.

FIG. 394.

double cloth principle, and the binding can be much more easily effected, although the weave is more expensive than double plain, if the same firmness is desired. Fig. 395 is a

FIG. 395.

section showing how the figure can be formed from two twill cloths, and how the binding can be best effected. The cloths in this example are of equal fineness.

Fig. 396 is a design for this fabric, showing a small portion of both ground and figure. The cloths are bound together once in every eight threads.

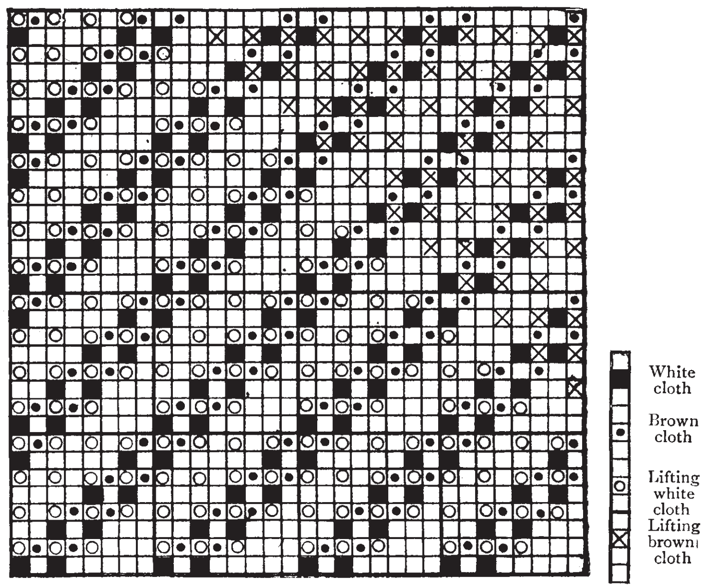


FIG. 396.

Figured Weft Pile Velvets.—When figuring with weft and pile, the chief difficulty is the cutting of the fabric after weaving, owing to the difficulty of keeping the knife-guide in the race when passing from one portion of the figure to another across the ground.

A considerable quantity of fabrics had been made with velvet cord figures—which are easy enough to cut—before it was found possible to cut the real velvet figure. This was rendered possible by throwing the short floats of pile weft to the back of the cloth at the edges of the figure, and always moving in steps or races at the edges of the figure, and in addition to this always keeping the end upon which the knife runs, to the inside of each step. By throwing out the short floats the chief difficulty was overcome, as the obstruction caused by these was the chief cause of the knife and guide being thrown out when cutting. These improvements were simultaneously devised by the writer and Mr. T. Anderson, of Wyke, and a large quantity of cloth was turned out a few years ago, but owing to the cottony appearance of the ground the demand quickly fell away.

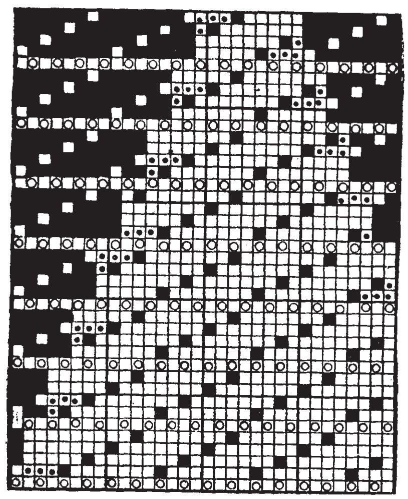


FIG. 397.

Two large manufacturers took out a patent to include all figured weft pile fabrics, but a thorough search could not have been made, as the writer recently came across a heap of patterns woven on the same principle, including the stepping in races, and also with a coloured extra warp ground, which had been made at least before the year 1870.

The method of putting the designs on point paper is shown at Fig. 397. The weave generally used is an ordinary E1 velvet with about 400 picks per inch, woven in an 80 reed 2-60's twist, 70's weft. It will be seen that the figure steps in twos at the edges, and that all floats less than five are thrown to the back of the cloth by the small dots in the design. The blanks represent the weft on the face, and the inside of the step or race is arranged to come on the third, fifth, seventh ends, and so on, these being the ends along which the knife runs. Where a turn is made in the figure it must be on an odd number of ends in order to keep the race in this position.

Other systems of making figured weft pile fabrics have been tried. One of these was to use an extra warp at the back for binding the pile picks where the ground is required, and binding the picks where the figure is required, to the ordinary warp. When the pile is cut the extra warp is torn away, pulling the pile with it where the ground of the pattern occurs.

Another method is to weave the figure fast pile, and the ground loose pile, and to brush the loose pile away at the back.

Velvet and leno stripes have been woven. As velvet requires a large number of picks and leno a small number, there is a difficulty in cutting the picks at the back of the leno stripe away. This can be overcome by interweaving the picks to be taken away at the back of the leno with some extra ends, and when the velvet stripe is cut, the back cloth can be torn away quite easily.

Solid Coloured Borders.—In some fabrics, such as dhooties, the borders are sometimes made with coloured warp and weft, and the middle of the piece with white or grey yarns. The method of obtaining the solid border is rather ingenious, and is as follows.

A coloured end is placed at each side of the warp, and this thread hangs loose from the bobbin, so that not much force is required to pull the thread into the border. The warp ends forming the border are on separate staves from the ground ends, and lift so as to allow two picks to go through each shed while the middle weaves ordinary plain cloth.

The coloured end A (Fig. 398) is lifted every other pick, and the shuttle containing the white weft will pass round it, and as the shed is not changed in the border ends, the coloured thread is taken into the border, thus forming a solid coloured border on an ordinary grey or white cloth. In the border, there will be two picks in a shed.

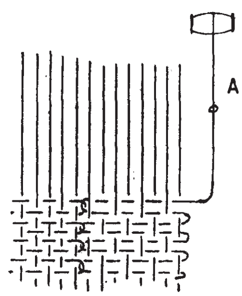


FIG. 398.

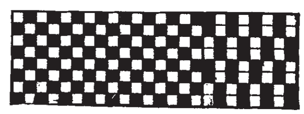


FIG. 399.

The point paper plan showing the difference in the shedding between the border and the middle is given at Fig. 399. The coloured thread from the bottom may be lifted by the plain staves.

Direction of the Twist in Yarns.—Warp yarns are usually twisted so as to show the lines of the twist from right to left, and weft yarns are twisted in the opposite direction. The reason for this is that when the yarns are woven into cloth the lines of both warp and weft run in the same direction, and the threads become embedded together as closely as possible through the strands falling into each other. This is shown at Fig. 400, where at A and B the warp and weft yarns are shown laid side by side. At C the same yarns are shown as laid in the cloth, when it will be seen that the lines of twist appear in the same direction, and the threads have thus a chance of getting together as closely as possible.

If the weft is spun in the same direction as the warp, or "twist way," as it is termed, when woven the lines or strands appear in opposite directions, and each thread has a tendency to be kept apart from the others, and appears separately. This, if anything, makes the cloth feel slightly thicker, and is preferred by many for certain purposes, including some classes of printing cloths. The finer appearance is obtained by the yarns spun in opposite directions.

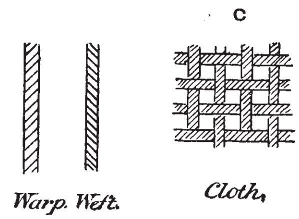


FIG. 400.

In twill and satin cloths, and similar fabrics, the direction of

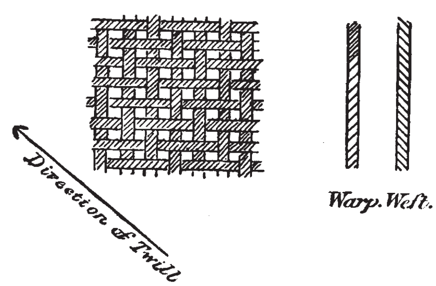


FIG. 401.

the twist has a very important bearing upon the appearance of the fabric.

The finest and closest effect is obtained by using warp and weft yarns spun in opposite directions, so that when woven the lines appear in the same direction, and the direction of the twill should be opposite to both. This is why one side of a twill cloth has a finer appearance than the other, as the twill runs against the lines on one side, and with the lines on the other side of the cloth, the former having the finer appearance. Fig. 401 shows the yarns spun oppositely, and the twill running in a direction opposite to the lines.

In sateen cloths there is a kind of twill in one direction, as shown in Fig. 402, and the above principle applies to this as well as regular twills.

It often occurs that for printing and dyeing purposes the weft is preferred spun "twist way," and as the weft greatly predominates over the warp, the direction of the twill should be contrary to the lines of the weft. Not much difference is noticeable in the better makes of cloth, but when there are few picks, a frayed appearance is often produced if the direction of the twill is not reversed.

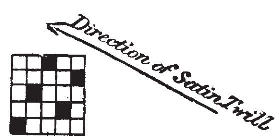


FIG. 402.

To keep the twill in a given direction, the twist may be spun "weft way" to give the desired effect.

In very small twills, such as Jeannettes, a more decided twill is obtained by using weft spun in the same way as the twist or warp yarns, but in larger twills the best effect is obtained in the opposite manner.

CHAPTER XI

TEXTILE CALCULATIONS

THE numbers of cotton yarns are based upon the hank of 840 yards, the number of hanks in 1 lb. being the "counts."

It follows that if 840—the yards in one hank—be multiplied by the counts, the result will be the yards in 1 lb. of that count.

Thus in 1 lb. of 30's yarn there will be $840 \times 30 = 25,200$ yards, and the yards in a pound of any count may be found in the same manner.

The counts of worsted yarns are based upon a bank of 560 yards, and the number of hanks in 1 lb. Avoirdupois is the count of the yarn.

Linen yarns are based on a hank or lea of 300 yards, and the number of these in 1 lb. is the count of the yarn.

Spun silk, which is the silk chiefly used in cotton fabrics for stripes and headings, is numbered on the same system as cotton yarns. The number of hanks of 840 yards in 1 lb. is the count of the yarn.

Net silks or thrown silks are numbered on an altogether different system. The "skein" or hank is 520 yards, and the number of deniers—$533\frac{1}{3}$ deniers = 1 oz.—which a skein weighs indicates the number of the yarn. In silk manufacture the number of the yarn is called the "size," the word "count" being used to denote the closeness of the reed.

Another system is used for silk yarns called the Manchester scale. This is based upon the hank of 1,000 yards.

The number of drams which one such hank weighs is the "size" or number of the yarn or thread.

In the former scale the yards per ounce may be found by multiplying the yards in a hank by the deniers in one ounce, and dividing by the number of deniers which a hank weighs.

The yards in an ounce of 40 denier silk will be—

$$\frac{\overset{\text{deniers per oz.}}{533\frac{1}{3}} \times \overset{\text{yards in skein}}{520}}{40 \text{ deniers}} = 6933\tfrac{1}{3} \text{ yards per oz.}$$

In the Manchester silk scale the yards per ounce of a 4 dram silk may be found by multiplying 1,000, the yards in a hank, by 16, the drams in an ounce, and dividing by the number of drams which the hank weighs, viz. 4; thus—

$$\frac{1000 \times 16}{4} = 4000 \text{ yards per oz.}$$

Twofold Yarns in cotton, worsted, and linen are numbered according to the count of the single yarn, with the number of folds put before it. Thus a 2-40's yarn means that the yarn is composed of two threads of 40's single, making a twofold yarn of 20 hanks to the pound.

In spun silk the yarns are nearly always two or more fold, and the number of the yarn always indicates the number of hanks in 1 lb. The number of folds is usually written after the hanks per pound. Thus, 40's-2 spun silk indicates that the yarn is 40 hanks to the pound, made up of two threads of 80's single.

It sometimes occurs in fancy yarns that threads of unequal thickness are twisted together. If a 60's thread and a 40's thread are twisted together, the count of the doubled thread will not be the same as if two threads of 50 hanks to the pound, but will be something less than this.

It is obvious that when the two threads are twisted together the weight of a hank of the doubled thread will be $\frac{1}{60} + \frac{1}{40}$ of a pound, and by adding these fractions together the counts of the twofold yarn may be obtained. Thus—

$$\frac{1}{40} + \frac{1}{60} = \frac{3 + 2}{120} = \frac{5}{120} = 24\text{'s counts.}$$

Another method of obtaining the same result is to multiply the two numbers together, and add them together, and divide one result by the other. Thus—

$$\begin{array}{rrl} & 60 & 60 \\ & 40 & 40 \\ \hline 100) & 2400 & (24\text{'s counts.} \\ & 2400 & \\ \hline \end{array}$$

If three or more unequal threads are twisted together the counts of the resulting thread may be found by adding the fractions of a pound which a hank of each count represents.

Example.—Find the counts of a threefold thread composed of one thread each of 10's, 20's and 60's cotton.

$$\frac{1}{10} + \frac{1}{20} + \frac{1}{60} = \frac{6 + 3 + 1}{60} = \frac{10}{60} = \frac{1}{6} \text{ or } 6\text{'s counts.}$$

Some allowance must be made for the twisting of the threads, but this will vary with the number of turns per inch in the yarn, and so is not taken into account in the example.

If it is required to obtain the weight of each count in 100 lbs. of the threefold yarn, the following is the method.

As one count is to the resulting count, so is the total weight to the weight required of that yarn—

10 : 6 :: 100 : 60 lbs. of 10's
20 : 6 :: 100 : 30 lbs. of 20's
60 : 6 :: 100 : 10 lbs. of 60's

100 lbs. Total.

Reeds and Setts.—The system of numbering reeds, now almost universal in the cotton trade, is known as the Stockport or Manchester count. The number of dents or splits per inch in the reed with two ends in each dent is the basis of the system. If the reed has 30 dents per inch, it is called a 60 reed, because if there are two ends in a dent in the 30 dents there will be 60 ends per inch. The number of the reed is always the same as the ends per inch in the reed, if the ends are all two in a dent.

A 60 reed Stockport counts, if reeded three ends in a dent, will have 90 ends per inch, because a 60 reed has 30 dents per inch, and if there are three in a dent, there will be $30 \times 3 = 90$ ends per inch.

Various other systems have been used, but are gradually giving way to the simpler Stockport or Manchester system. Some of these are—

The Bolton count, in which the number of "beers" of 40 ends, or 20 dents, in $24\frac{1}{4}$ inches is the basis of the system.

The Blackburn count, in which the number of beers in 45 inches was the basis. The beer, as above, being 20 dents, representing 40 ends in a beer.

The Preston count was based on the number of beers in different widths.

The 6-4 count was based on the number of beers of 20 dents —representing 40 ends—in 58 inches.

The 9-8's count was based on the number of beers in 44 inches.

The 4-4's count was based on the beers in 39 inches.

The 7-8's count was based on the beers in 34 inches.

The Scotch system is based on the number of dents in 37 inches. Thus in a 2000 reed there will be 2000 dents in 37 inches, representing 4000 ends in that space.

The Bradford system is based on the number of beers of

40 ends in 36 inches. If there are 50 times 40 ends in 36 inches, it is a "50 sett."

To find the number of ends per inch in a given sett, it is necessary to multiply the sett by 40 and divide by 36, thus—

$$\frac{50 \text{ sett} \times 40}{36} = 55\tfrac{20}{36} \text{ ends per inch.}$$

Quantity of Material in a Piece.—To find the weight of warp and weft of given counts in a piece, the total length of yarn in the piece may be found, and divided by the yards in 1 lb. of the counts of yarn used. This will give the weight in pounds. The following example will make the principle quite clear:—

Example.—Find the weight of warp and weft in a piece woven 30 inches wide in a 70 reed (Stockport) cloth 90 yards long, from 95 yards of warp, 80 picks per inch, the counts of twist or warp being 30's, and counts of weft 40's.

If the piece is 90 yards long, the length of warp used will be somewhat in excess of this, as the warp in interlacing with the weft is bent out of a straight line. The amount of "milling up," as it is called, varies according to the number of intersections in the pattern or weave of the cloth, and with the counts of yarn used. It will also vary considerably according to the elasticity of the yarn. Twofold yarns are more elastic than single, and therefore will require a shorter length of yarn for a given length of cloth.

In this example 95 yards of warp are used to weave a 90-yards piece, an allowance of a little over 5 per cent.

In making the calculation for the weft it is necessary to take the width in the reed, as this length of weft is used every pick. The cloth will contract a little owing to the pull of the threads when woven, and when calculating for a given width of cloth care must be taken to calculate for the reed width and not the cloth width only.

In the present example the width in the reed is given, and so the cloth will be somewhat narrower than this when woven.

To find Weight of Warp.

840 yards in 1 hank	70 ends per inch
30 counts	30 inches in reed
25200 yards in 1 lb.	2100 ends in warp
	95 yards long
	10500
	18900
	199500 yards of twist in piece.

Therefore, weight of warp $= \dfrac{\overset{\text{yards}}{199500}}{\underset{\text{yds. in 1 lb.}}{25200}} = 7$ lbs. $14\frac{2}{3}$ oz.

To find Weight of Weft.

840 yards in 1 hank	80 picks per inch
40	30 inches in reed
33600 yards in 1 lb.	2400 inches of weft in 1 inch of cloth
	36 inches in 1 yard
	14400
	7200
	36) 86400 inches of weft in 1 yard of cloth
	2400 yards of weft in 1 yard of cloth
	90 yards length of piece
	216000 yards of weft in piece.

Therefore, weight of weft $= \dfrac{216000}{33600} = 6$ lbs. $6\frac{6}{7}$ oz.

Weight of weft = 6 lbs. $6\frac{6}{7}$ oz.
Weight of warp = 7 lbs. $14\frac{2}{3}$ oz.

In the weft calculation, the picks per inch multiplied by the width in the reed in inches gives the inches of weft in one inch of cloth. This multiplied by 36 will give the inches of weft in one yard of cloth, and divided by 36, this gives the yards of weft in one yard of cloth. The two 36's may be left out, as it is obvious that the yards of weft in a yard of cloth are the same as the inches of weft in an inch of cloth. The formula to calculate the weight of warp in a piece is as follows :—

$$\frac{\text{Inches in reed} \times \text{length of warp in yards} \times \text{ends per inch in reed}}{840 \times \text{counts}}$$
$$= \textbf{weight of warp.}$$

The formula for the weft is—

$$\frac{\text{Inches in reed} \times \text{length of piece in yards} \times \text{picks per inch}}{840 \times \text{counts}}$$
$$= \textbf{weight of weft}$$

Working out the previous calculation in this manner, we get—

$$\frac{30 \times 95 \times 70}{840 \times 30} = 7 \text{ lbs. } 14\tfrac{2}{3} \text{ oz. of warp.}$$

$$\frac{30 \times 90 \times 80}{840 \times 40} = 6 \text{ lbs. } 6\tfrac{6}{7} \text{ oz. of weft.}$$

If it is required to find the number of hanks, it is only necessary to leave out the counts in the above formulæ. Thus we get—

$$\frac{\text{Inches wide} \times \text{length} \times \text{ends per inch}}{840} = \text{hanks,}$$

and using the figures in the previous example—

$$\frac{30 \times 95 \times 70}{840} = 237\tfrac{1}{2} \text{ hanks of warp.}$$

Before the actual cost of a piece of cloth can be calculated, it is necessary to know the price to be paid the weaver. In Lancashire the payment is made according to the list agreed upon by both employers and employed. For plain cloths and twills a new uniform list has been agreed upon, and this is now generally accepted. The following is the new list:—

UNIFORM LIST OF PRICES FOR WEAVING.

1. **The Standard.**—The standard upon which this list is based is an ordinary loom, 45 inches reed space, measured from the fork grate on one side to the back board on the other, weaving cloth as follows:—

Width: 39, 40, 41 inches.

Reed: 60 reed, 2 ends in a dent, or 60 ends per inch.

Picks: 15 picks per quarter-inch, ascertained by arithmetical calculation, with $1\frac{1}{2}$ per cent. added for contraction.

Length: 100 yards, 36 inches to the yard, measured on the counter. Any length of lap other than 36 inches to be paid in proportion.

Twist: 28's, or any finer numbers.

Weft: 31's to 100's inclusive.

Price 2*s.* 6*d.*, or 2*d.* per pick, per quarter-inch.

2. **Width of Looms.**—A 45-inch reed space loom being taken as the standard, $1\frac{1}{2}$ per cent. shall be added for each inch up to and including 51 inches; 2 per cent. from 51 to 56 inches; $2\frac{1}{2}$ per cent. from 56 to 64 inches; and 3 per cent. from 64 to 72 inches.

$1\frac{1}{4}$ per cent. shall be deducted for each inch from 45 to 37 inches inclusive, and 1 per cent. from 37 to 24 inches, below which no further deduction shall be made. For any fraction of an inch up to the half no addition or deduction shall be made; but if over the half, the same shall be paid as if it were a full inch.

All additions or deductions under this clause to be added to, or taken from, the price of the standard loom 45 inches.

DEDUCTED FROM STANDARD.

Loom.	Percentage.	Loom.	Percentage.
Inches.		Inches.	
24	23	35	12
25	22	36	11
26	21	37	10
27	20	38	$8\frac{3}{4}$
28	19	39	$7\frac{1}{2}$
29	18	40	$6\frac{1}{4}$
30	17	41	5
31	16	42	$3\frac{3}{4}$
32	15	43	$2\frac{1}{2}$
33	14	44	$1\frac{1}{4}$
34	13	45	standard

ADDED TO STANDARD.

Loom.	Percentage.	Loom.	Percentage.
Inches.		Inches.	
46	$1\frac{1}{2}$	59	$26\frac{1}{2}$
47	3	60	29
48	$4\frac{1}{2}$	61	$31\frac{1}{2}$
49	6	62	34
50	$7\frac{1}{2}$	63	$36\frac{1}{2}$
51	9	64	39
52	11	65	42
53	13	66	45
54	15	67	48
55	17	68	51
56	19	69	54
57	$21\frac{1}{2}$	70	57
58	24	71	60
		72	63

3. Broader Cloth than admitted by Rule.—All looms shall be allowed to weave to within 4 inches of the reed space; but whenever the difference between the width of cloth and the reed space is less than 4 inches, it shall be paid as if the loom were 1 inch broader: and if less than 3 inches, as if it were $2\frac{1}{2}$ inches broader.

4. Allowance for Cloth 7 to 15 inches narrower than the Reed Space.—When the cloth is from 7 to 15 inches narrower than the reed space of the loom in which it is woven, a deduction in accordance with the following table shall be made :—

DEDUCTIONS FOR NARROW CLOTH.

Reed space.	Cloth.	Per cent.	Reed space.	Cloth.	Per cent.	Reed space.	Cloth.	Per cent.
72	65	1·38	68	56	8·44	63	55	2·75
72	64	2·76	68	55	9·69	63	54	4·12
72	63	4·14	68	54	10·93	63	53	5·49
72	62	5·52	68	53	12·17	63	52	6·87
72	61	6·9	67	60	1·52	63	51	8·24
72	60	8·28	67	59	3·04	63	50	9·62
72	59	9·66	67	58	4·56	63	49	10·71
72	58	11·04	67	57	5·83	63	48	11·81
72	57	12·19	67	56	7·09	62	55	1·4
71	64	1·41	67	55	8·36	62	54	2·8
71	63	2·81	67	54	9·63	62	53	4·2
71	62	4·22	67	53	10·9	62	52	5·6
71	61	5·62	67	52	12·16	62	51	7·0
71	60	7·03	66	59	1·55	62	50	8·4
71	59	8·44	66	58	3·1	62	49	9·51
71	58	9·84	66	57	4·4	62	48	10·63
71	57	11·02	66	56	5·69	62	47	11·75
71	56	12·19	66	55	6·98	61	54	1·43
70	63	1·43	66	54	8·28	61	53	2·85
70	62	2·87	66	53	9·57	61	52	4·28
70	61	4·3	66	52	10·86	61	51	5·7
70	60	5·73	66	51	12·16	61	50	7·13
70	59	7·17	65	58	1·58	61	49	8·27
70	58	8·6	65	57	2·91	61	48	9·41
70	57	9·79	65	56	4·23	61	47	10·55
70	56	10·99	65	55	5·55	61	46	11·69
70	55	12·18	65	54	6·87	60	53	1·45
69	62	1·46	65	53	8·19	60	52	2·91
69	61	2·92	65	52	9·51	60	51	4·36
69	60	4·38	65	51	10·83	60	50	5·81
69	59	5·84	65	50	12·15	60	49	6·98
69	58	7·31	64	57	1·35	60	48	8·14
69	57	8·52	64	56	2·7	60	47	9·3
69	56	9·74	64	55	4·05	60	46	10·47
69	55	10·96	64	54	5·4	60	45	11·63
69	54	12·18	64	53	6·74	59	52	1·48
68	61	1·49	64	52	8·09	59	51	2·96
68	60	2·98	64	51	9·44	59	50	4·45
68	59	4·47	64	50	10·79	59	49	5·63
68	58	5·96	64	49	11·87	59	48	6·82
68	57	7·2	63	56	1·37	59	47	8·0

DEDUCTIONS FOR NARROW CLOTH—*continued.*

Reed space.	Cloth.	Per cent.	Reed space.	Cloth.	Per cent.	Reed space.	Cloth.	Per cent.
59	46	9·19	54	40	8·8	49	34	8·67
59	45	10·38	54	39	9·78	48	41	1·08
59	44	11·26	53	46	1·33	48	40	2·15
58	51	1·51	53	45	2·65	48	39	3·23
58	50	3·02	53	44	3·65	48	38	4·13
58	49	4·23	53	43	4·65	48	37	5·02
58	48	5·44	53	42	5·64	48	36	5·92
58	47	6·65	53	41	6·64	48	35	6·82
58	46	7·86	53	40	7·63	48	34	7·72
58	45	9·07	53	39	8·63	48	33	8·61
58	44	9·98	53	38	9·42	47	40	1·09
58	43	10·89	52	45	1·35	47	39	2·18
57	50	1·54	52	44	2·36	47	38	3·09
57	49	2·78	52	43	3·38	47	37	4·0
57	48	4·01	52	42	4·39	47	36	4·91
57	47	5·25	52	41	5·41	47	35	5·83
57	46	6·48	52	40	6·42	47	34	6·74
57	45	7·72	52	39	7·43	47	33	7·65
57	44	8·64	52	38	8·28	47	32	8·56
57	43	9·57	52	37	9·12	46	39	1·11
57	42	10·49	51	44	1·03	46	38	2·03
56	49	1·26	51	43	2·06	46	37	2·96
56	48	2·52	51	42	3·1	46	36	3·88
56	47	3·78	51	41	4·13	46	35	4·8
56	46	5·04	51	40	5·16	46	34	5·73
56	45	6·3	51	39	6·19	46	33	6·65
56	44	7·25	51	38	7·05	46	32	7·57
56	43	8·19	51	37	7·91	46	31	8·5
56	42	9·14	51	36	8·77	45	38	0·94
56	41	10·08	50	43	1·05	45	37	1·87
55	48	1·28	50	42	2·09	45	36	2·81
55	47	2·56	50	41	3·14	45	35	3·75
55	46	3·85	50	40	4·19	45	34	4·69
55	45	5·13	50	39	5·23	45	33	5·62
55	44	6·09	50	38	6·1	45	32	6·56
55	43	7·05	50	37	6·98	45	31	7·5
55	42	8·01	50	36	7·85	45	30	8·25
55	41	8·97	50	35	8·72	44	37	0·95
55	40	9·94	49	42	1·06	44	36	1·9
54	47	1·3	49	41	2·12	44	35	2·85
54	46	2·61	49	40	3·18	44	34	3·80
54	45	3·91	49	39	4·25	44	33	4·75
54	44	4·89	49	38	5·13	44	32	5·70
54	43	5·87	49	37	6·01	44	31	6·65
54	42	6·85	49	36	6·9	44	30	7·41
54	41	7·83	49	35	7·78	44	29	8·16

DEDUCTIONS FOR NARROW CLOTH—*continued.*

Reed space.	Cloth.	Per cent.	Reed space.	Cloth.	Per cent.	Reed space.	Cloth.	Per cent.
43	36	0·96	38	31	1·03	33	26	0·87
43	35	1·92	38	30	1·85	33	25	1·74
43	34	2·88	38	29	2·67	33	24	2·62
43	33	3·77	38	28	3·49	33	23	3·49
43	32	4·81	38	27	4·32	33	22	4·36
43	31	5·77	38	26	5·14	33	21	5·23
43	30	6·54	38	25	5·96	33	20	6·1
43	29	7·31	38	24	6·78	33	19	6·98
43	28	8·08	38	23	7·60	33	18	7·85
42	35	0·97	37	30	0·83	32	25	0·88
42	34	1·95	37	29	1·67	32	24	1·76
42	33	2·92	37	28	2·5	32	23	2·65
42	32	3·9	37	27	3·33	32	22	3·53
42	31	4·87	37	26	4·17	32	21	4·41
42	30	5·65	37	25	5·0	32	20	5·29
42	29	6·43	37	24	5·83	32	19	6·18
42	28	7·21	37	23	6·67	32	18	7·06
42	27	7·99	37	22	7·5	31	24	0·89
41	34	0·99	36	29	0·84	31	23	1·79
41	33	1·97	36	28	1·69	31	22	2·68
41	32	2·96	36	27	2·53	31	21	3·57
41	31	3·95	36	26	3·37	31	20	4·46
41	30	4·74	36	25	4·21	31	19	5·36
41	29	5·52	36	24	5·06	31	18	6·25
41	28	6·32	36	23	5·9	30	23	0·9
41	27	7·11	36	22	6·74	30	22	1·81
41	26	7·89	36	21	7·58	30	21	2·71
40	33	1·0	35	28	0·85	30	20	3·61
40	32	2·0	35	27	1·7	30	19	4·52
40	31	3·0	35	26	2·56	30	18	5·42
40	30	3·8	35	25	3·41	29	22	0·91
40	29	4·6	35	24	4·26	29	21	1·83
40	28	5·4	35	23	5·11	29	20	2·74
40	27	6·2	35	22	5·97	29	19	3·66
40	26	7·0	35	21	6·82	29	18	4·57
40	25	7·8	35	20	7·67	28	21	0·93
39	32	1·01	34	27	0·86	28	20	1·85
39	31	2·03	34	26	1·72	28	19	2·78
39	30	2·84	34	25	2·59	28	18	3·7
39	29	3·65	34	24	3·45	27	20	0·94
39	28	4·46	34	23	4·31	27	19	1·87
39	27	5·27	34	22	5·17	27	18	2·81
39	26	6·08	34	21	6·03	26	19	0·95
39	25	6·89	34	20	6·9	26	18	1·9
39	24	7·7	34	19	7·76	25	18	0·96

No further deduction shall be made when cloth is more than 15 inches narrower than the reed space, or when cloth is narrower than 18 inches. Fractions of an inch not to be recognized under this clause.

5. Reeds.—A 60 reed being taken as the standard, $\frac{3}{4}$ per cent. shall be deducted for every two ends or counts of reed from 60 to 50, but no deduction shall be made below 50. $\frac{3}{4}$ per cent. shall be added for every two ends or counts of reed from 60 to 68, 1 per cent. from 68 to 100; $1\frac{1}{2}$ per cent. from 100 to 110; and 2 per cent. from 110 to 132. All additions or deductions under this clause to be added to or deducted from the price of the standard 60 reed.

Deductions from standard.		Additions to standard.			
Count of reed.	Percentage.	Count of reed.	Percentage.	Count of reed.	Percentage.
50	$3\frac{3}{4}$	62	$\frac{3}{4}$	98	18
52	3	64	$1\frac{1}{2}$	100	19
54	$2\frac{1}{4}$	66	$2\frac{1}{4}$	102	$20\frac{1}{2}$
56	$1\frac{1}{2}$	68	3	104	22
58	$\frac{3}{4}$	70	4	106	$23\frac{1}{2}$
60	standard	72	5	108	25
		74	6	110	$26\frac{1}{2}$
		76	7	112	$28\frac{1}{2}$
		78	8	114	$30\frac{1}{2}$
		80	9	116	$32\frac{1}{2}$
		82	10	118	$34\frac{1}{2}$
		84	11	120	$36\frac{1}{2}$
		86	12	122	$38\frac{1}{2}$
		88	13	124	$40\frac{1}{2}$
		90	14	126	$42\frac{1}{2}$
		92	15	128	$44\frac{1}{2}$
		94	16	130	$46\frac{1}{2}$
		96	17	132	$48\frac{1}{2}$

6. Picks.—*Low Picks.*—An addition of 1 per cent. shall be made for each pick or fraction of a pick below 11, thus:—

Below 11	to and	including	10,	1	per cent.
„ 10	„	„	9,	2	„
„ 9	„	„	8,	3	„
„ 8	„	„	7,	4	„

and so on, adding 1 per cent. for each pick or fraction of a pick.

High Picks.—An addition of 1 per cent. shall be made for each pick whenever they exceed the following :—

Weft below 26's.	when picks exceed	16
„ 26's to 39's inclusive	„ „ „	18
„ 40's and above	„ „ „	20

In making additions for high picks, any fraction of a pick less than the half shall not have any allowance; exactly the half-pick shall have ½ per cent. added; and any fraction over the half-pick shall have 1 per cent. added.

7. Twist.—The standard being 28's or finer, the following additions shall be made when coarser twist is woven in the following reeds :—

Below 28's to 20's in	64 to 67	reed inclusive,	1 per cent.
„ „	68 „ 71	„ „	2 „
„ „	72 „ 75	„ „	3 „
Below 20's to 14's in	56 „ 59	„ „	1 „
„ „	60 „ 63	„ „	2 „
„ „	64 „ 67	„ „	3 „

and so on at the same rate.

When twist is woven in coarser reeds no addition shall be made.

8. Weft.—*Ordinary Pin Cops.*—The standard being 31's to 100's, both inclusive, shall be reckoned equal. Above 100's 1 per cent. shall be added for every 10 hanks or fraction thereof.

In lower numbers than 31's the following additions shall be made :—

For	30's	add 1	per cent.
,,	29's, 28's,	add 2	per cent.
,,	27's, 26's,	,, 3	,,
,,	25's, 24's,	,, 4½	,,
,,	23's, 22's,	,, 6½	,,
,,	21's, 20's,	,, 8	,,
,,	19's, 18's,	,, 10½	,,
,,	17's, 16's,	,, 13	,,
,,	15's, 14's,	,, 16	,,

Large Cops.—When weft of the following counts is spun into large cops, so that there are not more than nineteen cops to the lb., the following additions shall be made in place of the allowance provided for pin cops in the preceding table :—

For	29's, 28's,	add 1	per cent.
,,	27's, 26's,	,, 2	,,
,,	25's, 24's, 23's,	,, 3	,,
,,	22's, 21's, 20's,	,, 4½	,,
,,	19's, 18's,	,, 6	,,
,,	17's, 16's,	,, 8	,,
,,	15's, 14's,	,, 10	,,

9. Four-stave Twills.—*Low Picks.*—In four-stave twills an addition of 1 per cent. for each pick or fraction thereof below the picks mentioned in the following table shall be made when using weft as follows :—

Below 26's, the addition shall begin at	13
26's to 39's, inclusive, ,, ,, ,,	14
40's and above, ,, ,, ,,	15

High Picks.—When using weft—

Below 26's, the addition for high picks shall begin at						21
26's to 39's, inclusive,	,,	,,	,,	,,	,,	22
40's and above,	,,	,,	,,	,,	,,	23

In making additions for high picks any fraction of a pick less than the half shall not have any allowance; exactly the half-pick shall have ½ per cent. added, and any fraction over the half shall have the full 1 per cent. added.

10. **Splits.**—The following additions shall be made for splits:—

One split uncut, add 5 per cent.
Two splits ,, ,, 7½ ,,

Empty dents shall not be considered splits.

11. All the foregoing additions and deductions shall be made separately.

This list is subject to a deduction of 10 per cent.

For fancy cloths the CHORLEY LIST, 1886, is the one most commonly used. This is as follows:—

Double-Lift Jacquards.—To be paid the following over plain cloth prices:—

For cloths with plain grounds, 30 per cent.
For cloths with satin grounds, 25 ,,

Brocades, damasks, and crammed stripes with three or more ends in a dent, to be paid for by the number of ends per inch.

Picks 18 to 30 per quarter inch, 1 per cent. per pick;

from 30 to 40 picks, $\frac{3}{4}$ per cent.; all above 40 picks, $\frac{1}{2}$ per cent. instead of 1 per cent.

Lace brocades, 5 per cent. extra.

Single-lift jacquards to be paid 10 per cent. about double-lift machines.

The above applies to Jacquards only.

Dobby and Tappet Looms (except Satins).—To be paid the following above plain cloth prices—

Up to and including—

4 staves	12 per cent.		13 staves	21 per cent.	
5 ,,	13 ,,		14 ,,	22 ,,	
6 ,,	14 ,,		15 ,,	23 ,,	
7 ,,	15 ,,		16 ,,	24 ,,	
8 ,,	16 ,,		17 ,,	25 ,,	
9 ,,	17 ,,		18 ,,	26 ,,	
10 ,,	18 ,,		19 ,,	27 ,,	
11 ,,	19 ,,		20 ,,	28 ,,	
12 ,,	20 ,,				

Stripes and other cloths with three or more ends in a dent to be paid for by the number of ends per inch.

In single-shuttle checks, handkerchiefs, and all special classes of goods in which more than one pick is put in one shed, all lost picks shall be counted.

Plain handkerchiefs, 72 reeds and below, to be paid 5 per cent. extra.

Single-shuttle cord checks with more than two picks in one shed to be paid $2\frac{1}{2}$ per cent. less.

Lace stripes and other special classes of goods shall be paid extra as per special arrangement to be agreed upon by Employers' and Operatives' Associations.

The following example will show the method of calculating the price to be paid for weaving under the Uniform List:—

Example.—Find the weaving price of a 44-inch cloth, 40 yards long, woven in a loom 48-inch reed space, 92 reed, 30 picks per quarter-inch, 40's twist, 60's weft.

2*d.* per pick standard	
·09	= 4½ per cent. added for reed space
2·09	
·3135	= 15 per cent. added for reed
2·4035	= price per pick, 100 yards, with standard picks
30	picks
72·1050	= price for 30 picks 100 yards
40	yards
100)2884·2000	
28·84200	= price for 40 yards
2·884200	= 10 per cent. added for high picks
31·726200	Total.

From this must be deducted 10 per cent., as per agreement, which will give 28·5535 pence as the actual price to be paid for weaving this piece of cloth.

The following example includes the allowance for narrow cloth woven in broad looms:—

Example.—Find the weaving price for 38-inch cloth woven in a 48-inch reed space loom, 50 reed, 507 dividend, 50 change wheel, 75 yards long, 32's twist, 36's weft.

2*d.* per pick standard	
0·9	= 4½ per cent. added for reed space
2·09	
·078375	= 3·75 per cent. deducted for reed
2·011625	= price per pick, 100 yards, 50 reed, 48-inch loom.

$$\frac{507}{50} = 10{\cdot}14 \text{ picks per quarter inch.}$$

$$\frac{2{\cdot}0116 \times 10{\cdot}14 \text{ picks} \times 75 \text{ yards}}{100 \text{ yards}}$$

= 15·283218	price for 75 yards
·152832	= 1 per cent. added for pick
15·436050	
·637508	= 4·13 per cent. deducted for narrow cloth
14·798542	= price per list
1·4798542	= 10 per cent. deduction
13·3186878	= net price.

In making the additions and deductions it is important that they should be made in the above order.

The Cost of a Piece of Cloth.—Besides the cost of material and the weaving wage, the expenses of the manufacturer must be taken into account. When a manufacturer makes only one kind of cloth, his expenses will obviously not be so proportionately great as another manufacturer's who only takes a single order of a particular make. The expenses also vary with the district and distance from the market, and with other circumstances.

A manufacturer knows from experience exactly what amount of expenses to allow in different classes of fabrics in his own case, and in quoting prices for plain or fancy cloths he usually includes under the term "expenses" all the items of cost from the carriage of the yarn to the delivery of the cloth, including winding, warping, sizing, waste, and other fixed expenses in the mill.

The expenses are usually calculated in proportion to the weaving wage, and a manufacturer quotes "double weaving" or "three times weaving," according to the class of fabric in question.

The following example will illustrate the principle of estimating the cost of a piece.

Find the cost of a piece, 34 inches full, 75 yards s.s. (short stick), 19 × 18, 32's/40's. Twist at 7*d.* per lb., weft at $7\frac{1}{2}$*d.* per lb.

Weaving 2*s.* Expenses equal to weaving.

The 34-inch cloth would stand, say, 36 inches in the reed. The 75-yards cloth, "short stick," or 36 inches to the yard, will require, say, 78 yards of warp.

A cloth counting 19 × 18, nominal, is usually woven in a 68 or 70 reed, and the picks per inch will be about 66 or 67 actually.

Assuming that the cloth stands 36 inches in a 70 reed, and the picks per inch are 67, we get—

$$\frac{36 \text{ inches} \times 78 \text{ yards} \times 70 \text{ reed} \times 7d.}{840 \times 32\text{'s}} = 51{\cdot}188d., \text{ cost of twist,}$$

and

$$\frac{36 \text{ inches} \times 75 \text{ yards} \times 67 \text{ picks} \times 7\tfrac{1}{2}d.}{840 \times 40\text{'s}} = 40{\cdot}38d., \text{ cost of weft.}$$

d.	
51·188	cost of twist
40·38	cost of weft
24·00	weaving wage
24·00	expenses
139·568	cost of piece = 11*s.* 7½*d.*

The amount allowed for expenses in the preceding example is perhaps sufficient for most cloths woven on dobbies, but more is required for jacquard-woven fabrics.

If 11*s.* 7½*d.* is quoted for the above cloth, the price is said to be based on "double weaving."

For jacquard fabrics the price is usually based on 2½ to 3 times weaving, and in special cases, such as new styles, an extra profit is put upon the 3-times weaving.

Sometimes the expenses are said to be 5 or 10 per cent. more than weaving. If the weaving wage were 2*s.* 6*d.*, and the expenses 10 per cent. more than weaving, the expenses would be 2*s.* 9*d.*

Contraction.—The length of warp required to weave a piece of a given length will vary with the pattern or weave of the cloth, and depends also on the elasticity of the yarn and the counts of both warp and weft. Owing to this difference in the elasticity of various classes of yarns, and the variation in the elasticity of the same yarn at different degrees of tension, it is impossible to lay down rules for the calculation of the exact warp length for a given length of piece, or for the exact width in the reed for a required width of piece. The length of warp required can only be obtained with exactness from experience, especially in fancy cloths.

As previously stated, twofold yarns are more elastic than single; indeed, with some kinds of twofold American yarns, such as are used in velvets, the percentage of contraction becomes less with an increase in the number of picks, owing to the increase of tension upon the yarn, which causes it to stretch more.

Roughly, the amount of contraction to allow in the warp can be obtained by taking into account the counts of weft and the number of intersections which the warp makes with the weft. The thicker the counts of weft the more the warp will be bent out of a straight line, also with an increase in the number of picks the amount of take-up or contraction will increase. This does not vary in a regular manner, as the angle which the warp makes in bending over the weft changes with any variation in the picks. Furthermore, the greater the tension on the warp yarn the more it will stretch, and also the more it will compress the weft at the point of intersection.

A rough estimate only can therefore be made if there is no previous experience in the same class of goods to guide the manufacturer.

A method of roughly estimating the percentage of milling-up of the warp is to multiply the intersections of the warp per inch by a number found by experience to give the right result, and to divide this product by the counts of weft used.

For rather heavily picked cloths the multiplier 4 gives a fairly accurate result, and in cloths with a medium number of picks and medium counts the multiplier 3 will be used. In some classes of goods the multiplier requires to be 5; but when a correct multiplier is found for a certain class of goods, it will serve for changes in that class. The system is certainly not accurate in all cases, but it embraces roughly the different causes which alter the percentage of contraction or milling-up in the warp, and is therefore of some use in practice.

Example.—Find the length of warp required to weave a piece of 5-stave satin 94 yards long (36 inches to the yard), 94 reed, 180 picks per inch, 60's twist, 70's weft.

The number of intersections per inch will be two-fifths of the number of picks, as the warp intersects twice every five picks or pattern.

$$\therefore\ 180 \times \tfrac{2}{5} = 72 \text{ intersections per inch};$$

$$\text{and} \qquad \frac{72 \times 4}{70\text{'s counts}} = 4 \text{ per cent. contraction.}$$

The length of warp required to weave the 94 yards piece would therefore, roughly, be 98 yards.

In a plain cloth the contraction is much more than in a satin, and the percentage is greater in heavily picked cloths than light ones.

In a plain cloth of, say, 120 picks per inch, 60's twist, 70's weft, the percentage of take-up will roughly be as follows :—

$$\begin{array}{lr} \text{Intersections per inch} = & 120 \\ & 4 \\ \hline & 70)480(6\tfrac{6}{7} \text{ per cent. contraction.} \\ & 420 \\ \hline & 60 \end{array}$$

In a plain cloth the warp intersects every pick, and so the intersections per inch are the same as the ends per inch. In a "two and two" twill the warp intersects twice in four picks, and the intersections per inch will be one-half the picks.

In more medium cloths the multiplier 3 is used; as, for example :—

Find percentage of contraction in a piece of plain cloth woven with 60 picks per inch, 32's twist, 40's weft.

$$\frac{60 \times 3}{40\text{'s counts}} = 4\tfrac{1}{2} \text{ per cent.}$$

In fancy cloths experience is the only guide as to the warp length required, but in striped cloths and similar fabrics woven from one beam the contraction of the whole will be that of the tightest weave in the pattern.

In a fabric in which there are only a *few* plain ends in the pattern, the other ends being loosely interwoven, it does not follow that the take-up will be as much as in a plain cloth, as the plain ends will compress the weft more at the point of intersection than could occur if *all* the ends were weaving plain.

Testing Yarn.—It often occurs that only a short length of yarn is available for being weighted when it is required to test it for the counts. If it is required to test the weft in a piece of grey cloth it is usual to take out of the cloth 120 yards, or one "lea." This is one-seventh of a hank, and therefore if the weight of 120 yards is divided into 1,000 grains—the one-seventh part of a pound—the quotient will be the counts of the yarn. The reason of this will be obvious when it is remembered that if the weight of one hank is divided into 7000 grains, or 1 lb., the result is the number of hanks in 1 lb., or the counts.

The counts are based upon the number of hanks in 1 lb. avoirdupois, and as this weight is not suitable for weighing small quantities, it is necessary to weigh them in Troy weight. As nearly as possible 7000 grains Troy = 1 lb. avoirdupois.

Example.—If 120 yards of cotton weft weighs 20 grains, what counts is it?

$$\frac{1000}{20 \text{ grains}} = 50\text{'s counts.}$$

If it is required to know the number of grains which 120 yards of any count should weigh, the method of procedure is the reverse of the foregoing.

Example.—How many grains should 120 yards of 40's yarn weigh?

$$\frac{1000 \text{ grains}}{40\text{'s counts}} = 25 \text{ grains.}$$

When testing the counts of cops, it is usual to wrap two, three, or four cops, in order to arrive at a more satisfactory test.

If two leas, or two-sevenths of a hank, are weighed, the counts can be obtained by dividing the weight into 2000 grains, or two-sevenths of 1 lb. If three leas, or 360 yards, are weighed, divide the weight into 3000 grains, and the result is the counts. If 480 yards are weighed, the dividend is 4000; if 600 yards, or five leas, are weighed, the dividend will be 5000; if six leas, or 720 yards, are weighed, the dividend is 6000; and when seven leas, or one hank, is weighed, the dividend will be 7000 grains, or 1 lb.

As it takes a considerable time to take 120 yards of weft out of a piece, a shorter length is often weighed and the counts found therefrom. A balance is extensively used which registers the counts when twenty yards of yarn are put upon the pointer. This is a very useful, though not always accurate, method.

When any odd length of yarn is weighed, the counts may be obtained by proportion, thus—

If 34 yards of yarn have been found to weigh 8 grains, what count is it?

The yards in 1 lb. can first be found as follows:—

$$\begin{array}{ccccc} \text{grains} & & \text{grains} & & \text{yards} \\ 8 & : & 7000 & :: & 34 \end{array}$$

$$\begin{array}{r} 34 \\ \hline 8)\overline{238000} \\ \hline 29750 \end{array} \text{ yards in 1 lb.;}$$

and this divided by 840 will give the counts, thus:—

$$\frac{29750}{840} = 35{\cdot}41 \text{ counts.}$$

From this we get the formula :—

$$\frac{7000 \times \text{yards weighed}}{840 \times \text{counts}} = \text{counts.}$$

This is a very useful formula, as when only a small piece of cloth is available to be tested it is necessary to get as near as possible to the counts from weighing sometimes only 10 or 15 yards, or any odd length.

A calculation may occur in the following form :—

How many grains should 16 yards of 20's cotton weigh ?

There are $840 \times 20 = 16{,}800$ yards of 20's in 1 lb., or 7000 grains.

Then if 16,800 yards weigh 7000 grains, how many grains will 16 yards weigh ?

$$\overset{\text{yards}}{16800} \; : \; \overset{\text{yards}}{16} \; :: \; \overset{\text{grains}}{7000} \; : \; 6{\cdot}6 \text{ grains.}$$

This may be stated in a formula as follows :—

$$\frac{7000 \times \text{yards weighed}}{840 \times \text{counts}} = \text{weight in grains.}$$

Staub's Yarn Balance is a small balance which is made to test the counts of very small quantities of yarn. A template is given with the balance, and the yarn is cut into lengths the size of the template, about two inches. One end of the balance is slightly heavier than the other, and the number of threads the size of the template which are required to draw the balance indicate the counts of the yarn. If twenty threads or about 40 inches balance the small weight, the count of the yarn is 20's, and so on.

The principle is the same as if a 1 lb. weight were put on one end of a balance, in which case the number of hanks required to draw the weight would indicate the counts, because if 20 hanks = 1 lb. the counts are 20's, and if 21 hanks

= 1 lb. the counts are 21's. The balance may be made to weigh any length, according to the weight on one end of the balance.

The form in which it is usually made makes it specially suitable for testing the counts in small patterns of a few inches.

The test is, of course, only approximate, as could only be expected from weighing so short a length.

If the foregoing examples are thoroughly understood, the following will not be found difficult.

If a warp has 2000 ends, and is 500 yards long, and weighs 60 lbs., what counts is it?

The ends multiplied by the length will give the total length of yarn in the warp, and this divided by 840 will give the hanks. If the hanks are divided by the weight, the result will be the counts.

The result may be obtained at once as follows:—

$$\frac{2000 \times 500}{840 \times 60} = 19{\cdot}84 \text{ counts.}$$

If a beam has 2200 ends, the counts being 40's, and the weight 50 lbs., find the length.

By multiplying 40 by 840 the yards in 1 lb. are obtained, and multiplying this by 50, the yards of yarn on the beam are arrived at. If this is divided by the ends in the warp, the result will be the length of warp thus:—

$$\frac{40 \times 840 \times 50}{2200} = 763{\cdot}6 \text{ yards.}$$

A simple method of mentally calculating the number of hanks in a piece is as follows:—

A warp 84 yards long will contain just one-tenth as many hanks as ends. Thus a warp of 2000 ends, 84 yards long, contains 200 hanks. This can be proved as follows:—

$$\frac{2000 \times 84}{840} = 200 \text{ hanks.}$$

The number of hanks in a warp 84 yards long can thus be seen at once, and it is a very simple matter to mentally calculate the difference for any other length.

The hanks of weft can also be calculated mentally in a similar manner.

If the piece is 84 yards, the counts multiplied by the width and divided by 10 will give the number of hanks required for 84 yards. Thus, find the hanks of weft in a piece 34 inches wide, 84 yards long, 60 picks per inch.

$$\frac{60 \times 34}{10} = 204 \text{ hanks.}$$

The calculation is really simpler than it looks in the above form, as the dividing by 10 can be done by simply pointing off the last figure in the product of the picks and width. The formula may be proved correct by working out fully as follows :—

$$\frac{34 \times 84 \times 60}{840} = 204 \text{ hanks.}$$

This system of mentally calculating the hanks is very useful, as it serves as a check upon a full calculation.

The Firmness of Cloth.—The number of ends and picks per inch which can advantageously be put into a fabric depends upon the number of intersections per inch in the pattern or weave, and on the counts or diameters of the yarns used. In a plain cloth woven with 32's twist and 32's weft, the number of threads per inch which could be put into the cloth without undue compression would be a little more than one-half the number which could be laid side by side touching each other. The reason for this is that the warp and weft threads interlace with each other every pick, and therefore, supposing that 156 threads of 32's occupy one inch when laid side by side, one-half of these threads would have to be left out to allow of the intersection of the weft between every end.

In a "two and two" twill the weft intersects once for every two ends, or twice in the pattern; therefore there are four threads and two intersections in the pattern. It is obvious, therefore, that to keep the same firmness in the twill as in the plain cloth with the same yarns, a larger number of threads per inch both in warp and weft will be required.

To keep the same "firmness" the threads must be kept as close together in one cloth as in the other, and as in a plain cloth one-half the threads which occupy one inch are dropped out, so in a twill with two intersections for four ends there must be one-third of the ends occupying one inch left out. Thus with 32's yarn, of which the diameter is $\frac{1}{156}$ of an inch, there will require to be about 102 threads per inch in a "two and two" twill.

A perfectly balanced plain cloth may be defined as a cloth in which the warp and weft yarns are equal in diameter, and the spaces between the threads are equal to the diameter of the yarn.

If the diameters of yarns of various counts are known, it is an easy matter to find the number of threads per inch which will produce the desired firmness in any simple weave.

The diameters of yarns of cotton, woollen, worsted, and other threads are given by the late Mr. T. R. Ashenhurst in an excellent little work on "Textile Calculations and the Structure of Fabrics," which has done much to promote this branch of the art of weaving.

Mr. Ashenhurst estimates the diameter of a 32's cotton yarn at the $\frac{1}{148}$th part of an inch; but this is probably somewhat under the mark, and in the following table I have taken $\frac{1}{156}$th inch as the diameter of 32's.

The variation in the thickness of any yarn, and the fact that they are not strictly cylindrical, renders measurements of little avail, but taken in conjunction with an examination of a range of woven cloths, the approximate or practical diameter can be estimated.

TABLE OF DIAMETERS OF COTTON YARNS.

Counts.	Diameter.	Counts.	Diameter.	Counts.	Diameter.
1	27½	28	145½	80	246
2	39	30	151	82	249
3	47½	32	156	84	252
4	55½	34	160½	86	256½
5	62	36	165	88	258½
6	67½	38	169	90	261
7	73	40	174½	92	264
8	78	42	178	94	267
9	83½	44	183	96	270
10	87½	46	187	98	272½
11	91	48	191	100	275½
12	95	50	195	105	282
13	99	52	198½	110	289
14	103	54	202½	115	295½
15	106½	56	206	120	202
16	110	58	210	125	308
17	113	60	213	130	314
18	117	62	216½	135	320
19	120	64	220½	140	326
20	123½	66	224	145	331½
21	126	68	227	150	337
22	129½	70	230½	160	349
23	132	72	233½	170	359
24	135	74	237	180	369
25	138	76	240½	190	380
26	140½	78	243	200	390

The preceding is a table of the diameters of cotton yarns from 1's counts to 200's. The number given as the diameter is the number of threads which occupy the space of one inch when laid as close together as possible without compression.

A perfectly balanced plain cloth will require one-half this number of threads per inch, plus, perhaps, 5 per cent. for the threads being forced somewhat out of the same plane in weaving.

Relative Diameters of Yarns.—The "counts" of yarns indicate the number of hanks in 1 lb., and therefore a given length of 30's is twice as heavy as the same length of 60's; but the diameter of the 30's will not be twice that of the 60's, as the yarns are cylindrical, and the diameters will vary as the square roots of the areas, which in this case are as 1 : 2.

If one thread is four times as heavy as another, and if it is of the same *density*—which in these calculations is assumed, although it is not strictly correct—the diameters of the two threads will be as 2 : 1. For example, looking at the tables, the diameter of a 60's is seen to be the $\frac{1}{213}$ of an inch, whilst the diameter of a thread four times the weight, viz. 15's, is seen to be $\frac{1}{106\frac{1}{2}}$ of an inch, or exactly twice the diameter of the 60's thread.

The diameter of one yarn being known, the diameter of any other may be obtained by the following rule:—

RULE.—As the square root of one count is to the square root of another count, so is the diameter of one to the diameter of the other.

Example.—If the diameter of a 16's yarn is the $\frac{1}{110}$th part of an inch, find the diameter of a 36's.

$$\sqrt{16} : \sqrt{36} :: 110$$
$$4 : 6 :: 110 : 165 \quad \textit{Ans.}$$

In this form the calculation necessitates the extraction of two square roots, and with most numbers would require the use of two fractions in the calculation. By squaring all the three terms the calculation is much simpler, as in the following example:—

Example.—If the diameter of a 32's is the $\frac{1}{156}$ of an inch, what is the diameter of a 50's?

$$
\begin{array}{l}
32\text{'s} : 50\text{'s} :: 156^2 : x^2 \\
\text{or } 32 : 50 :: 24336 : x^2 \\
\qquad\qquad\qquad\qquad 50 \\
\hline
32)1216800(38025 \\
\quad 96 \\
\quad 256 \\
\quad 256 \\
\qquad 80 \\
\qquad 64 \\
\qquad 160 \\
\qquad 160
\end{array}
$$

and $\sqrt{38025} = 195$ *Ans.*

As the diameters of yarns vary as the square root of their counts, it follows that the diameters will always bear a certain relation to the yards in 1 lb. If this relation is once obtained, it becomes easy to calculate the diameter of any yarn on this principle.

Taking the diameter of a 32's yarn from the table, viz. 156, it will be found that this is equal to the square root of the yards in 1 lb., less 5 per cent.

Example.

$$
\begin{array}{r}
840 \\
32 \\
\hline
1680 \\
2520 \\
\hline
26880
\end{array}
\text{ yds. in 1 lb. of 32's.}
$$

$$
\begin{array}{rl}
\sqrt{26880} = & 164 \\
& 8 = 5 \text{ per cent.} \\
\hline
& 156 = \text{diameter of 32's.}
\end{array}
$$

The number of ends and picks per inch required to make plain cloths of equal firmness from different counts may be at once seen from the table of diameters, as one-half the number given as the diameter is required.

Thus if a plain cloth with 78 threads per inch of 32's is taken as the standard, and it is required to make a cloth of equal firmness, with 60's yarns, the number of threads per inch required would be $106\frac{1}{2}$. In 20's yarns about 62 threads would be required. In 16's yarns 55 threads per inch, and so on.

In twills, or other regular weaves, the following rule will give the number of threads per inch required of any count:—

RULE.—As the sum of the ends and intersections in the pattern is to the ends, so is the diameter to the number of threads required.

Example 1.—How many threads per inch are required to make a perfectly balanced "2 and 1" twill cloth, with 24 yarns, warp and weft?

There are 3 ends and 2 intersections in the pattern; therefore

$$3 \text{ ends} + 2 \text{ intersections} = 5;$$
$$\text{and as } 5 : 3 \text{ ends} :: 135 \text{ diameter} : x$$

$$\begin{array}{r} 3 \\ \hline 5)405 \\ \hline 81 \end{array} \text{ threads per inch required.}$$

Example 2.—How many threads per inch are required to make a perfectly balanced "3 up, 2 down, 2 up, 2 down twill" with 44's yarns?

In this pattern there are 9 ends and 4 intersections; therefore

$$\text{as } 9 + 4 : 9 :: 183 \text{ diameter of 44's} : x$$
$$\text{or, as } 13 : 9 :: 183$$

$$\begin{array}{r} 9 \\ \hline 13)1647(126 \\ 13 \\ \hline 34 \\ 26 \\ \hline 87 \\ 78 \\ \hline 9 \end{array} \text{ threads per inch required}$$

One of the most useful purposes to which a knowledge of this principle can be put is in changing the weave of a fabric, to find the threads per inch of a given count of yarn required to keep the same firmness as in a sample cloth.

It must be remembered that the word "firmness" is here used as implying that the space between the threads bears the same relation to the diameters of the threads in both cases, or, if the given cloth is perfect, the proposed one will also be perfect.

Suppose it is desired to make a "two and two" twill of the same "firmness" as a plain cloth made with 103 threads per inch.

The yarns being the same, the number of threads per inch required will be as the ends plus intersections in a given number of ends in both patterns.

In the above question the given cloth is plain, with 103 threads per inch, and the proposed cloth is a "two and two" twill. Taking the same number of threads in each case, we get—

	Ends + Intersections in proposed twill cloth.		Ends + Intersections in given plain cloth.				
	$4 + 2$	:	$4 + 4$	: :	103	:	x
or	6	:	8	: :	103		
					8		
					6)824		

Ends required in twill cloth $= 137\frac{1}{3}$

It must not be forgotten that it is necessary to take an equal number of ends of each pattern in this class of calculation. In more complex patterns it is often advisable to take the number of ends which is the L.C.M. of the ends in the two patterns in order to get a complete number of intersections in each case.

Another Example.—If a "two and two" twill cloth is made with 137 threads per inch, and it is proposed to make a cloth with the same counts of yarns in a "5 up, 2 down, 1 up, 2 down" twill, how many threads per inch are required to keep the same firmness?

In 40 ends of the proposed cloth there are 16 intersections, and in 40 ends of the sample cloth there are 20 intersections.

Then as $40 + 16 : 40 + 20 :: 137$
or $\quad 56 : 60 :: 137$

$$\begin{array}{r} 137 \\ 60 \\ \hline 56)8220(146{\cdot}8 \text{ threads. } \textit{Ans.} \\ 56 \\ \hline 262 \\ 224 \\ \hline 380 \\ 336 \\ \hline 440 \end{array}$$

If it is required to make a cloth with the same number of threads as a sample cloth, and to change the pattern and keep the same firmness, it is necessary to change the counts on the following principle :—

RULE.—As the sum of the ends and intersections in the sample cloth is to the sum of the ends and intersections in the proposed cloth, so is the square root of the counts in the sample to the square root of the counts in the proposed cloth.

Example.—If a plain cloth has been made with 36's yarns, and it is proposed to make a "two and two" twill with the same number of threads per inch, find the counts required to keep the same "firmness."

	Ends + Inters. in sample cloth.		Ends + Inters. in proposed cloth.				
or	$4 + 4$	:	$4 + 2$	::	$\sqrt{36}$	:	$\sqrt{x}$
	8	:	6	::	6	:	

$$\begin{array}{r} 6 \\ 6 \\ \hline 8)36 \\ \hline 4\frac{1}{2} \end{array}$$

And $4\frac{1}{2}^2 = 20{\cdot}25$ counts required.

This may be proved correct by referring to the table of diameters on page 315, where it will be seen that a plain cloth with $82\frac{1}{2}$ threads per inch of 36's is "perfect," and a "two and two" twill with $82\frac{1}{2}$ threads of $20\frac{1}{4}$'s counts is equally perfect.

To change the Counts, the pattern and threads per inch remaining the same.

If a sample cloth has 78 threads per inch of 32's yarn, and it is proposed to make a cloth of the same weave with 55 threads per inch, what counts of yarn are required to keep the same "firmness"?

This is simple enough. The diameters of yarns vary as the square root of their counts, and therefore as the threads in one cloth are to the threads in another, so will the square root of the counts in one be to the square root of the counts in the other.

Threads in sample.		Threads in proposed cloth.		Counts in sample.		
78	:	55	::	$\sqrt{32}$	:	$\sqrt{x}$
or as 78^2	:	55^2	::	32		
6084	:	3025	::	32		

$$\begin{array}{r} 3025 \\ 32 \\ \hline 6050 \\ 9075 \\ \hline \end{array}$$

6084)96800(15·91, or 16's nearly = counts required
6084
35960

On referring to the table of diameters (p. 315), it will be found that a plain cloth with 78 threads of 32's is "perfect," and that a plain cloth with 55 threads of 16's is also perfect. Therefore the above calculation is correct.

To change the Threads per Inch, the counts and pattern remaining the same.

If a sample has 78 threads per inch of 32's, and it is proposed to weave a cloth of the same pattern, but with 60's yarns, find the number of threads per inch required to keep the same firmness.

This is simply a continuation of the previous statement.

If the two counts are known, the number of threads will vary as the square roots of the counts; thus—

Counts in sample.		Counts in proposed cloth.		Threads in sample.		
$\sqrt{32}$	:	$\sqrt{60}$	::	78	:	x
or as 32	:	60	::	78^2	:	x^2

$$\begin{array}{r} 6084 \\ 60 \\ \hline 32)365040 \\ \hline 11407\frac{1}{2} \end{array}$$

$$\sqrt{11407} = 106{\cdot}8 \text{ threads required.}$$

The above may be proved correct by referring to the table of diameters. A plain cloth with 78 threads per inch of 32's is "perfect," and so is a plain cloth with $106\frac{1}{2}$ threads per inch of 60's.

The same principle must be employed if the warp and weft are of different counts, or if the threads per inch are not equal in warp and weft.

Example.—A sample cloth is made with 78 ends per inch of 32's and 91 picks per inch of 44's. How many picks will be required to keep the same firmness, if the weft only is changed to 60's?

Counts in sample.		Counts in proposed cloth.				
$\sqrt{44}$	:	$\sqrt{60}$	::	91	:	x
or as 44	:	60	::	91^2	:	x^2

$$\begin{array}{r} 8281 \\ 60 \\ \hline 44)496860 \\ \hline 11292 = x^2 \end{array}$$

and $\sqrt{11292} = 106\frac{1}{2}$ $\therefore$ picks per inch required $= 106\frac{1}{2}$

One advantage gained by a knowledge of the principle of cloth "balance" is that the number of picks per inch which a given pattern or weave will take can easily be obtained by calculation. This is of great advantage to designers for Jacquard weaving, as it often occurs that a design is made and the cards cut for a pattern which will not admit of the required number of picks of the given counts being put in the cloth, which a slight alteration in the ground weave would have rendered possible.

To alter the Weight.—If the weight of a cloth is required to be altered, and the same firmness kept, the threads per inch and counts can be found on the same principle.

If a cloth is made heavier it must be done by using *coarser* yarns and *fewer* threads; it cannot be done by using more threads, and preserve the same "firmness" or "perfection."

Suppose a sample piece of cloth weighing 10 lbs. is made with 93 threads of 45's, and it is proposed to make a piece of the same length and width, but weighing 15 lbs. To find the threads per inch and counts of yarn to keep the same firmness.

The weights of two cloths will vary as the square roots of the counts if they are of the same perfection.

Therefore—

Weight of proposed cloth.		Weight of sample.				
As 15 lbs.	:	10 lbs.	::	$\sqrt{45}$	:	$\sqrt{x}$ counts
or 15^2	:	10^2	::	45 to x		
225	:	100	::	45		

$$
\begin{array}{r}
45 \\
100 \\
\hline
225)4500(20\text{'s counts required} \\
450 \\
\hline
0
\end{array}
$$

To find the threads per inch required of the above counts—

Weight of proposed cloth.		Weight of sample.		
15	:	10	::	93

$$\begin{array}{r} 93 \\ 10 \\ \hline 15)930(62 \text{ threads required.} \\ 90 \\ \hline 30 \\ 30 \\ \hline \end{array}$$

Then to make a piece of the same perfection or firmness as the sample piece, and to alter the weight from 10 lbs. to 15 lbs., the counts must be changed from 45's to 20's, and the threads per inch from 93 to 62.

To prove this is correct take a piece 20 inches wide, 102 yards long, 93 threads per inch both in warp and weft of 45's yarns.

The weight of this sample piece will be—

$$\frac{20 \times 102 \times 93}{840 \times 45} = 5 \text{ lbs. of twist};$$

and as there is the same weight of weft, the total weight of the piece will be 10 lbs.

Now calculate the weight of a piece of the same length and width with 62 threads per inch of 20's yarns:—

$$\frac{20 \times 102 \times 62}{840 \times 20} = 7\tfrac{1}{2} \text{ lbs. of twist};$$

and with the same quantity of weft, the total weight of the piece will be 15 lbs.

This proves the calculation to be correct so far as altering the weight goes.

To see if both cloths are of the same firmness, the table of diameters may be referred to. It will there be seen that a plain cloth with 93 threads per inch of 45's yarn is "perfect," and also that the altered cloth with 62 threads of 20's is equally perfect.

It thus proves the principle of the calculation to be correct.

A lighter cloth may be made, and the same firmness kept. The formula is the same in both cases. If a cloth is made lighter it must be done by using finer counts and more threads. It cannot be done by using fewer threads, as the firmness could not be kept and the required weight obtained.

In altering the weights of cloths some allowance would have to be made for the difference in milling-up with different counts of yarns and numbers of threads. If a cloth is made heavier, thicker yarns would be used, and the warp length to give a certain length of piece would be different in the sample to the altered cloth. But this is a comparatively small matter, which can be adjusted with a slight alteration in the basis of the structure.

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THE END

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