first. In Fig. 55 the reverse is the case, the cross-rows, as shown, being the first filled; this is owing to the twist in the harness, as the machine is sitting so that the cards will hang over the side of the loom. The letters A, B, C, and D in both figures denote the same corners of the machines, showing that in Fig. 55 there is a quarter twist in the harness. In Fig. 54, the dotted lines from the 200th hook show the

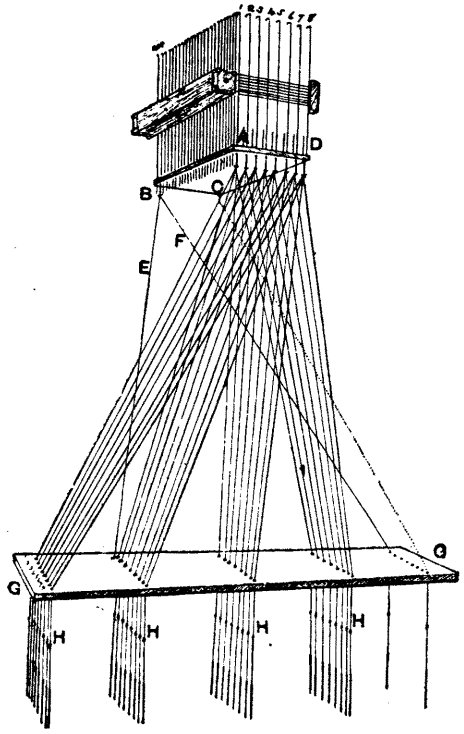


FIG. 55

last cord of each repeat; L is the first cord of the last cross-row, and E and F are the same in Fig. 55. In these figures only the skeleton of the mounting is given; it must, of course, be filled up as the first rows which are given.

For this description of mounting the yarn is drawn into the mails in regular order, beginning at No. 1, and proceeding with the numbers

as given. In this case the back hook to the left-hand corner must be taken as the first hook of the machine, and the cards cut to suit this. Sometimes the first hook to the front left-hand corner is considered the first hook, but if so it must be remembered when cutting the cards. Sometimes the mounting is begun at the right-hand side, but in any case it is only necessary to see that the draft of the yarn and cutting of the cards correspond with the order of mounting; the result of the work should be the same in all cases.

Fig. 56 shows a pattern for a gathered border with a repeating centre, which is a very common style of design. It will be seen that the two halves of the border, A and B, are alike, if taken from the centre outwards; or if one-half of the border were traced on tracing paper, it would, if turned over, form the other half. For this reason it is also called a 'turn-over' border. In the same way, if two cords are tied to each hook of the jacquard for the border, and those to the first hook taken down to the cumber board for the two outside threads of the border (that is, one to the right and the other to the left), then those from the next hook taken to the two next outer holes, and so on, coming from the outsides to the centre, the first half of the pattern would be repeated by the mounting in exactly the same way as by turning over the tracing paper.

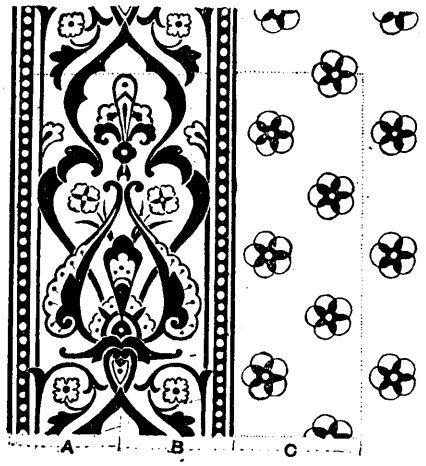


FIG. 56

Fig. 57 shows a mounting for a gathered border and four repeats of the centre. Eighty hooks are taken for the border, which are repeated four times in the cumber board, as at 80*a*, 80*b*, 80*c*, and 80*d*, and 120 hooks are allowed for the centre repeat (see also Fig. 58). This mounting is made up for a 200 machine with 208 hooks, the extra

eight hooks being left for working the selvages. Only the front row of the harness is shown, but they are all alike. By following the cords from the hooks to the cumber board, it can be easily seen how they are taken through it. The first eight hooks are left idle, for the selvage to be fixed to if required. The next ten rows = 80 hooks, are for the

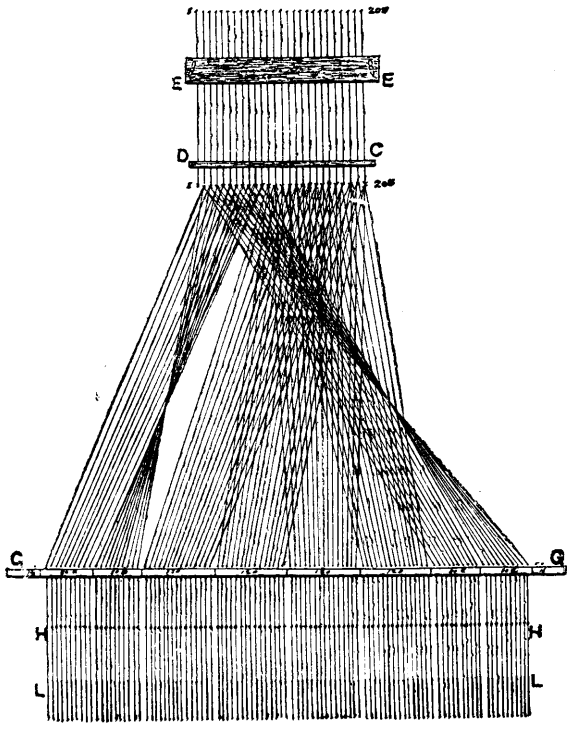


FIG. 57

border; these 80 hooks, with one twine on each, taken down through the cumber board at 80*a*, would work the first half of the border, as A. The other half of the border, B, can be wrought by the same hooks, with another set of twines tied to them, and taken through the cumber board at 80*b*; but the twine from the first hook must be crossed over to the right-hand side of the border, being the 160th twine in the cumber board; the twine from the second hook is the 159th in the cumber

board, and so on, coming in towards the centre to meet the first set of twines; hence the name, 'centred tie.'

The border must also be repeated on the other side, and two more sets of twines must be tied to the same hooks (four to each hook in all), which are taken down through the cumber board at 80*c* and 80*d*, to work the two halves of the border marked G and H, Fig. 58. The next 15 rows of hooks = 120, work the repeat of the centre pattern, C, Figs. 56 and 58; and as this is repeated four times, at C, D, E, and F, Fig. 58, there must be four twines tied to each of the 120 hooks, which are taken down through the four divisions of the cumber board marked 120; one twine from each hook being taken through each division, beginning at the left and working to the right side, alike in them all, as this portion is a simple repeating tie. Fig. 58 gives a portion of the pattern in Fig. 56 completed across, as it would be on the cloth by the mounting in Fig. 57; the cumber board is laid across the top of the pattern and marked, showing, in conjunction with the mounting, Fig. 57, how the harness repeats the pattern so that a large surface can be figured with a small machine by adopting a suitable tie.

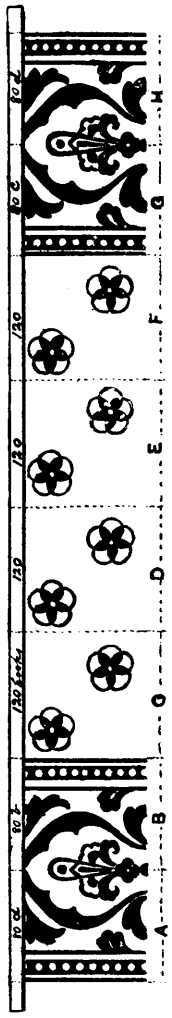


Fig. 58

When drawing the warp into the harness, wherever there is a gather in the tie, or a turn in the harness, there must be a turn in the draft also; not that there is any real change in the draft, but when the harness is turned in the direction it is drawn through the cumber board, the draft must also be changed to follow the mails in regular order. Fig. 59 shows a draft for a gathered border, with 48 hooks for the border and three repeats of the centre. It will be seen that the first half of both borders A and B and the three repeats of the centre are drawn in the same direction, but that the two turned-

over portions of the borders C and D are drawn in the reverse direction. The numbers on Figs. 62 and 62A may assist in explaining this, the border A in 62 and B in 62A being taken; in these it will be seen from

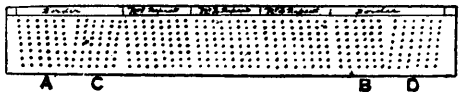


FIG. 59

the numbers, which are those of the harness twines, that 1 to 8 in border A (Fig. 62) run in the reverse direction of 1 to 8 in border A (62A), and both are from the same hooks.

When two borders are to be woven on any piece of cloth, though the pattern for each border may be single in itself, as Fig. 60 (which is single except the two outlying lines, A and C), they will to each other

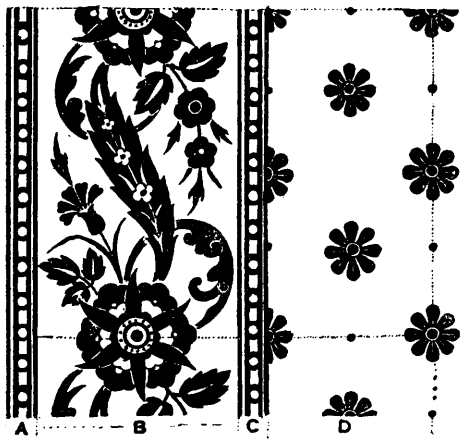


FIG. 60

form a gathered tie, provided they have to be turned in the same way to the centre of the cloth—that is, if the inside of one border on one side is to be the inside of the other border on the other side. In such a pattern as Fig. 60 it would not matter much if the inside of one border was the outside of the other, as the border is much alike either way, and if wrought in this way the twill on the cloth would not be reversed, as is always the case in a turned-over border. In many

patterns this would not do, and it is therefore necessary to gather the tie and turn the twill. Fig. 61 shows how, in the London style of tying, the harness can be turned so that a turn in the draft is not necessary, but this will not alter the reverse twill on the cloth. It will be seen that one of each of the two cords tied to the eight hooks goes to one border, and the other to the opposite border, but instead of both going to the same row of the cumber board, the cord from the first hook goes to the back row in one border, and to the front row in the other. All the cords follow in this way, which has the same effect as turning the draft, as would require to be done in the Norwich mountings, and could also be done on this principle. Fig. 62 shows the draft of the two borders for Fig. 61 mounting, A and B being a plan of the warp passing through the mails.

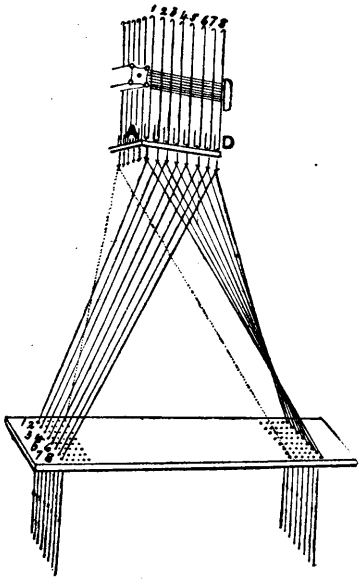


FIG. 61

The numbers refer to the hooks of the jacquard. C and D are the two innermost threads of the borders, both on the 48th hook of the machine. Fig. 62A shows how the draft would be if the cords were not brought

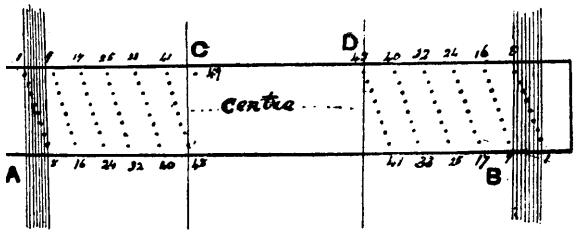


FIG. 62

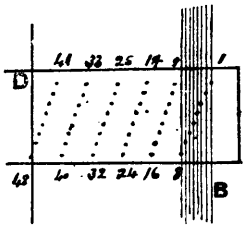


FIG. 62A

from front to back of the cumber board, as the numbers will show. No. 1 shows where the cords from the first hook pass through the

cumber board. Fig. 62A gives the right-hand border only, the left-hand one remaining the same as in Fig. 62.

In Fig. 60, the two bars A and C could be wrought from the same hooks, and, unless they might be required to be different from each

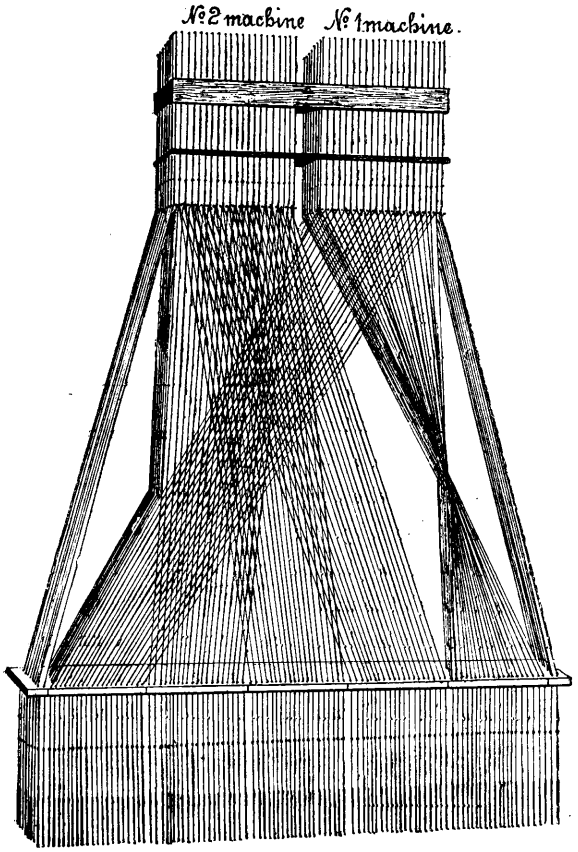


FIG. 63

other on another pattern to work on the same loom, it would be unnecessary to allow machinery for the two; either the outer or inner one could be tied up, and the other repeated from it, but the one that is tied up must be painted on the design paper.

Fig. 63 shows the front view of a mounting for weaving a pattern

such as that given on Fig. 60, one machine being used for the border, and another for the centre. Usually the border machine would be to the left-hand side, to correspond with the pattern; but in Fig. 63 it will be observed that No. 1 machine is to the right-hand side, and that it works the borders. It does not matter which machine is used for border or centre; the mounter can use the one he considers most suitable for the borders, and the pattern may be painted and the cards cut without any consideration of this, it being only necessary to put the border cards to the border machine, and those for the centre to the centre machine. The only consideration is to avoid any unnecessary slanting of the harness twines, which the present arrangement does; and it also keeps the turned portion of the harness (that for the right-hand border) separate from the twines of the centre, thus avoiding any unnecessary friction.

TO MARK OUT A CUMBER BOARD

Cumber boards may be either the exact fineness of the harness, or any set finer; they are better to be a little finer, to allow for any broken rows at the beginning or end of any of the repeats. When the cumber board is finer than the harness, the surplus rows are left idle. A convenient plan of marking off a cumber board is as follows:—Let the pattern be as Fig. 60—that is, with a border at

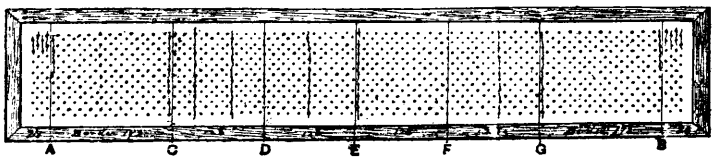


Fig. 64

each side and the centre to be repeated several times to make up the width of the cloth. Let 24 cords be required for the selvage, 172 cords for the border, and 128 for a repeat of the centre; there are to be four repeats of the centre. Now mark off on the cumber board whatever width the harness is to stand, which should be the same or rather wider than the warp occupies in the reed, and let it be so as to have the harness in the centre of the loom. Suppose Fig. 64 to give

the width of cumber board required. The selvages are wrought from 6 hooks, and there are 8 hooks in each row of a 400 jacquard; therefore 4 rows of the cumber board will be required for each selvage. Mark these off by drawing the lines A and B on the cumber board. Now find out the width the borders are each to occupy, by calculating how wide the yarn will be in the reed, and mark them off by the lines C and G; then mark off the width of each repeat by the lines D, E, and F. Counting the number of holes marked off for the margin, it will be found that there are 32; but as the selvage is on six hooks, the two back holes of each row of the cumber board are marked out, as shown, not being required. The portion marked off for the borders contains 23 rows on each side, whereas only $21\frac{1}{2}$ are required for 172 cords. As the centre repeat is on even rows, and it is usual to leave broken rows to the left-hand side of the painting, the first 4 hooks of the border portion of the machine will be idle; therefore the 4 back holes of the cumber board for both borders are marked out; this still leaves a row too much, which may be marked out at any place. For the repeats, 128 cords, 16 rows are required, and the surplus rows are marked out, as shown. This mounting is supposed to be on a 400 machine, leaving 100 hooks idle to the left-hand side of the mounting, then using 1 row for the selvages, and the remaining 38 rows for the pattern, all but the half of the first row, which is not required.

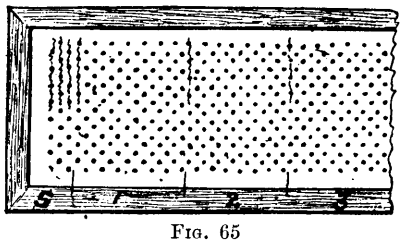


FIG. 65

In marking out a cumber board for a lay-over, or repeating pattern—if, say, 108 hooks are required for each repeat, which makes $13\frac{1}{2}$ rows of an 8-row machine—if the broken row is to the left-hand side of the painting, and the harness mounted from left to right, then the first four holes of the first row of each repeat of the pattern are marked out in the cumber board to be left empty, as shown in Fig. 65. When mounting, no attention would be paid to the cords on the half-row of the machine till the first four rows along the cumber board have been filled, the mounter beginning

with the back cord on the first full row of the machine, which is the fifth hook of the tie. Three rows for the selvage, which is on four hooks at the front of the harness, are shown at s, Fig. 65.

The front of a jacquard is generally considered by workmen to be the cylinder side. Of course, when there is a cylinder on each side there is neither front nor back to it. Sometimes it is very confusing talking of the front and back, one considering it to mean the front of the harness, or front of the loom, and another taking it to be the front or cylinder side of the jacquard, which is usually at the back of the loom for Norwich ties. Of course, the front of the loom is where the weaver stands, or where the cloth is made, and the front of the harness is towards the front of the loom. It simplifies matters greatly by not minding the back or front of the machine, but speaking of every part of the harness, &c., towards the front of the loom as the front of it.

It frequently happens that figured stripes are required, running up plain or fancy textured goods, either forming borders to the outer edges, or merely ornamental stripes, say 3 or 4 inches from the edges of the cloth, as in towels, toilet-covers, &c. For this class of work it is generally most advisable to work the stripes with a small jacquard, and the plain or fancy texture of the body of the cloth with a shaft mounting. Fig. 66 shows a mounting of this class; the shafts can be wrought by tappets in the usual way, and small cumber boards, as A, A^1, are fastened to the top rail of the loom for the harness to pass through. It is usual to keep the harness behind the heddles, and it is levelled in the usual way. The yarn may or may not be on the same beam for both portions, according to whether the take-up, or shrinkage, will be the same for both portions or not. Sometimes the

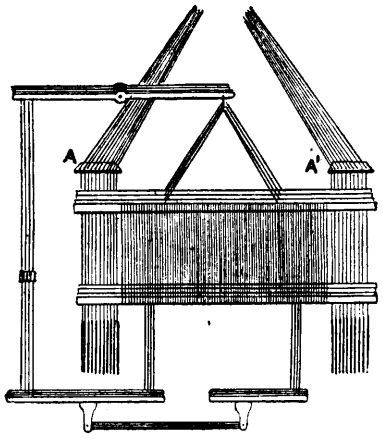


FIG. 66

shrinkage may be regulated to be alike in both by using different counts of yarn, or drawing it thicker into the reed; but perhaps in most cases two beams would be desirable, unless the texture is much alike for both the stripes and body of the cloth.

The lease rods for the yarn in the harness will not, probably, do to be the same as those for the body yarn, as the action of the heddles will be different from that of the harness. If the same rods will not suit, it is easy to have a pair for each warp, those for the harness being farthest back. Stripes of this description are frequently made in towels, glass-cloths, &c., for clubs or hotels, with the name of the company woven into them. A gathered tie is mostly used for these mountings, except when letters are required to be woven, in which case a gathered tie is not suitable. (See Letters and Monograms.)

TO VARY THE SET OF THE HARNESS

It may often be that in weaving figured piece-goods it would be an advantage to have a harness that would weave different degrees of fineness, so that the loom could be utilised for one when the other is not required. For weaving small quantities, for samples or special orders, this is often an advantage.

The usual method of procedure is to draw the warp into a finer or coarser reed if only a slight difference is required, and to pay no attention to the strive in the warp between the harness and reed. The better the quality of the warp, the greater the strive may be, but from 1 in. to 2 in. at each side is as far as it can safely be run when the harness is wider than the yarn in the reed; and if the reed is coarser than the harness, 1 in. at each side will probably be the maximum limit.

When changes of this kind are liable to take place, the cumber board should not be too low down, nor should the mails hang too close to the back of the slay; with the cumber board high and the harness a little back the strive will not tell so severely on the warp. When the cumber board is made of boxwood slips, they can be spread out a little in the frame, but when there is much of a slant in the harness this would take the mails off the level; though this can sometimes be

counteracted a little by raising the cumber board slightly higher at one end than at the other.

The best plan when much of a change is required is to pass over the surplus rows of mails in the harness, as in harness work, as well as in shaft mountings, the mounting may be used for any coarser set of warp than it is built for—of course, if the width is suitable. This would necessitate the warp, or at least a part of it, being drawn out of the harness, and also requires a new set of cards for the new pattern, or for the same pattern on a new set of cloth. The surplus mails may be cast out in rows across the loom if many are to be rejected, or in rows across the harness (from back to front) if found more suitable, or when a small number of mails are to be left idle. Suppose for an 8-row harness, 400 machine, with 6 repeats=2400 mails on 30 in., or 80 threads per inch, and it is required to weave a piece of cloth on this having 74 threads per inch. Drawing the yarn into a coarser reed, and, if only 30 in. wide is required, throwing off the surplus yarn at each side, would probably be the simplest method; but if the cloth to be woven is to have 60 threads per inch, every four throw of mails across the harness, or one-fourth of the harness, might be left idle, or the two back rows of the harness may be left empty. In the latter case the pattern could be painted on 6-row design paper as if for a 6-row machine, and in the former case the number of designs across the painting would be reduced by one-fourth, the card-cutter taking care that he omitted those rows on the card that have been thrown idle on the machine.

In order to reduce this trouble and expense to a minimum Messrs. Devoge & Co. have patented an expanding harness which is intended to admit of cloths of different degrees of fineness being woven without any trouble but a little setting of the cumber board and re-reeding the warp. The method of doing so is as follows:—There are two cumber-board frames, one above the other, as shown in the sketch Fig. 67; these frames are filled with slips which can be moved along when desired. The harness can be set for two degrees of fineness of warp, as is shown in the sketch. The slips in the upper frame, B, are set midway above the two positions for a slip in the lower frame indicated by the letters a and a^1. The black lines show the position of

the cords when weaving the finer set. The only change required to be made is to shift the lower slip, *a*, to the position a^1, and to re-reed the warp; other changes can be made on the same principle, or by altering both sets of slips in relation to each other. When the slips are moved in the frames, they can be kept in position by interposing blank slips between them.

The same cards will suit in this case for several sets of cloth, if

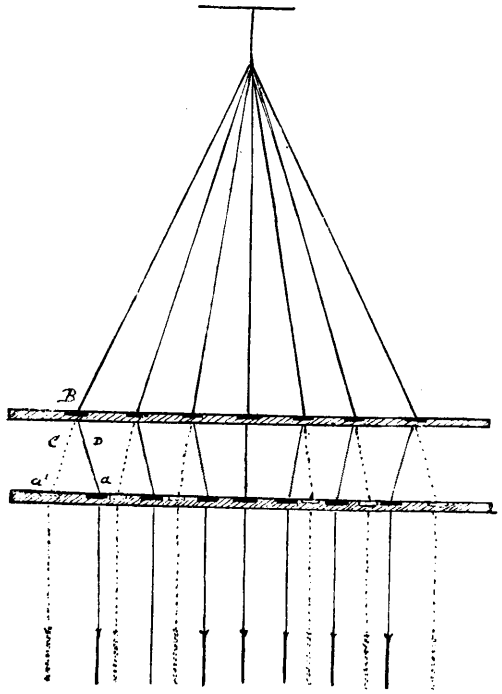


FIG. 67

required. Of course it is plain that the friction on the harness twines working through the two cumber boards must be greatly increased from that of the ordinary method of working; but for light work, and when the harness is not required to last long, it may prove very serviceable when frequent changes are required, as it furnishes a ready means of accomplishing the desired object, which cannot be done without cost in some direction. For wide looms or intricate mountings

it will not be of much service. In the Figure only one hook of the jacquard is given, for simplicity, but the harness would be filled up in the usual manner. If the harness is built with long mails having several eyes in them, the second cumber board is not required; the slips can be shifted and the warp levelled by drawing it through suitable holes in the mails.

CHAPTER IV

DESIGNING AND DRAUGHTING

DESIGNING is the composing, drawing, and colouring, if necessary, of the sketches for jacquard patterns, and in some cases planning the texture of the cloth ; and draughting (or drafting) is the term usually applied to the painting of the patterns upon design paper.

A designer should be a first-class draughtsman, and have a thorough knowledge of the various styles of ornament ; he should also be well practised in drawing floral forms from Nature, without which there is generally a stiffness and want of freedom in his style of work. For coloured work, such as carpets, &c., skilful colouring is the most essential point. No drawing will atone for bad colouring ; at the same time, good colouring should not be wasted on bad drawing.

A designer may draught his own patterns, and if he is an experienced draughtsman with a good knowledge of weaving, perhaps this is the most successful method of working ; but if the greater portion of his time is to be taken up with draughting, his talent as a designer will be, to a great extent, lost, and he will probably deteriorate ; besides, he will not have the same opportunity for getting up a variety of designs that he would have if he had nothing else to attend to. A designer for any class of work should have a knowledge of the technicalities of the material for which he is designing a pattern ; at the same time, a very slight knowledge is essentially requisite, provided the sketch be given into proper hands to be worked out. It must be remembered, however, that in this case a sketch may often have to be taken only as an idea for a pattern, and not be handed by the manufacturer to the draughtsman with directions to make a truthful reproduction of it on the cloth. A draughtsman may be a skilful designer as well, or he may be a skilful

draughtsman and have very little powers of designing. When he is a designer, the most successful method of getting a variety of patterns would be for the manufacturer to purchase sketches for ideas and hand them over to his designer, who will be considered to have a thorough knowledge of the practical work, to prepare them to suit the fabrics for which they are intended, perhaps completely altering them, mak'ng two or three out of one, or combining two or more to make one pattern if necessary—in fact, using them as material to work from. They may then be handed over to the draughtsmen, or be sent to a designing establishment for draughting and cutting. In case the manufacturer has no designer in his place, but only a draughtsman, the sketches must be bought prepared to suit his fabrics, or it would be better to have the complete work done, in many cases, at a designing establishment. Of course, in draughting, as in all classes of work, a great deal of the less important portions may be done by junior hands, but a knowledge of drawing is required, if only to guide the eye, by them all, except the twillers.

Sometimes designers accustomed to selling sketches get them up in a very deceptive manner in order to deceive manufacturers or their agents, who may have very little knowledge of the work; but this can easily be checked by submitting them to a practical designer before purchasing them.

A design that may be very suitable for one class of cloth may be equally unsuitable for another class, and in many cases fashion regulates the suitability quite independently of its artistic merits. For coloured work, designs should be of such forms as lend themselves to the disposing of colours, no style being more suitable than Persian; whereas in plain work, as damask, the flow of line or the variation of the forms, assisted by portions of fancy shading or twilling, must give the complete effect. Again, different degrees of fineness of cloth will suit for different designs; of course, any pattern that can be put on a coarse cloth can also be put on a fine one, but many patterns are very suitable for fine work that could not be put on a very coarse fabric. When it comes to fine coloured silks, anything that the artist can paint can be fairly represented, as may be seen in the work from the

Coventry silk marker looms, so that any design can be put upon cloth; but the question is, Is the cloth suitable for the design?

Fig. 68 shows a piece of 8×9 design or point paper; 8×9 meaning that each of the large squares, or designs, contains 72 small checks or squares, 8 in breadth and 9 in length, but the 9 should occupy the same space as the 8. Ten by ten appears to have been the standard design, as patterns are still counted by the 100 designs, each containing 100 checks, or 100 checks in length and the same in breadth: and in some places machines are known as so-many-design machines; thus, a 400 jacquard is called a 40-design machine.

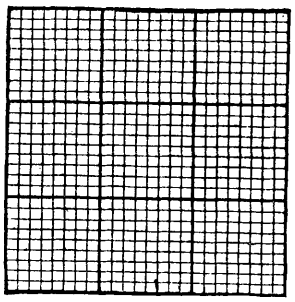


Fig. 68

When each design contains as many checks in length as it does in breadth, the paper is intended for work that is to have equal quantities of warp and weft threads in it; thus 8×8, 10×10, 12×12 paper would all suit for cloth with, say, 80 threads of warp and 80 picks of weft per inch, the difference being that 8×8 is intended for a jacquard with 8 needles in the row, and 10×10 and 12×12 for 10 and 12 row machines respectively. It is not necessary to have different papers to suit, as one could be used for all, and after the pattern is painted it could be ruled in rows to suit the machine, but it is much more convenient to get the correct size of paper.

If 80 threads of warp required to have 100 picks per inch, then to find the size of the paper state as 80 : 100 : : the number of needles in one row of the machine to the number of cards in each design, giving 8×10, $10 \times 12\frac{1}{2}$, or 12×15; but 10×12, or 12×14 would have to be used for the last two, as a half could not be made, and 12×15 is an unusual size. Either would do by drawing out the design a little when enlarging it for the point paper. Square paper might also be used by counting off the number of checks required, and drawing an elongated pattern to cover them; but it is more desirable to have suitable paper for work that is at all particular, and in case of such as

12×15 paper, 8×10 is the same proportion, and could be used for it, the squares afterwards being ruled in 12's for the card-cutter.

Each upright space on the design paper, between the lines, represents a thread of warp or one hook of the jacquard, and each space between the horizontal lines represents a pick, or shot, of weft, or one card of the pattern ; so that a painted pattern is a magnified view of the texture of the cloth, in common jacquard work.

Fig. 69 is a small sketch for a border with spot filling, which is shown on design or point paper in Fig. 70. The paper is 8×8 ; the first four checks are used for a selvage, and the pattern is on $12\frac{1}{2}$ designs or 100 threads of warp, and 22 designs or 176 cards would be required for the weft, the pattern being made about three times the

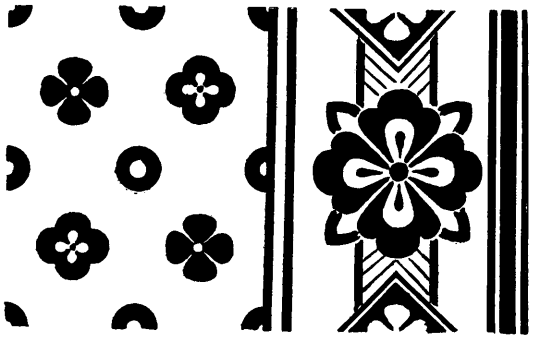


FIG. 69

size on the design paper that it is on the sketch. The design paper has 16 checks per inch, consequently the cloth would have about 48 threads to the inch to make the pattern appear as the sketch. If the cloth were finer, say with 72 threads per inch, then 150 checks on the design paper would be required for the pattern, which means that 150 hooks of the jacquard would be required for working it. Whatever width the sketch occupies (one repeat of the pattern), multiply this by the number of threads of warp per inch to be in the cloth required, and the product will be the number of hooks required for the jacquard, and the number of checks or spaces required on the design for the warp. The number of cards is found similarly from the weft of the cloth. If, on the other hand, a pattern is to be made for a jacquard,

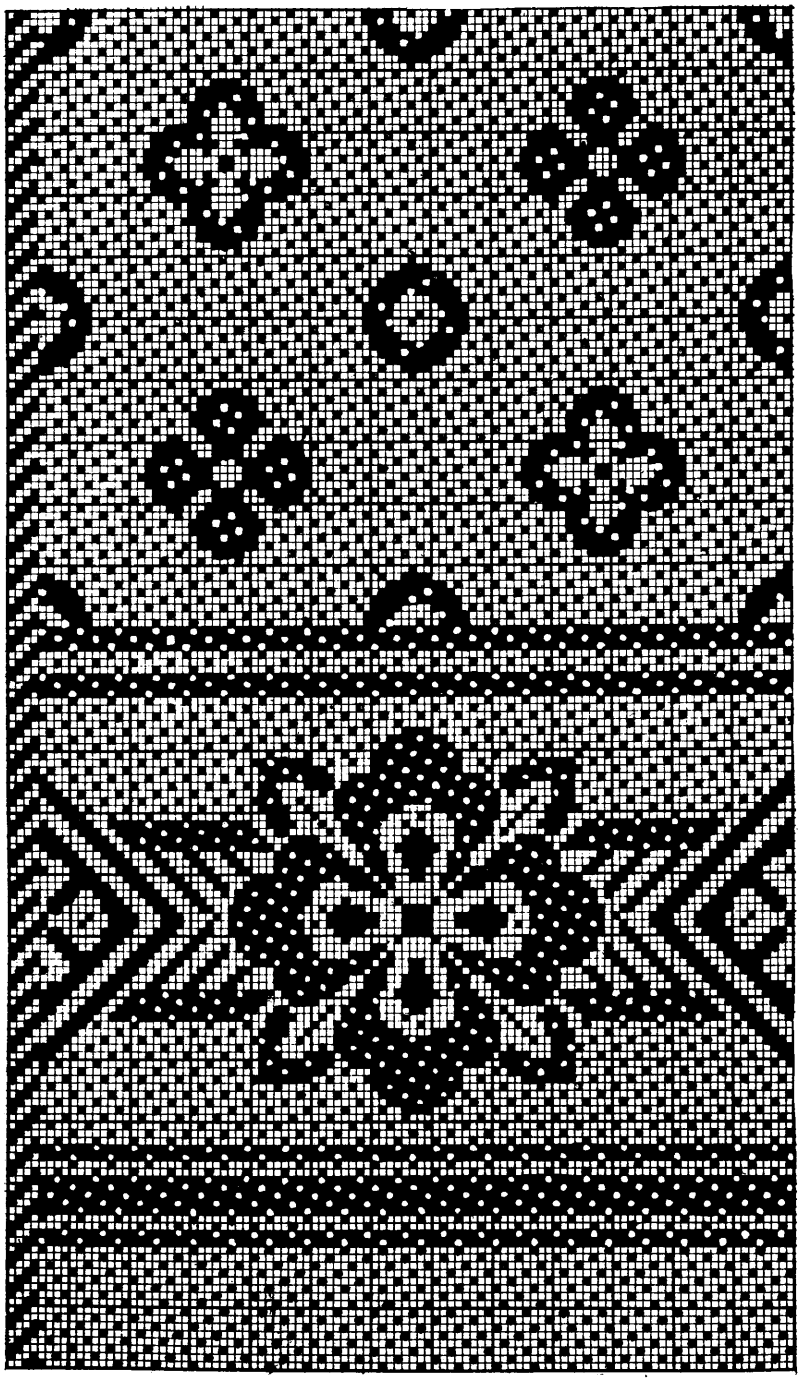


Fig. 70

and it is required to find what size of pattern will work on it, divide the number of hooks in the jacquard by the number of threads per inch in the cloth required, and the quotient will be the size of the pattern warp-ways, in inches. The length or weft-way of the pattern can then be arranged to suit the number of cards, or the pattern can be made any length to suit the style of design. Fig. 71 is a pattern of the same style as Fig. 69, and it might be wanted to use it instead of Fig. 69 for cloth of the same make, say 40 to 45 threads per inch. This could not be done, as it could not be put on the design paper, but it would suit very well if intended for cloth with 80 to 100 threads per inch, which would admit of its being sufficiently enlarged (say four

FIG. 71

times the size of the sketch) to be correctly represented by the checks. Fig. 69 would be better on cloth having 50 to 60 threads per inch, coarser sets requiring larger forms.

In preparing a design for point paper, the sketch is usually first made out and selected by competent judges as suitable for the fabric required, as well as for the taste of the market in which the goods are to be sold. When selected it has to be enlarged to suit the size it is to cover on the point paper. Sometimes the enlargement is made on another piece of paper, and is then transferred to the point paper; this is perhaps one of the best methods of proceeding, but it is not so quick as if the enlargement were made upon the point paper direct. It is usual

to rule squares on both the sketch and design paper, which bear to each other the same proportion that the size of the sketch does to the size of the design paper required to be covered. This guides the draughtsman, as everything in the small squares on the sketch should be put into the corresponding large squares on the enlarging paper or point paper.

A pantagraph is sometimes useful, and proportional compasses are a great assistance if very correct enlargements are required. When a careful outline of the pattern is made upon the design paper, it is then painted. Some painters dot round the outlines, and in large forms leave them to be filled in by assistants ; others paint in solid as they go along. Vermilion and scarlet and crimson lakes are the paints mostly used. The first is easily washed out, but the lakes are more transparent, and admit of the checks on the paper being clearly seen through it, which is a benefit to both twiller and card-cutter. Scarlet lake, with from a half to a quarter its quantity of crimson lake mixed with it, makes a very good paint. The ordinary water-colour cakes are the best paints to use, but powdered colour is sometimes preferred on account of its cheapness. In Fig. 70 the painting is all black, with white twilling on the flowering.

Simple flat ornamental forms, if of sufficient size, are not difficult to put on the design paper, but more intricate forms and shaded effects require a considerable amount of skill, and are tedious, unless to an experienced hand, the difficulty being to get the checks on the design paper to express the figures in the best possible manner, and frequently it is necessary to slightly alter the forms to make them come nicely on the paper.

When the sketch has to be enlarged to, say, three or four times its size, a slight inaccuracy in the painting will have but little effect, as it will be reduced on the cloth. At the same time, advantage should not be taken of this to employ inferior hands at the work, as, the more correct the painting, the more correct will be the pattern on the cloth, although it be reduced in size ; and a ragged-edged painting will never have a clear, defined appearance on the cloth. It is in coarse coloured work, such as carpets, that the accuracy of the painting is of the utmost

importance, as the pattern on the cloth is as large as, or may be much larger than, it is on the design paper; therefore all inaccuracies are magnified, and no forms that do not come satisfactory on the squares of the paper will have a good appearance on the cloth, so that to a great extent the design must be made to suit the paper. When the pattern is all painted on the design paper, both the ground and pattern for ordinary full-harness work have to be dotted over with the texture of the cloth. This is called twilling. In Fig. 70 the texture is a 5-end satin on both ground and flower. For twilling the ground the same colour is used as the flower or figured portion is painted with, and for the figured portion black is mostly used, sometimes white. The twilling dots on the figure mean blanks, as if these checks were left without any colour on them, or as the ground, and they are passed over by the card-cutter when the cards are being cut.

In twilling care must be taken not to run the dots up against the edges of the flowering so as to injure the form of the figures. In some cases, as at any flat portion, such as a horizontal or vertical line, or any portion of one, this cannot be avoided, but the red dots on the ground should here fall in against the black dots on the figure. It is necessary to begin one set of dots against the other set to carry this out as far as possible, and in some cases, when they will not join, the dots are set out of their places to make them come together. The two dots coming together bind the threads and keep the last thread of the ground on one side, and of the figure on the opposite side—according as it is the weft or warp that is forming the line—from hanging loose or sliding out from the others. The direction of the twill on the ground or flower may vary so as to suit the twill used, and whether a satin or sateen effect is required. Various kinds of twills are frequently used to give effect, but too great an irregularity of texture should be avoided, though a plain ground, with an 8- or 10-end satin for the flowering, may be used for handkerchiefs with a good effect; for heavier work a 5-end satin ground and an 8-end satin figuring may be used, but for firm, strong cloth an 8-end satin for both ground and figure is much better, letting either warp or weft predominate largely in the cloth.

Fig. 72 shows how a leaf or any piece of ornament may be shaded; care should always be taken not to let the texture be too close at any part in the shaded portion so as to make hard pieces in the cloth, as would be the case if a plain texture were used in a firm cloth.

Fig. 73 shows how a flower and bud should be painted so as to give a natural, or rather semi-natural, representation. The shading should be made to express the form as well as possible; a variety may also be made in the twilling on the flower, as may be seen on the front

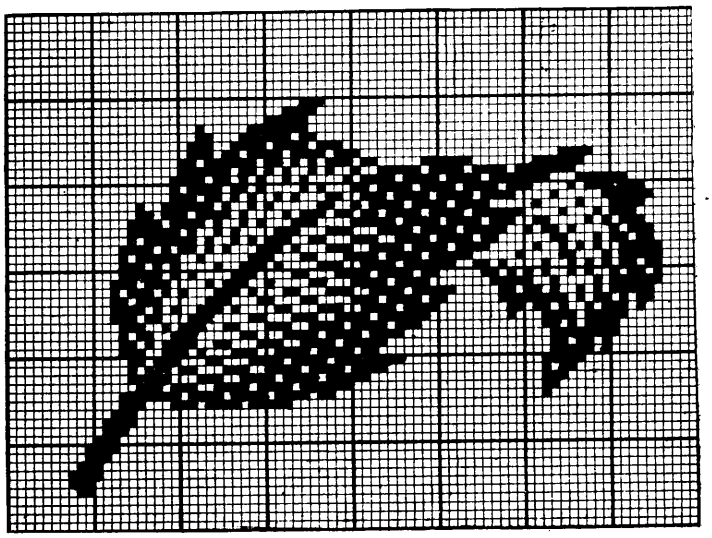


FIG. 72

petal, where a straight twill is used; this makes the cloth richer and the petal come out fuller. This pattern is rather small on the design paper to come well on the cloth; it would be better twice as large, as it may be seen that in many cases single lines of the design paper have to be used for divisions, and for full-harness work it is generally better to have at least two lines, representing two threads.

This painting, omitting the twilling, would suit for a pressure harness, with each line of the design paper representing two or three threads of both warp and weft. No twilling is required on a pressure-

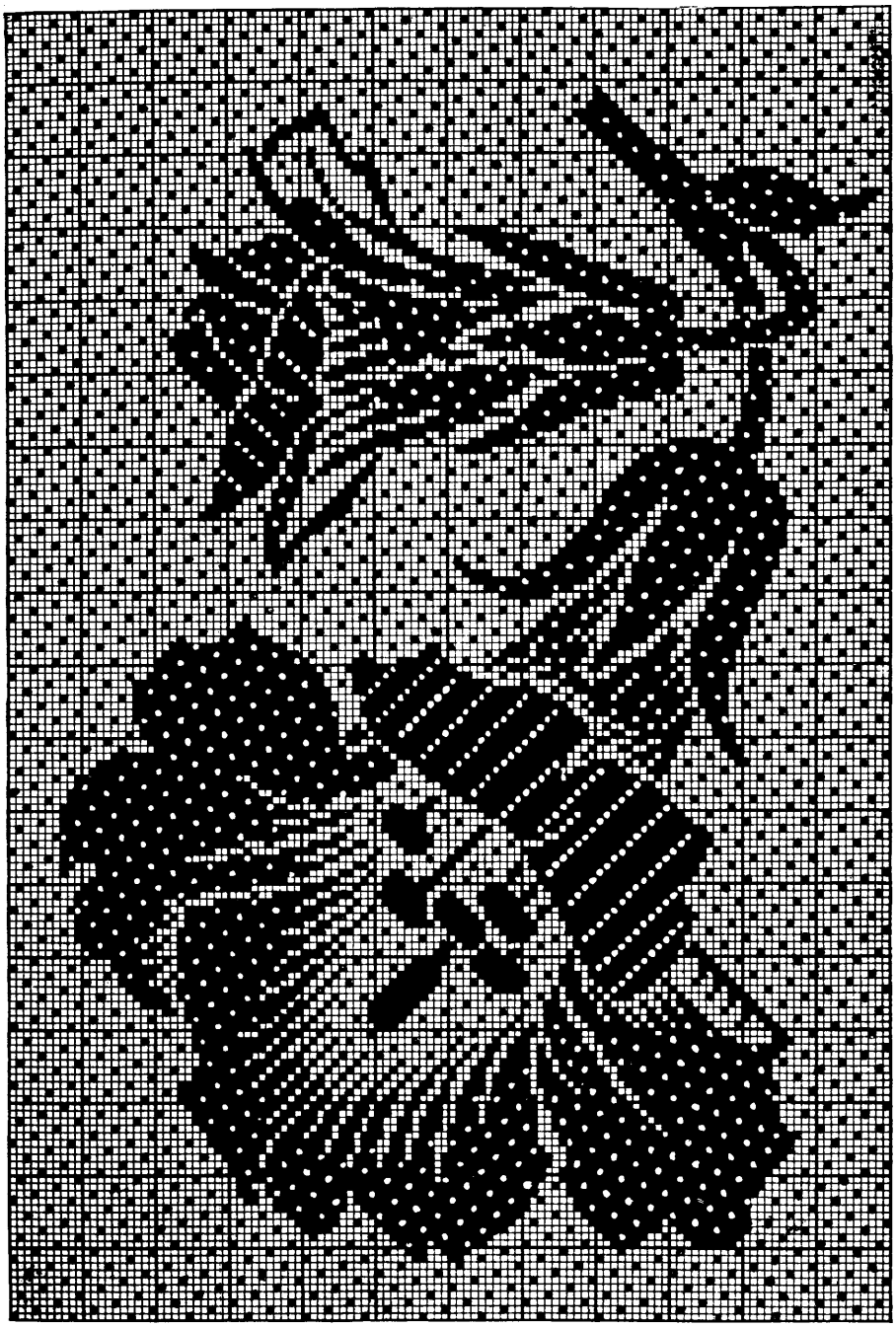


Fig. 73

harness pattern, as the texture is wrought by the front mounting; otherwise the pattern is the same, bearing in mind that as each check represents two or three threads, it will not be reduced on the cloth as a full-harness pattern would. The twilling of this pattern is the 8-leaf satin, which is generally used for fine damask, giving a much richer effect than the 5-leaf satin.

It will perhaps be well to make some reference as to the desirability of using these natural forms for designs, though it would be useless to enter into the oft-disputed point of whether it is correct or in good taste to attempt to imitate natural forms upon cloth, or whether even shaded or rounded forms should be treated upon a flat surface. To the latter I would answer without hesitation, by all means do so, but make the appearance satisfactory and keep them in good taste; and this can be done if the subject treated is duly considered.

The former, it must be admitted, is rather pandering to the popular taste than following the dictates of decorative art. One thing is certain, that the 'million' are better satisfied with floral forms than any other class of ornament, and the more loosely treated these are, or the further they are from ornament, the more pleasing they are to those uninitiated in the beauty of line, wanting which no ornamental forms can be pleasing to those educated in art. However, these natural forms suggest Nature, and their admirers have so little idea of Nature's beauties that they do not see the defects in the attempted representations. At the same time, it must not be understood that a pleasing design, or one in good taste, cannot be composed of natural forms—quite the contrary; for small, simple patterns, principally for light fabrics, they are perhaps more suitable than any other ornament, giving lightness and gracefulness of appearance, as may frequently be seen from the designs on the better class of dress goods, whether woven or printed; but the natural treatment must be kept subservient to the flow of the design. Generally, a moderately flat treatment without any strong attempts at light and shade is most successful, the treatment consisting of a graceful arrangement of forms drawn from nature. Everyone knows the beauty and grace of the Japanese designs; but this is not simply because they are natural forms: it is the arrangement of the forms that gives the

effect. Very effective patterns can be made for dadoes of coloured curtains from natural objects, as here they can have the upright forms suited to them; but for coloured work, generally speaking, and for carpets in particular, natural forms, unless treated flatly and conventionally, are rarely either pleasing or in good taste. With them it is difficult to obtain that intermingling of colours, be they bright or dull, that produces a neutral bloom and a satisfactory result. Another important point in a pattern, and often overlooked, or not understood, is that, unless the pattern, as a whole, is satisfactory, no variety or beauty of detail can make it a good design. The general character or lines of the pattern must first be made satisfactory, after which the detail may be made as interesting as possible, provided it does not injure the general effect, and is not incongruous to the nature of the design. As to whether flat surfaces should be treated with shaded ornament or not is a point that will always be in dispute, but it may be asked why should a designer be hampered with such restrictions? If he can produce a satisfactory pattern by using either flat or shaded ornament, or both, why not let him do so? The criterion should be whether the result is satisfactory or not. Of course such barbarous work as representing leopards or tigers prowling over carpets or hearthrugs, or even decorating them with the more homely duck or drake nestling, or waddling through water, cannot be too strongly condemned, highly though they were once appreciated, and though they still find favour with many: even shading forms or objects in such a manner as will produce a feeling of weakness, insecurity, or danger, can never be upheld—that is, such a practice as shading ribbons flowing over carpets or hearthrugs like snares, and buttoned down at certain points; or making the surface of the carpet appear very irregular, which has often been done, and is often seen in coloured tile pavements. Of course these remarks refer more or less to any fabric, but a little relief in a curtain would not be nearly so objectionable as on a carpet, so that almost everything turns upon whether the result produced is satisfactory or not—of course, to those competent to judge, and who are not overcome by biassed prejudices. Natural or semi-natural floral ornament will rarely be injured by a little shading, whether on a white

or coloured fabric, but it should not be overdone—a moderate amount of shading or a half-flat treatment generally giving a more pleasing effect. Conventional floral ornament is, perhaps, best treated flatly, or with a very little shading on some portions that require a little relief. A richer and purer effect in colour can be got with flat than with shaded colours.

Fig. 74 is an example of a small floral pattern of a class much used for dress goods, either woven or printed, and gives a very pleasing effect. One repeat of the pattern is bounded by the lines

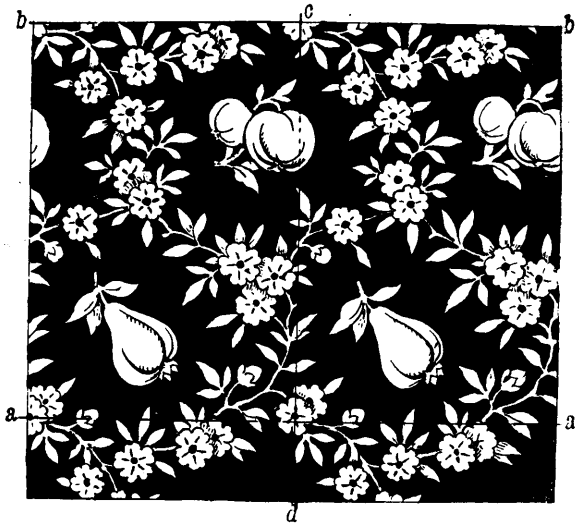


FIG. 74

a b c d, or the whole might be taken as one repeat, and instead of having a row of pears on a line, have a pear and some other fruit alternately, and the same with the apples. This pattern is a semi-natural floral treatment, and if on a larger scale a little more shading on the fruit and a few turned-over leaves or half-open flowers would not injure it, but would add to its richness.

Fig. 75 is a sort of floral ornamental, or flatly and symmetrically treated floral pattern, somewhat after the Persian style, and though some would consider it stiff in comparison with the previous one, it

has a very pleasing effect, and could be used the size indicated for dress goods, &c., or if enlarged to two or three times the size it would make a very good curtain pattern. Small sprigs of flowers, grasses, grain, &c., scattered about over the surface of the cloth make generally a favourite style of pattern.

So far the patterns given are such as would require the designer to have a good knowledge of drawing and of ornamental and floral forms, and many consider that a designer must be a draughtsman; but such is not the case.

Fig. 75

Large quantities of patterns are made that do not necessarily require the designer to have any knowledge of drawing; this is called 'small pattern' or 'texture' designing.

A designer of this class should have a thorough knowledge of weaving and of the effect which the patterns on design paper will produce on the cloth. He must, of course, have a taste for the arrangement of forms, and can produce considerable variety by a judicious arrangement of fancy threads through the cloth, particularly in worsted or woollen goods. The following examples will show how great a variety of patterns can be produced without any knowledge of drawing. But a knowledge of drawing will be a great assistance, as it trains the eye to correctness of form. Fig. 76 is a pattern for dress goods; it may be made of cotton only, or with a cotton warp and worsted weft, and a good effect is produced by having the warp a different colour from the weft, say a gold cotton warp and a brown or giraffe worsted weft. Warp 60 to 80 threads per inch, and weft about the same. This is a pattern of the bird-eye class, and a very large range can be made in this style, both bold and effective, or fine and

neat, as may be desired. The smaller patterns may, of course, be woven with shafts, but larger ones require a jacquard.

Fig. 77 is another pattern, of the flushed stripe class, also suited for dress goods ; this is a silk handkerchief pattern for 90 threads and 96 picks per inch ; 60/2 China silk for warp, and 60's single China silk for weft. If the small dots on the pattern are cut on the cards, a finer and closer pattern will be produced than if the black squares

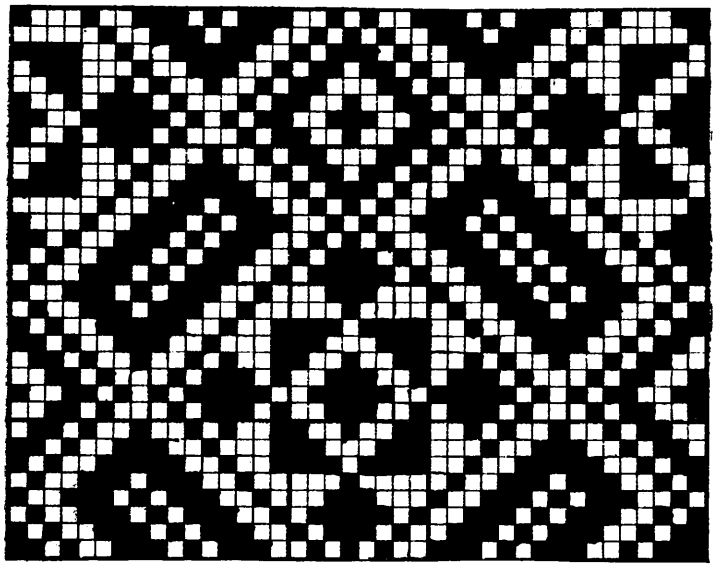


Fig. 76

only are cut, but of course it would be less effective unless on a coarser fabric.

Fig. 78 is a pattern that would suit for dress goods if woven similarly to Fig. 76 ; and if woven much coarser, say 25 to 30 threads per inch, it is suited for quiltings. Great variety can be made in this style of quilts, particularly when floral and other forms are interspersed through the texture, and also when the honeycomb texture is employed, an example of which is given in Fig. 79 in combination with diaper or bird-eye figures ; only a portion of this pattern is given,

but it shows all that is required. In either pure white, or with a warp of one colour and a weft of another colour, these patterns are very effective when made from good twist yarn and coarsely set in the reed; the flushing might be over twice as many threads as is shown in the patterns, and then more threads of warp and weft be used. It is perhaps to the woollen and worsted trades we must turn to find the greatest variety of patterns of the description we are now dealing with. True, the greater portion of them can be wrought on shafts, and

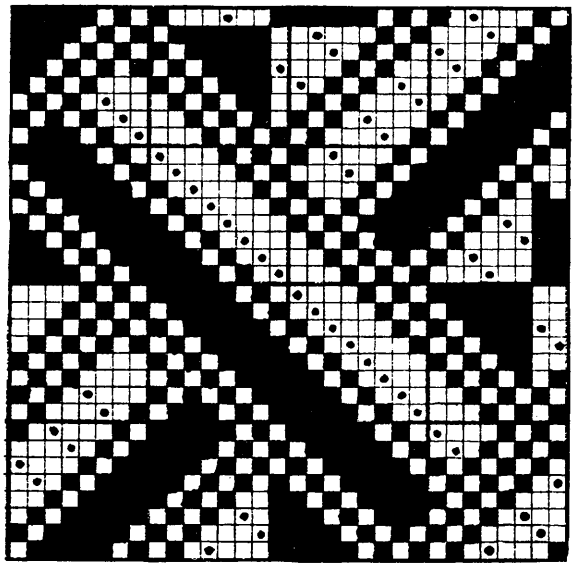


FIG. 77

perhaps a greater number of shafts are used in these trades than in any other branch of textile work, as shafts produce a firmer cloth than a harness; but when large fancy patterns are required, recourse must be had to the jacquard. Fig. 80 is an example of a fancy twill stripe which could be wrought on 48 shafts if desired, but might also be wrought on a small jacquard with greater simplicity, unless very heavy cloth is required. Patterns of this description require considerable skill in designing, and are in some cases more difficult as they increase

in size. It may be seen that the pattern or figure is composed of different textures, and to make a perfect cloth the various textures should all work together at an even tightness, or so that there will be an equal amount of take-up of shrinkage of the warp for each. When checks or large patterns are to be formed this is most essential, but in smaller patterns it can in a great measure be remedied by letting the

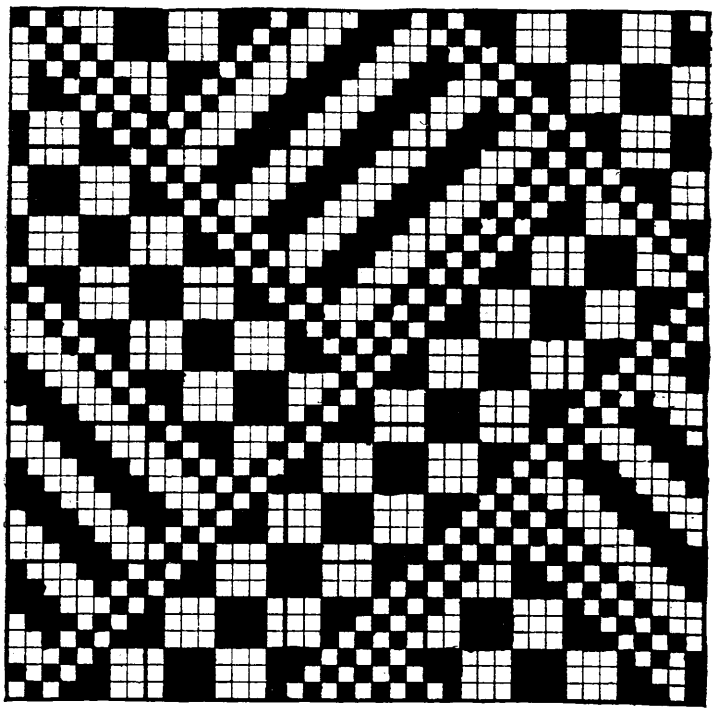


FIG. 78

various textures follow each other, so that if one tightens a little another will make a corresponding slackness, and all together will balance each other. Another important point is to join the edges of the various textures together so that there will be no break, or floats of warp and weft greater or less than in the textures themselves. In some cases tight and loose textures are wrought together to give a

special effect, and figures may be formed by the close texture pressing the looser threads together.

Another class of pattern by which a very good effect can be obtained by very simple means, is the hair line or tricot style. Fig. 81 is a dice pattern on this principle. The texture is plain cloth throughout, and the effect of pattern is obtained by using two colours of warp and weft, say black and white, and by arranging the draught and

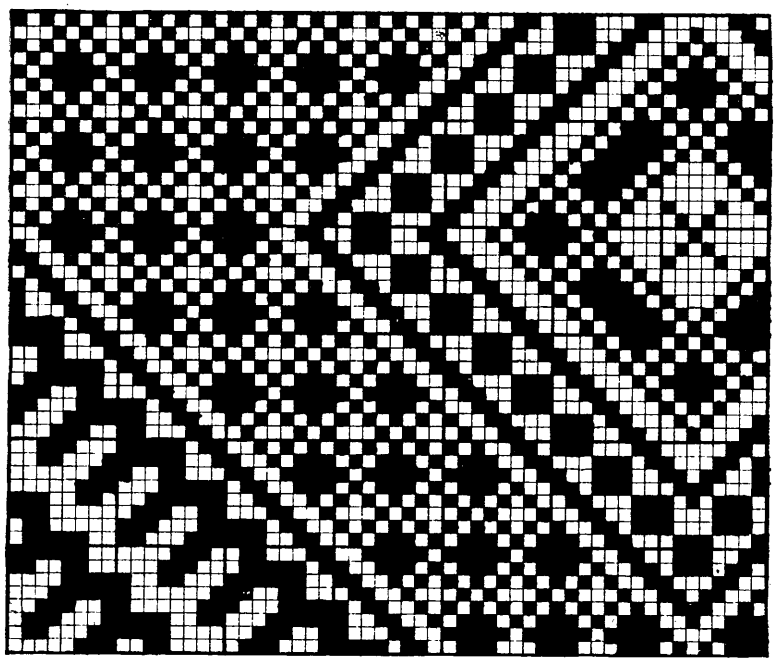


FIG. 79

treading so that the black weft will pass over the black warp and the white weft over the white warp on one dice, and the reverse of this for the next one, a horizontal and vertical lined effect will be produced, giving a subdued pattern. The dark checks on the design paper are the tricot or horizontal line effect; the grey checks the vertical lines or hair line effect. It will be seen at the edge of each dice how the colours are changed in both warp and weft by the two dots coming

together. The crosses along the bottom and to the left side of the design show the dark threads and dark picks coming alternately with the white ones.

Fig. 82 is a small figure pattern arranged in this manner, the reversing of the colours being done by the jacquard, as may be seen

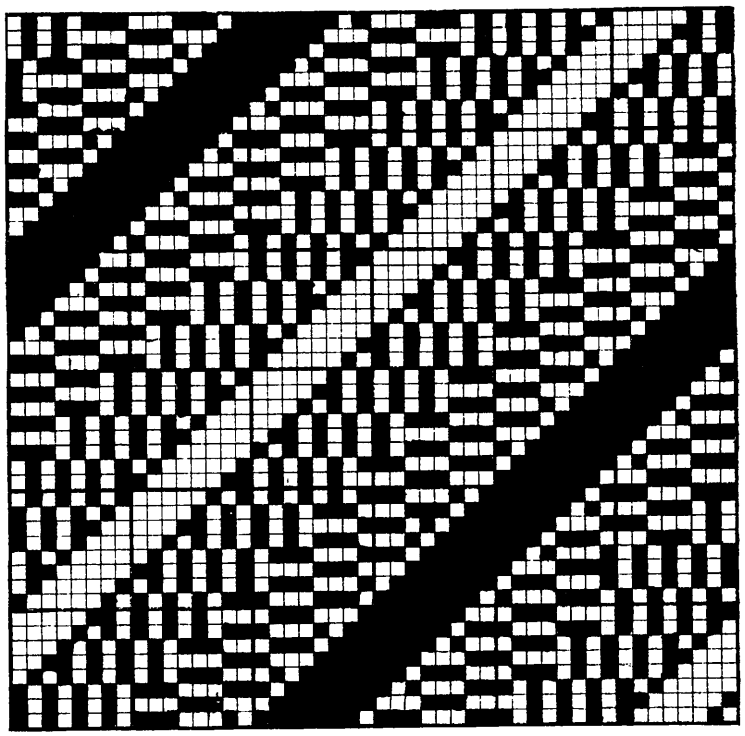


FIG. 80

from the dots on the design. Almost any figure may be treated in this manner, but simple patterns, not too irregular or broken in outline, will perhaps be found most successful.

These fabrics may be made in either woollen, worsted, or cotton for dress goods. About 36 threads of warp per inch of 2/30's worsted, and 32 threads of weft per inch, is a good setting for them; and in

any mild contrasts of yarns, such as two shades of grey, they are very pleasing.

Coming now a step further towards the damask or figure patterns, we have still great scope for variety, without much, if any, knowledge of drawing being required from the designer. This consists of

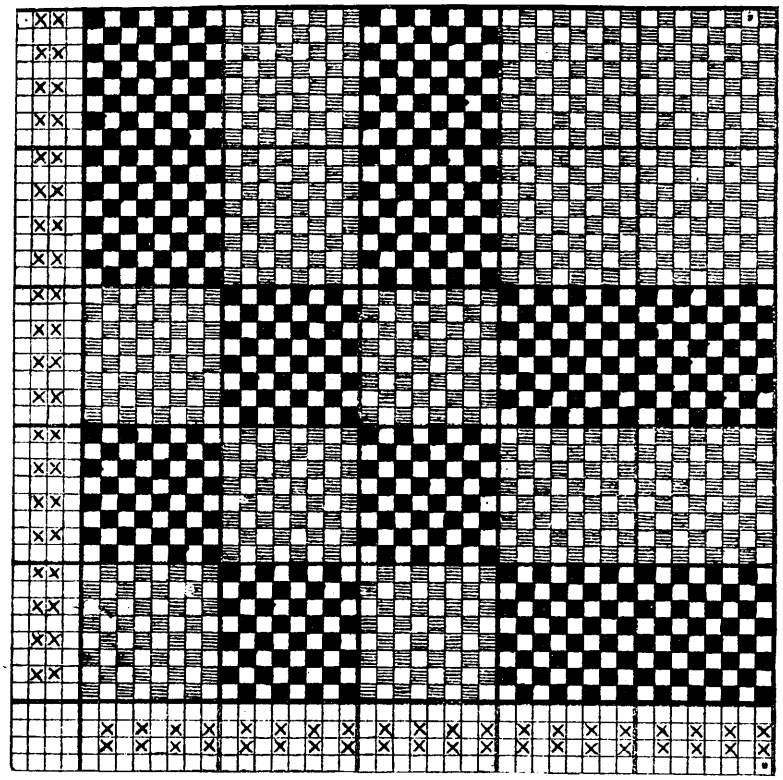


Fig. 81

spotting small geometrical figures over the cloth, the body or ground of which may be plain, twill, or any texture desired. Fig. 83 is a pattern of this description with a plain ground. The figures are arranged in satinette or 4-end satin order. Of course, the ground might be a twill if desired, and the figures may be of any form that

ingenuity can suggest. They may be solid, and a twilled texture used to bind them if the flushes of warp or weft are too great, and part of the figure might be warp flush and part weft flush; in fact any variety that the designer can arrange to produce a good effect on the cloth, which, if the warp and weft are of different colours, may be made very effective. Any arrangement for the figures may be used if suited to the size of the figure and the space they have to occupy to suit the repeat of the pattern. The 4-end satin gives two figures on one

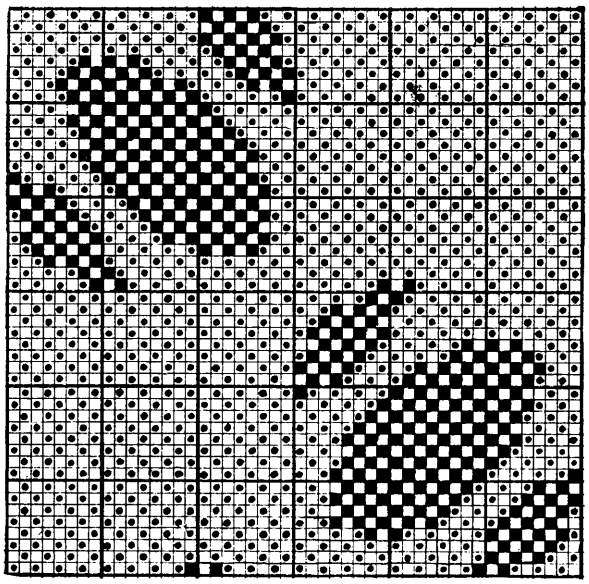


FIG. 82

diagonal, and two on the other diagonal alternately; one figure on each diagonal may be used, and also three figures on each with equally good effect, subject, of course, to some extent to the size and form of the figures. Five and eight-thread satin arrangements are two of the best that can be used if a greater number of figures are required in each repeat of the pattern. To arrange a pattern in satin order, the usual way is to rule the repeat into as many squares in length and breadth as there are threads in the satin to be used. Thus, for a

5-thread satin, rule the repeat into five squares in length and the same in breadth, or twenty-five squares in all, then place one of the figures into each of five of these squares, the order being that of the 5-end satin twill. A draughtsman would either sketch these figures on the design paper, or sketch one of them on a piece of plain paper, trace it, and transfer it to the different positions it would occupy on the design paper, and then paint each of them independently. But a designer, without a knowledge of drawing, would mark out the spaces on the

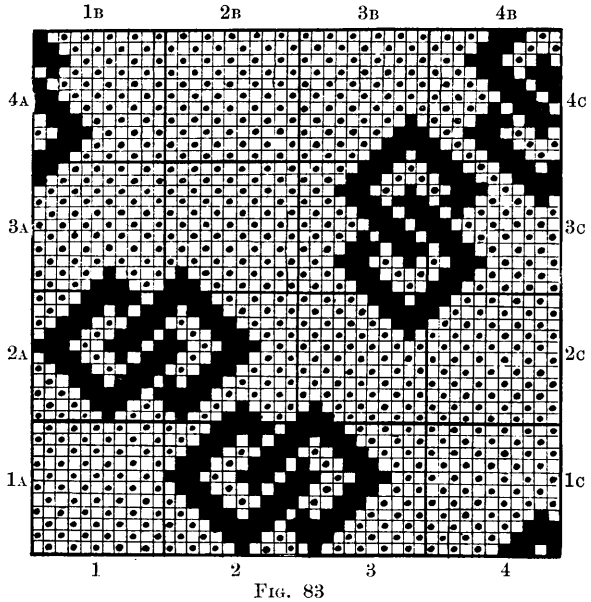


FIG. 83

design paper for each figure, and, having made one of the figures the required shape on the checks or small squares, would copy the others from this. In Fig. 83 let 2A be the first figure formed, it being started in the second square upwards and first row. Now, the second figure can be similarly begun in 4-thread satin order, which would bring it to square No. 2, and it is begun in the same position in this square that the first one was begun in square No. 2A. The third figure falls to the third square from 3A and 3, but as this figure is turned round for variety, the point for beginning it at figures 1 and 2

must be marked, and an imaginary square run round it, and it must be kept in its position in the square, or the centre of the figure may be found by counting the checks in either of the first or second figures and this figure wrought from the centre; or, again, as the figure is six checks greater in length than in breadth, it must be set three checks to one side, and the top point should rise three checks higher up above the large square of the design paper on which it should be

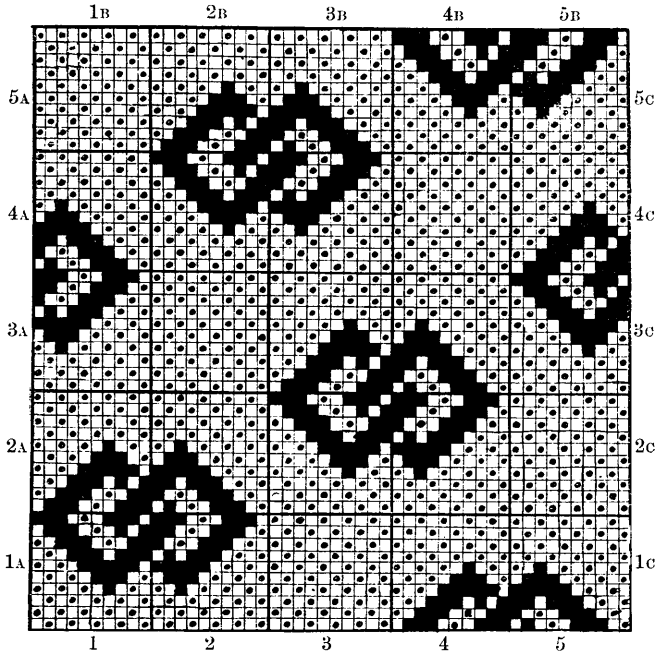


FIG. 84

started; but with a plain ground it is sometimes necessary to move the figures one check out of position to allow the plain to fall in regularly all round them. This figure is set one check down. Fig. 4 is copied from fig. 3, and is in the same position. With a twilled ground or irregular figures, it will not matter if the ground does not fall in quite regularly round them.

If it was required to make a pattern similar to Fig. 83, but with five figures instead of four, and preserve the same density of ground

structure round them, it could be calculated as follows :—Fig. 83 is on 44 checks broad and 44 long. Now $44 \times 44 = 1936$, and on this there are four figures, then $1936 \div 4 = 484$. As five figures are required $484 \times 5 = 2420$ checks for design. If there are to be as many checks across the design as up it, find the square root of 2420 for the number of checks, as $\sqrt{2420} = 50$ nearly. If the pattern is not to be square, the proportion may be found for each side by making two calculations, one for the greater number of checks squared, and the other for the lesser number of checks squared, and extracting the square roots for the two sides of the required pattern; or, suppose the warp to be to the weft in the proportion of 10 to 12, then state, as 12 is to 10, so is 50 to 42, the number of checks across the bottom of the pattern; and as 10 : 12 : : 50 to 60, the number of checks in the length of the pattern, and $42 \times 60 = 2520$, which is nearly the same as 50 squared $= 2500$ for a square pattern. But if this is for adding extra weft to the cloth, the size of the pattern would be reduced, which might bring the figures too close together and would alter the shape of them; in this case the addition should be made to the number of checks in length, making the pattern 50 broad and 60 long, or to contain 3000 checks, and the length of the figures should be increased in proportion. Of course this will produce a finer cloth. Fig. 84 is a pattern arranged with five figures on it.

A great variety of patterns may also be formed by arranging dice or squares in various ways, some of which, as may be seen on the Indian fabrics, make very pretty patterns. It will thus be seen that there is plenty of scope for the ingenuity of a textile designer without his being of necessity a draughtsman; but a knowledge of drawing will generally be of assistance to him. For the more elaborate patterns, the designer does not require to have the same knowledge of manufacturing that is required for these small patterns.

Twilling.—It has already been shown how the patterns are bound or twilled to form the texture of the cloth for ordinary repeating patterns on a straight over-tie; but when a turn-over or gathered tie is used, the twilling of one half of the gathered portion will, on the cloth, be the reverse, or run in the reverse direction to that of the other

portion, and this is often a disadvantage to this description of tie, as one half of the border or pattern, whatever it may be, will look coarses than the other. It frequently happens that to avoid the stiffness of a clean turn-over pattern, which must always have a clear cutting line through the centre of it, so that, if cut up, one half would, if turned over, be exactly the same as the other, a portion of single, or a turning portion, is placed in between the two turned-over portions, which in many cases adds very considerably to the effect of the pattern, though it is often almost useless. Fig. 85 is a pattern of the turn-over type, and, but for the interlacing of the bands in the centre, might be wrought with a simple gathered tie. For this pattern the portion marked B would require to be single, and A turned over to C. Perhaps it is in floral patterns that this form of tie is of most service. When a single tie takes up too much machinery, and a double over or gathered tie would make the pattern too stiff, a small portion of single introduced, as at B, is of great service to the designer in making a pleasing pattern.

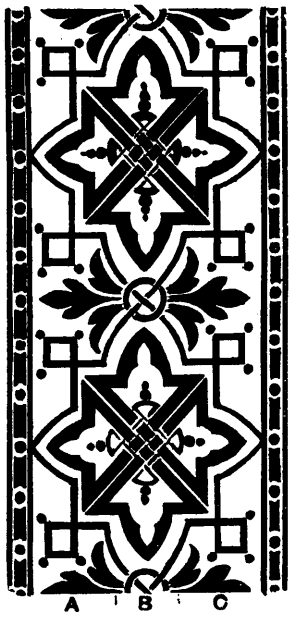


FIG. 85

When twilling a pattern of this description, the portion marked A would be twilled straight across, and this twilling would be continued to the centre of B, as shown in Fig. 86, which gives the idea, the spots in the centre being taken as the single portion. The portion marked C is repeated from the first part A by the harness, and does not require to be put on the painting ; in the figure it is shown (in different type) as it would fall on the cloth. It may be seen that the twilling dots on the last line of A and the first line of C are alike, and that every pair of lines corresponds, moving from these to the edges of the pattern. Now a turn must be made in the twill in the single portion so as to make it join correctly with C, and this should be done in such a manner as to

prevent it from showing plainly on the cloth, or having too long floats on some of the threads while others are too closely bound. This must be done by setting the dots out of their places on a few lines in the

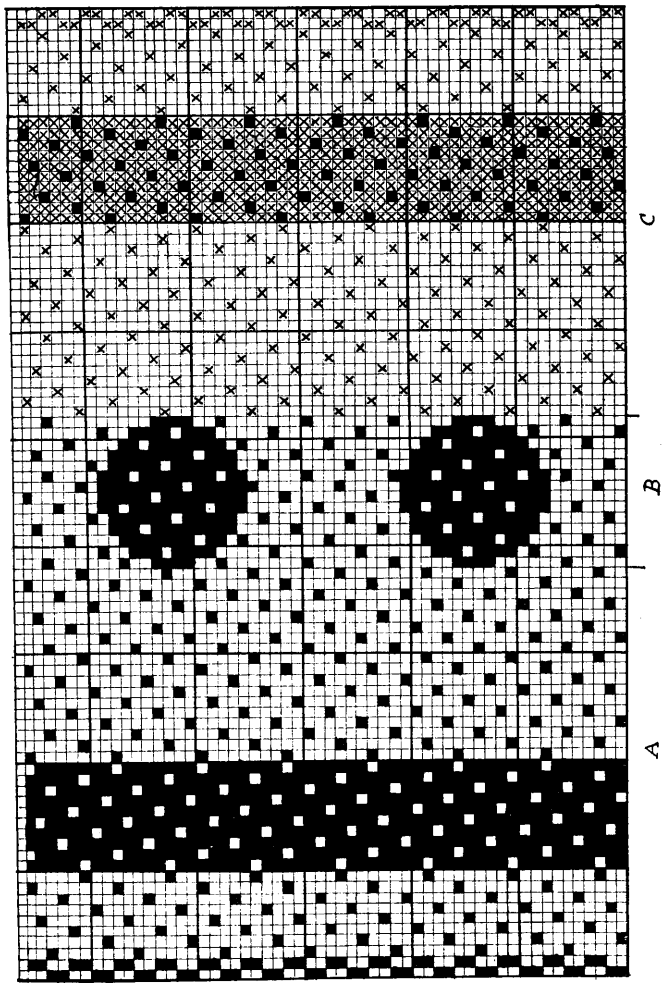


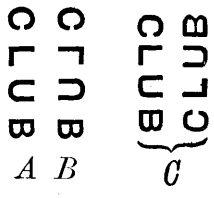
Fig. 86

centre, so as to make the join produce as even a texture as possible. Advantage should always be taken of any portions of the pattern that come on this part, such as the spots in Fig. 86, to turn the twill round

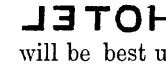
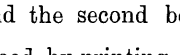
the edges of them. By following the dots on the design paper, it will be seen how they are brought in at the join. Any twill may be broken similarly, but a different number of threads in the single will alter the arranging of the dots to join the two twills together; however, when the principle is understood, it can easily be worked out.

LETTERS, MOTTOES, ETC.

A turned-over mounting or gathered tie will reverse any ornament, but while for borders it makes the ornament come correctly, it prevents letters or words from falling in as they should be read. Thus, if the word



CLUB were woven at one side of a cloth, as at A, and the harness mounted as a gathered repeat so as to turn over a similar border to the other side, the letters would fall as at B, making them read correctly to the under side of the cloth instead of to the upper side. Instead of making a gathered tie, it would be better to make a plain repeating tie for the second border, making the word CLUB on both borders as either A or B, according as they are to read correctly on the under or upper side of the cloth; but if it is desired to make the letters read correctly from both sides or edges of the cloth, as at C, it is plain that there must be hooks in the jacquard to work each border independently, as one is not a repeat of the other. Of course letters on damask will only read correctly on either the face or back of the cloth, not on both. The same principle holds good when putting names across the cloth, or for coats of arms and mottoes in the centre, as is frequently done in quilts, tablecloths, &c., but in this case it would be the cards that would do the work. Suppose the word HOTEL to be put across a cloth at one end, and it was required to have the same at the opposite end to read similarly from that end of the cloth, it would require to be painted thus, ⅂ƎꞀOH, or the cards might be cut from the painting of the former, turned upside down. Provided it was required to make these words read correctly on the under side of the cloth in the loom instead of

on the upper side, then the first border would be painted and cut as  and the second border as  This will be best understood by printing the letters on tracing paper and turning it round into the position required. In case of a motto or coat of arms wanted for a large cloth with two centres in it, one centre to be correct from one end of the cloth, and the other from the opposite end, as shown by the girdles at A and B, Fig. 87, the painting would be as in this figure if the upper side of the cloth is to be the right side, but if the under side is to be the right side, the first centre would require to be painted as shown in Fig. 88, and the second one would be as this turned round, the top where the bottom is, not turned over. It might be thought that the same painting would do for both ; either that cutting the cards from top to bottom, or backwards, or lacing them backwards, or working them backwards on the loom, would do for the second centre ; but it would not unless the cards were turned over as well—that is, to have the outsides of the cards turned inwards, and the right-hand end to the left. This would suit if it could be done, but could only be done when the jacquards are made with an equal number of needles to each side of the machine, as 25 rows, or 200 needles, to each half of the card for a 400 machine, instead of 26 rows to one side and 25 to the other, making 408 needles, as is usually the case.

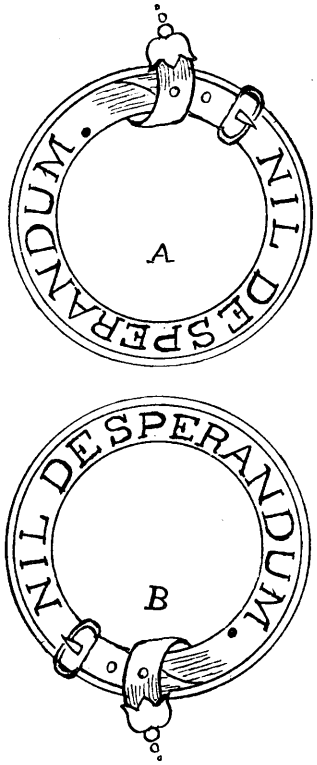


FIG. 87

In hand-loom districts, where old makes of machines are used, it is common to have 400, 500, or 600 needles to the machine, and the cards can be turned on the cylinders if required, and are also wrought

backwards or forwards to suit. By cutting the cards from the painting in the reverse order—that is, beginning at the end of the painting and reading and fingering backwards—cards from a painting of a first centre could be cut to suit for a second centre, as it has exactly the same effect as turning over the card; but all the rows of needles must be used except any left at the first, and these and any selvage must be brought to the end of the painting when cutting the second set of cards, so as to get them to the first end of the card. The cutting begins, as is usual, at the numbered end of the card. Repainting the centre to suit is the safest way to avoid mistakes.

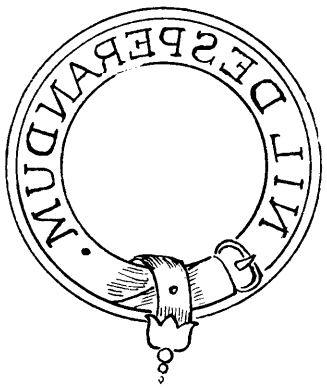


FIG. 88

When a name is running up the side of the cloth, lacing or working the cards backwards will reverse the reading of the letters from one side to the other, but not when they are running across the cloth. If the loom is mounted with the cards hanging to the front instead of to the back, the letters would also be turned from one side of the cloth to the other, and to be correct they would have to be painted or cut the reverse, unless the machine or mounting was built to suit.

CHAPTER V

CARD-CUTTING AND LACING

THE mountings which have been given are of two descriptions—the Norwich, with the straight harness, and the London or twisted harness, with the cards hanging to either side of the loom, as the machine can be turned either way to suit. For the Norwich ties the cards are supposed to hang to the back of the loom, but it often happens that there is not space between the looms to admit of all the cards being hung at the back, and it is usual for one loom to have the cards to the back and the next one to the front. When the cards hang to the front of the loom the mounting is tied up so that when finished it will be the same as if mounted for the cards to hang at the back; and afterwards turned round so that the back will be at the front. In case the back left-hand corner twine is the first cord of the harness with the cards at the back, the front right-hand twine would be the first if the cards are at the front, and the drawing in of the yarn must begin at it. If the loom is mounted in this way, and the yarn drawn in from the opposite side, as if the cards were to hang at the back, the result will be a toothed or broken-up appearance round the edges of the pattern. The same cards will do for either mounting, but the pattern and twill will be reversed on the cloth—that is, they will run from left to right on the one, and from right to left on the other. The effect produced on letters was mentioned when speaking of them.

It was mentioned that jacquards are usually made with 51 rows of hooks or needles, of 8, 10, or 12 in the row, being for 4°°, 5°°, and 6°° machines respectively, which are those most used; 2°° and 3°° machines are used for small mountings, but they may be considered as half 4°° and 6°° machines. Sometimes the machines are made of any size

required—that is, with any desired number of rows of holes in the needle boards. The objection to this is that the cards cannot be copied on the ordinary repeating machines; but piano card-cutting machines can be made with the index to suit for cutting any length of card. When using 4°°, 5°°, or 6°° machines, or the double sizes, 8°°, 10°°, or 12°°, and more than one is required for the mounting, a second must be used, such as an 8 and a 4. or a 12 and a 6; a 12 and a 5 would not do so well, as the 12 has 12 needles in the row and a 5 has but 10. It would be better to use a 12 and a 6 and leave 100 hooks idle, if only 1700 are required. If a 12 and a 5 is to be used it may be done by having the cumber board made 12 in the row, but made finer in the proportion of 12 to 10; then, where the 12-row harness is to pass through it, every sixth row of holes can be left empty, and it will be all right for the 10-row harness from the 5°° machine.

Designs are painted upon the point paper for the purpose of enabling them to be transferred to the cards, which act on the needles of the jacquard, and cause the proper warp threads to be raised. The pattern is put upon the cards by punching holes in them, one hole being punched for each check on the design paper that is filled in with colour, or it may be the reverse of this, or otherwise, according to circumstances. The common method is to cut the red, and leave the ground or unpainted portion, and the black, which stands for ground. There is a card for each line of the design paper for damask patterns; the holes in the cards represent the dots on these lines, if each line was cut off and cut into separate designs or larger squares, then these squares set up lengthways and laid together. Take the pattern, Fig. 70, and cut the first line from left to right. The card is shown at Fig. 89 at A. Turn the pattern upside down and examine the first line to the right-hand side. The two first checks are empty; two holes in the card or two punches of the piano machine are passed over; the next three checks are painted, for these three holes are cut in the card, and the remaining three checks in the design being empty are passed over. The next design has the second and seventh checks filled and these are cut on the card, and so on with the others. The two small holes at each end of the card are for the lacing twine, and the

large one at each end for the peg on the cyclinder of the jacquard. The intersections of the fine lines on the card show where the holes fall when required to be cut.

This card would be for a 200 machine, the empty or unused needles being left at the first half of the card; 26 rows of 8 needles to the card. The card B given in this figure is the first of the heavy cutting, No. 17 on the pattern. Reading from the pattern as before, pass 2, cut 2, pass one which is black, cut 3, and so on, cutting the red and passing the black or twilling dots whether they be white, black, blue, yellow, or green; they are only there for convenience, to avoid the trouble of leaving the spaces empty when painting the pattern at first, it being simpler to dot them over afterwards.

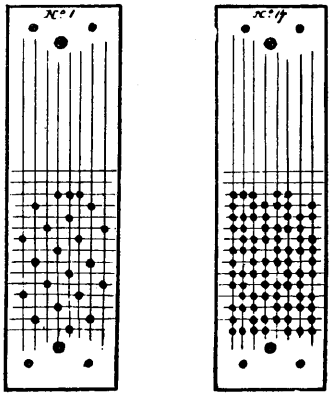


FIG. 89

The cards are numbered at the selvage end, which goes to the sneck side of the jacquard when working. The design may be read from left to right, but the usual method is to turn it upside down, and read from right to left, which comes to the same thing, beginning to cut from the numbered end of the card. Some begin to cut at the other end of the card, and read from right to left on the design without turning it, which is still the same. If the loom is mounted or the yarn drawn in, beginning with the front row of the harness instead of with the back row to the left-hand side, the cards should be read the reverse way from the design paper; or, what would be the same, turn them over after cutting them. This changes the top row of holes in the cards to the bottom, or from the back to the front of the cumber board. In case of the loom being mounted from back to front, and the yarn being drawn into the harness beginning with the front row in the cumber board, the cards, if cut in the ordinary way, would give the pattern a broken or toothed appearance. Turning the cards upside

down would remedy this, but would only answer if each part of the mounting consisted of full rows of needles, for, if any part began or ended on a broken row, turning the card would take the holes in it for this part row away from the needles: that is, say if the harness was connected with four needles at the top of the row and the card cut for these, the holes would fall on the four needles at the bottom of the row, if the card was turned upside down. The cards should be numbered on the side which is uppermost when they are being cut, and this side should come against the needles if the work is properly carried out.

The old method of cutting cards was for one to take the pattern and call out the holes to be punched, and they were punched out by a

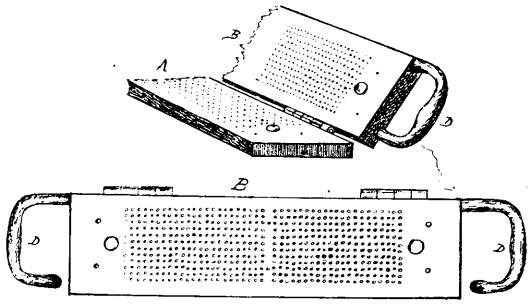


FIG. 90

second person, a perforated plate over the card being sometimes used as a guide to place the holes in their correct positions. A better method was found in the punching plates shown in Fig. 90. A and B are two plates hinged together. B No. 2 shows the full upper plate. The card is placed on the lower plate, and the upper one closed down on it. Punches are then filled by hand into the holes in the upper plate according as the pattern is read from the design; then the plates are passed through a roller press, which pushes the punches through the card. With small machines this suited very well; but the filling in of the punches was tedious for larger machines, and shortly after the introduction of the jacquard by Mr. S. Wilson, in 1821, he introduced a method for filling the plate

with punches to correspond with each line of the design paper, as follows :—Over, or in front of, the design a set of upright cords is placed, as in reading the patterns on the simple of the draw-loom. On these cords the pattern is picked, and weft threads drawn in, one for each line of the design paper, for plain damask. When all the design is finished the threads compose one repeat of the pattern in a loosely-woven cloth. The upright cords or leashes pass through eyes in a set of needles, arranged like those in a jacquard machine and each weft thread put in, when picking the pattern, shows which of the leashes are to be drawn. As each set of leashes is drawn the needles connected with them come into contact with a set of punches arranged in a frame or plate, and push them into a punching plate, which is then placed over the card, as in Fig. 90, and passed through a roller press. This method of picking the pattern for card-cutting is still in use, and an improved method of using the plates and rollers is still found very convenient for many purposes, such as copying cards and small patterns, &c. (See Copying Machines.)

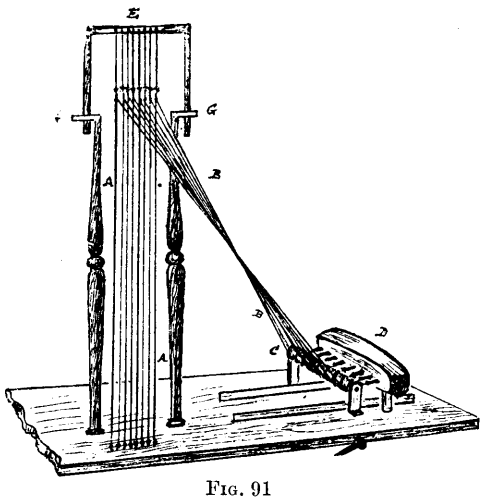


Fig. 91

Card cutting is now almost entirely done by 'piano machines.' They take the name of piano from the pins or keys which are arranged for the cutter's fingers, and to distinguish them from an older machine, which is similar in make, but in it the pins or keys which act as locks on the punches are wrought with cords instead of by the fingers. The cord machine is similar in make to the piano machine; but the cutter usually sits at one side, and has the board or stand for the pattern facing him. The treadles are also turned sideways; but the cord is put in at

the end, as in the piano machine. Fig. 91 shows how the cords are arranged. AA are the cords, 12 in number, which the cutter draws. BB are another set from the former ones to the keys, passing under pulleys at C. D is the punch-box. The keys have springs on them, which press them in over the heads of the punches; but at the top of the cords are indiarubber springs, fastened to the crossbar E on the frame which supports the cords, and these springs are strong enough to draw out the keys. When any of the cords AA are drawn down the cords BB connected with them are slackened, and the keys spring in over the punches, locking them, and punching holes when the treadle is pressed down.

The cords BB can be connected from the right-hand side of AA to the right-hand side of the punch keys, and run from right to left, or they may be the reverse of this, according to the way the cutter reads the pattern. Sometimes piano machines are fitted to work with cords to suit the cutter. In this case there is only one set of cords, as AA, set behind the punch block, and the cutter sits at the end of the machine. Instead of springs, weighted levers, or tumblers, may be used at the top of the cords on the bar E. When springs are used the bar should be lowered when the cutter is not working, by slackening the set screws at GG, so as to relieve the strain on the springs. When working the cord machine the cutter uses only one hand to draw the cords; but on the piano machine he uses both hands, and can proceed quicker with the cutting.

Fig. 92 is a view of Devoge's piano cutting machine. In these machines one cross row of the card is punched at each tread; the cutter sits in front of the machine, with the design fastened on the frame before him, as shown in the figure. The straight-edge, or ruler, across the design is for the purpose of guiding the cutter's eye along the line of the design paper that he is cutting from, and he screws it up or down a line, as the case may be, for every card he cuts. He keeps one foot on each treadle and his fingers on the keys in the punch block, the arrangement of which is shown in Fig. 93, and presses in a key to correspond with each dot on the line of the design paper on one design, or large square, for each tramp.

The numbered end of the card is put into the clip on the index carriage, and the guide for the card set to suit the width of the card used, so that the punch will cut the holes in the centre of the card. The lacing and cylinder peg holes are first cut, by pressing in the keys E for the peg hole, and for the lacing 2 and 7 for an 8-row card, 1 and 8 for a 10-row, and *a* and *c* for a 12-row. Any blank designs, or rows of the card, are now passed over, by running back the index carriage, if

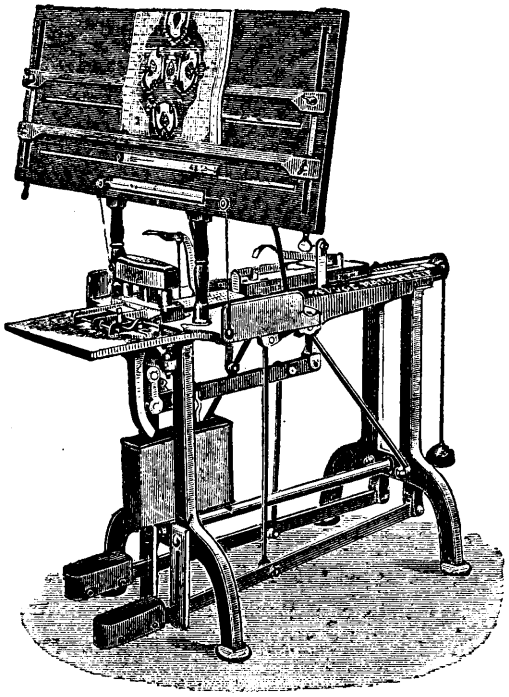


FIG. 92

the design does not occupy the full length of the card, it being the usual custom to leave all empty rows to the selvage or numbered end of the card, though it may in some cases be advisable to be otherwise. The selvage, if any, is usually cut first, and then the pattern.

Pressing down the right foot treadle, when any of the keys are pushed in, punches holes in the card with the punches locked, and the

left foot treadle, which works alternately with the other, is for moving the index carriage, which shifts the card from one row of holes that have been punched to the next one, so as to place it in position for the punches. In Fig. 93 the black dots represent the heads of the punches, 12 in number. The keys 1 to 8 are used for cutting an 8-row card; when any key is pressed in it passes over the head of its corresponding punch, and locks it, so that when the cutter presses down the treadle and the punch block is brought down on the card, the locked punch is pressed through it, while those not locked rise up. The keys *a* and *c* added to the 8 suit for cutting 10-row cards, and *b* and *d* added to these suit for 12-row cards. The four keys *a b* and *c d* can be pressed in with the two thumbs. E is the key for the peg hole.

A good cutter can cut from 100 to 150 cards per hour, but this is

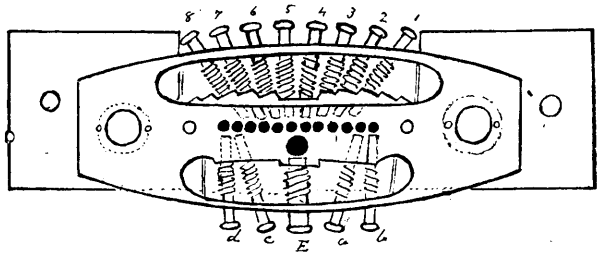


FIG. 93

laborious for constant work. Sometimes the cutting machines are driven by power, but as yet (1894) this is not general.

Messrs. Devoge & Co. can attach an arrangement to their machines so that they can be driven with a belt. The punch block is wrought by a lever driven by an eccentric, and is kept constantly rising and falling; the cutter fingers the pins so as to keep time with the punch block, and should he wish to stop, or should anything go wrong, he can stop the card at once by raising one treadle and pressing down the other, which throws the motion for shifting the index carriage out of gear, and the card stands stationary, and although the punch block continues to work it takes no effect when the punches are not locked by the keys. The machine works very smoothly, with very little noise, and with a little practice any boy or girl accustomed to card cutting can

easily become acquainted with working it. The index of the piano machine is generally made for 51 rows of holes in the cards, 400, 500, and 600 machines being those generally employed: 51 rows of 8=408 needles; 51 rows of 10 = 510 needles; and 51 rows of 12 = 612 needles, which, with a few odd needles on the 25-row side, represent the number of needles in a 4°°, 5°°, and 6°° machine. If larger machines with longer cords are required, the index of the cutting machine must be altered to suit them.

Card paper should be of such a quality as will not be easily affected by the atmosphere. When cards are for small machines, and are only required to work for a short time, an inferior paper will do for them, and save expense; but for large patterns which are intended to work for years it will come cheaper in the end to get a good quality of paper—in fact, the best that can be made. Specially prepared oil-saturated paper is made for the purpose of preventing the atmosphere taking too much effect on it. For hand looms, sometimes the cards are painted with red lead, and sometimes with shellac varnish, or shellac (best red) dissolved in methylated spirits.

Cards are made of different weights of paper; some prefer them thin, and others thick. A moderately thin, tough paper is the best. About 16 to 18 cards to 1 lb., for 400 cards, is a good medium weight.

After the cards are cut they have to be laced into a chain to revolve round the jacquard cylinder on the loom. The usual method of lacing is to have a frame with pegs or studs set in it at a distance apart to suit the size of the jacquard cylinder. The cards are spread on this frame as shown at A, Fig. 94, and laced with a steel needle, thicker in the centre than at the ends; it is about $2\frac{1}{2}$ in. long, and has an eye in the centre, through which a piece of fine twine is tied in a loop, and the lacing tape can easily be drawn through this. The cards at A are numbered 1, 3, 5, but all the numbers would follow in rotation if the jacquard had only one cylinder; if a double-cylinder machine, half the cards would be laced forward, as at A, and the other half (the even numbers) backward, as at B. The odd numbers usually go to the back of the loom, and the even ones to the front.

Several kinds of cord and tape are used for lacing cards, but two

plies of round cotton cord, well soaped or waxed, is usually the most satisfactory for wear.

When lacing cards, the lacings should be crossed over, each one passing from left to right of the other in turn, at each hole and between the cards. This is important, to keep the cards straight.

The cards should be tightly laced, as the lacing is almost certain to stretch a little; so that they are better for being rather tight for the cylinder at first, otherwise they are liable to become too slack after a little wear, and if such is the case they will not fall properly on the cylinder pegs. This and other causes—such as irregular expansion or contraction of the cards, badly cut cards, and a long draw on the cards—occasion considerable wear on the peg holes, and now eyelets are being tried in them to avoid the breaking-up of the holes; but it is

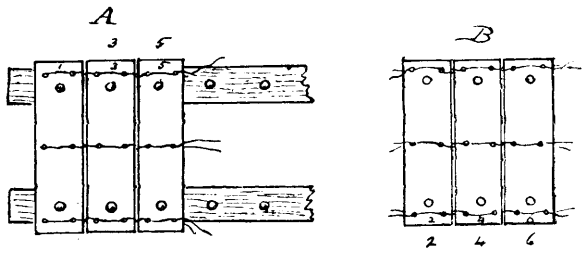


FIG. 94

probable that good paper and careful work will prove a more suitable remedy. The card should not be deeper than the face of the cylinder; better a trifle less, to allow for the lacing to pass between them, and then if laced as tightly as possible they will still be pliable and work freely. Cards are usually numbered with pen and ink, but the numbers may be stamped on with an indiarubber stamping machine similar to that used for paging books.

Lacing Machines.—The Singer Sewing Machine Company brought out a machine some years ago for lacing cards, and it performs its work very well, though many object to it, as it stitches a lacing tape along the cards, instead of lacing them in the usual way. The machine is a 3- or 4-head sewing machine, according as three or four rows of lacing are to be used on the cards. The lacing is a tape; one tape is

laid below the cards at each row of lacing, and another above, and both are stitched together through the cards.

Another machine was invented by Count Sparre more recently which laced or sewed the cards through the ordinary lacing holes, much in the same manner as hand lacing, except that the lacings are looped on each other through the holes instead of passing up and down through alternate holes.

A still later one, by Messrs. Reid & Fisher, of Dunfermline, and Mr. Parkinson, of Bradford, has further improvements; this machine is now working very satisfactorily. Other machines have since followed.

Copying or Repeating Machines.—There are several varieties of machines for copying or repeating a set of cards after they have been cut by the piano machine, and it often happens that this is required in case of several looms being put on the same pattern; or it may be that a set of cards for one loom is made up of two or three parts repeated several times.

One of the simplest of the repeaters is a small treadle machine in which the card is repeated by rows, the holes of the cut card acting upon needles that push in the pins above the punches, which are similar to those in the piano machine; and each row is punched by depressing a treadle. This is a slow method of repeating, but suits for small factories where it is not worth while having a more expensive machine. Any boy or girl can repeat the cards, instead of requiring a card-cutter to read them.

A more useful machine is the railway press repeater; it is taken from the old method of cutting described on page 142. The cards to be repeated are placed on a cylinder the same as that used in the jacquard, and pass down over the ends of long needles similar to the jacquard needles, but arranged in a box, and with long helical springs on them. In a thick plate, or box, in front of the needles is a set of punches, and the stamping plate rests in front of the punch box, close up against it. By means of a treadle the needle box can be drawn forward, and where there are holes in the card to be copied the needles pass through them, and, pressing on the punches, push them from the box into the stamping plate. The punches have heads on them that will not pass through

the stamping plate, but will go into the holes in the box or frame, and when they are pushed into the plate it can be drawn away and turned over so as to prevent them from falling out. The plate is then placed on a box-plate made to hold the card to be cut, and somewhat similar to that shown in Fig 90. The box or hinged plates are set on a slide frame with rollers to travel on, and at the end of the frame is a strong roller press. The plates can easily be run forward to the press, and the card punched by running them under the roller; it may then be taken out, and as many impressions from the plate cut as are required. When finished, the stamping plate is taken back to the punch box and placed against it as before; then, with a comb, or block of wood, set

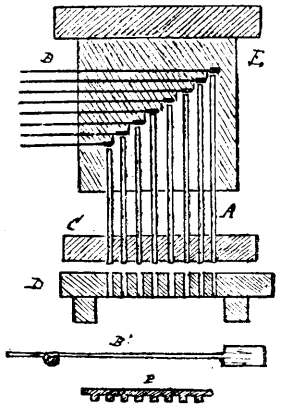


FIG. 95

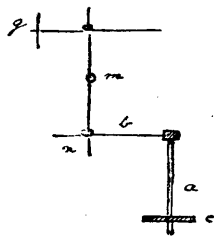


FIG. 96

with pins, all the needles are pushed out of the plate into the punch box. Another card can be brought before the needles, and the plate filled as before.

This machine is very useful for copying damaged cards, even when a repeater as those about to be described is at hand. A damaged card can be held between the needles and punches, and the plate filled, same as when copying a set.

Figs. 95, 97, and 98 show the principle of working three of the best-known repeating machines, which will copy a set of cards at the rate of from 40 to 60 per minute. Fig. 95 shows the arrangement of the punches in Nuttall's patent repeater. The punches are shown at

A, and the stoppers or keys at B; the cards to be punched pass in between the blocks C and D. B^1 shows the shape of one of the stoppers which, when over a punch, locks it, and causes a hole to be cut in the card. The stoppers all stand over the punches when at rest; the cards to be copied are hung on a cylinder, and act on a set of horizontal needles, *g* (Fig. 96); these needles have upright wires, *m*, *n*, passing through eyes in them, and also through eyes in the stoppers *b*. The upright wires act as levers, working on centres, *m*; and when one of the horizontal needles *g* is pushed back by the card to be copied, the corresponding stopper *b* is drawn from above the punch *a*, which allows it to rise when the card to be cut is raised up against it by the block D (Fig. 95), between which and the punch block *c* the cards to be cut pass, so that no hole is punched in the card; but where there are holes in the card to be copied, the needles *g* are not pressed back, and the stoppers are allowed to remain over the punches, locking them, and causing holes to be cut in the card pressed up against them.

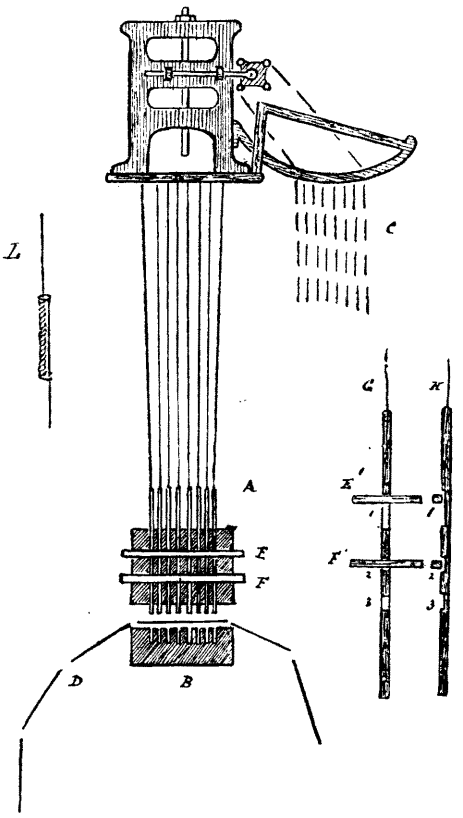


FIG. 97

This machine has been superseded by one in which upright rods act as stays on the punches. These rods stand on the punches, which have concave tops on them; the upper ends of the rods rest under the

bars of a grid, or rebated plate, shown in section at P (Fig. 95). When in this position the punches are all locked. A set of needles are connected with these rods, and when the card to be copied presses on them, those that are pushed back move the top of the rods connected with them from under the bars to the spaces between them, which allows

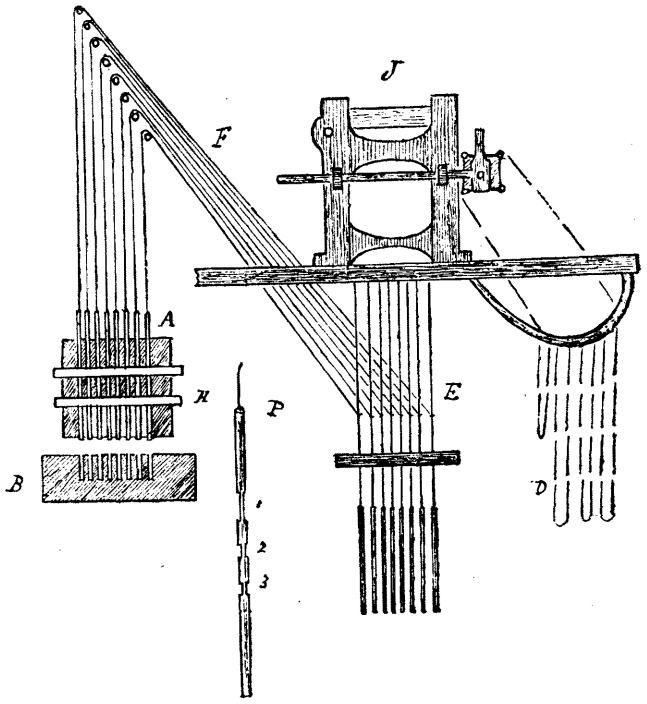


FIG. 98

the rods to rise up with the punches when the card to be cut is pressed up.

The principle of a repeating machine made by Mr. McMurdo, of Manchester, is shown in Fig. 97. The cards to be copied hang on the card frame of a jacquard, as shown at C. From the hooks of the jacquard to the punches A are wires in the form of a single harness. The blank cards D pass in over the block B, which is stationary. Enlarged front and side views of a punch are given at G and H. At 1, 2, and 3

are shown the notches cut in the punch, through which the slide bars E and F pass. These slides are also shown at E^1 and F^1. The bar E is stationary, acting as a stay for keeping the punches in the box, and the notches in them, at 1, are long enough to let them slide up and down on the bar. The slide F is drawn out before the jacquard is drawn, and pushed in again afterwards; if any of the punches are raised by the jacquard, the notch 3 will be raised to the position of the notch 2, and the slide bar will pass through the lower notch, thus holding the punch up, and when the punch block is pressed down, holes will be cut in the card where the punches are locked in the upper notch. When the punch block is being sunk to punch the cards, it is necessary to have a spring in the wires that connect the punches to the jacquard hooks, and this is effected by having the wires made with a sliding joint and a small spiral spring on them, as shown at L.

The principle of Devoge's repeater is shown in Fig. 98. This is one of the oldest machines in the market, and there are various opinions as to whether it is excelled by any of the others, or not. It is somewhat on the principle of the French repeating machines, being wrought by a jacquard and harness, E, to which a second harness or set of cards, F, is attached, and passes over pulleys to the punches A. When the harness E is drawn by the jacquard, the cords F are slackened, allowing the punches to drop, and they are locked in the punch box by the slide bar, H. The cards to be copied are shown at D, and those to be cut pass through at C. The punch block is stationary, and the block B rises against the punches with the card on it.

The blank cards require to be laced to make them ready for the repeaters, and also to have the peg holes cut in them; blocks are provided for the purpose of cutting the lace and peg holes. An enlarged view of a punch is shown at P.

WIRING CARDS

After the cards are laced, if intended to be wrought on power looms in the usual way, they require to be 'wired'—that is, to have pieces of straight stiff wire, about 2 in. longer than the cards, tied across them

to the lacing, so that they may be hung on the racks or frames prepared for them on the looms. The wires should project 1 in., or rather more, at each end of the cards; they should be tied to the under side of the cards, so as not to come against the jacquard cylinder, and it also bears them better, being under the lacing. A piece of waxed twine is mostly used for tying them on.

The distance between the wires depends upon the number of cards, and the height they are when on the loom. For a small set, a wire to every fourteen or sixteen cards is a very good distance apart, but for a large set a wire to every twenty or twenty-four cards will be sufficient in order to give a longer drop and take up less lateral space.

CHAPTER VI

SPECIAL JACQUARDS AND HARNESSES

CROSS-BORDER JACQUARDS

A DIFFICULTY has always existed in working cross borders on handkerchiefs, cloths, &c., so as to avoid having to shift or change the cards, and also to do without the expense of getting a complete set of cards cut for the whole cloth. It may be also that different patterns are required on the cloth, such as cross bands of small figures, and if, say, twenty cards would make a repeat of one figure, and it was required to weave, say, 100 repeats of this, and then change to, say, fifty repeats of some other figure, the same difficulty would arise as with cross borders. When there is only a short distance between the changes of pattern, it will generally be found more profitable, all things considered, to have the complete set of cards cut, so as to require no changing, particularly if the pattern will run for a length of time ; but when the patterns or cloths are long, the cards become very expensive, and even if it would be desirable to get a complete set for the full cloth, it may be that there would not be space on the looms to hold them, over 15,000 cards being sometimes required to weave a complete tablecloth.

Many methods have been adopted to remedy the inconvenience and to save expense. A few of them will be given, but it must be left to manufacturers to judge whether they would prove an advantage to them or not.

For weaving cloths or curtains it is a common practice to have the cross-border cards and one repeat of the centre pattern cut. The card rack is made as in No. 2 (Fig. 99).

When either the border or centre cards are working, they are put

into the hollow part of the rack or card frame, as at F, and the other set is hung on the flat rest of the frame, at either D or E. When a change is to be made, a card-shifter has to go up and change from one set to the other, lifting the set that had been working out of the hollow of the frame, and putting it back or forward on the rest D or E, and bringing the set which is to work down into the place of those removed. This, of course, is expensive, gives a great deal of trouble, and is severe on the cards; at the same time, in many cases it is found to answer as well as any method yet adopted, particularly where space is a consideration, and when two or more sets of cards are used, in case of two or more machines.

A better plan is to have a sliding-card frame, as shown in No. 1 of

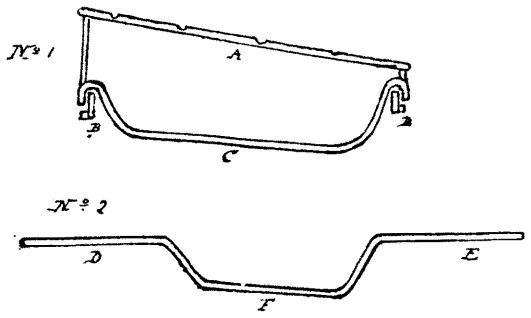


FIG. 99

the same figure. A is the frame for the rollers over which the cards travel, B, B are two bars on which the card frame C, with the roller frame A attached, travels. The card frame is only shown in end view. Two of these must be for each set of cards, and the whole frame must be fastened together complete for all the cards required, so that it will all slide on the bars B, B. Suppose there are two machines working there must be four card racks; on two of these the centre cards are hung, and on the other two the border cards. Either set can be placed opposite the cylinders of the jacquard, and wrought as long as is required; then they must be taken off the cylinders, the card frame shifted till the other set of cards comes into their place, when they can be put on the cylinders and wrought over. This is a very good plan for working

long cloths, but takes up a good deal of space, and for more than two machines might in many cases be unsuitable.

Another method is to have two sets of card irons, one above the other; the border cards are hung on the lower frame, and the centre cards on the upper one. The centre cards will work in the usual way, and when the border is to be wrought the cards for it are taken round the centre set, which, of course, are taken off the cylinder. The rollers must be made to shift so as to direct the cards properly into their respective frames; the top frame is smaller than the bottom one, and farther out from the machine. If hooks and eyes are sewn on the first and last cards of these sets, the weaver can hook them together when a fresh pattern is required, so that the one set will carry the other round the cylinder. Then, by drawing a cord, the rollers should

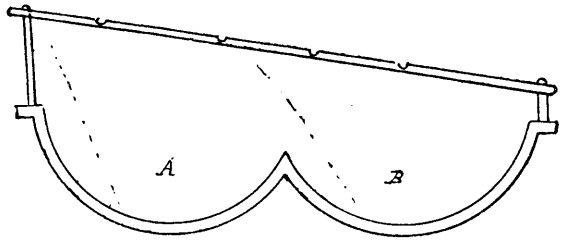


FIG. 100

change position so as to direct the falling cards into the proper frame. The card irons are of the usual shape, and the distance between the upper and lower ones may be regulated by circumstances.

Another simple method is to have the card frame made with a double curve in it, as shown in Fig. 100. One set of cards hang in each of these curves, as at A and B. The set in the curve A can be wrought over as long as required; then these cards can be taken off the cylinder and the set at B put over it. One thing must be observed: that the frame and rollers be so placed that the cards can be guided into the receptacle B, and to do this there must be a considerable fall for the cards, so that for a loom with a low framing this might not be feasible. Otherwise, it is a simple method of arranging two small lots of cards, and if one lot is much larger than the other, let A be a narrow

curve, and the small lot of cards hang in it, which will lessen the slant of the cards falling to B.

Although such arrangements as the foregoing are required where there is much machinery used, it is evident that for frequent changes they would take up quite too much time. Several machines have been made for the purpose of changing from one set of cards to another without having to move the cards. The principle of these machines is to have two cylinders, one at each side ; one set of cards is placed on one cylinder, and the other set on the other cylinder, so that by working one or other cylinder, as required, either border or centre may be woven. No. 1 (Fig 101) shows a plan that was tried some time ago, but did not work satisfactorily. The needles passed through a needle board at each side of the machine, as at A and B, and had small spiral springs fastened on them inside the needle boards. The border cards could be put on the cylinder at A, and the centre cards on that at B. The cylinder at A could be wrought as a single-acting machine till a change of pattern was required; then the cylinder at B could be brought into action, and that at A remain stationary and clear of the needles. The heads of the hooks were made heart-shape, as shown, and the blades of the griffe could revolve into the position shown by the dotted lines, so as to suit the working of the cylinder at B ; this was effected by the weaver pulling a cord. This machine was given up, as it was difficult to keep it in order.

Another method is shown at No. 2 (Fig. 101), where there are two griffes—one at F, and the other at G ; one cylinder works at E, and the other at D. Only one set of springs is required on the needles—behind the needle board E—as the spring of the hooks is sufficient to act in the opposite direction. When the cylinder D is working the lower griffe is stationary, and when the cylinder E is working the upper griffe is stationary. The cylinders and griffes are brought into action as required by suitable mechanism. This machine has not been considered sufficiently successful to make it worthy of being persevered with.

The principle of Davenport & Crossley's border jacquard is shown in Fig. 102. The upright hooks are as in an ordinary machine. Four of the needles are shown at *b*, and are made in the ordinary way,

with the exception of the eyes in them for the small upright needles *d* to pass through. These needles *d* are connected with a set of horizontal

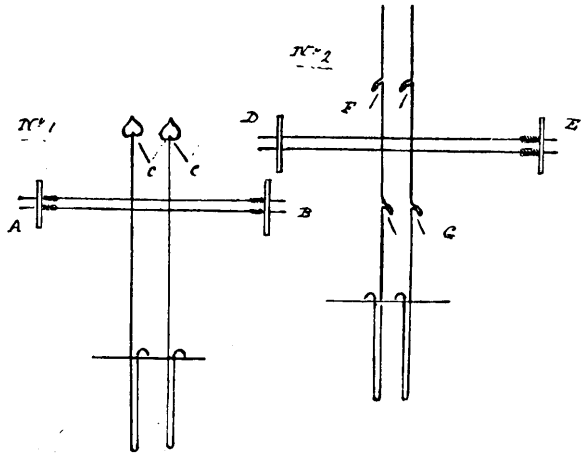


FIG. 101

ones, as shown at *a*, and act as levers between them and the needles *b*, the bars behind them serving as fulcrums ; so that when the needles *a*

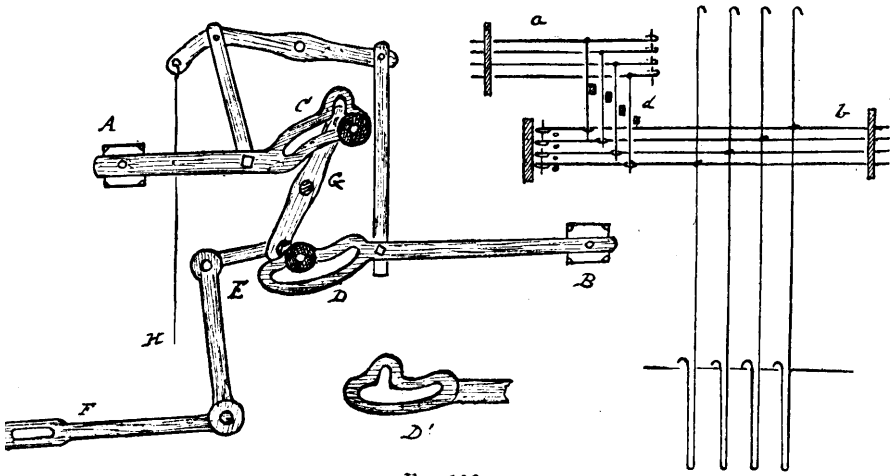


FIG. 102

are pressed back by the cards, the needles *b* are also drawn back through the medium of the uprights *d*. The cards least in action are put on

the cylinder for the needles *a*, and the others act on the needles *b*. The cylinders can be brought in or out of action by the motion shown at A, B, C, D, E, F, G. A and B are the cylinders, working on swing motions; C A, D B, are connecting-rods for giving motion to the cylinders; either of these can be brought into action as required. G is a rocking lever carrying a stud on each end, which work in the slots C and D; these slots are shown at D¹, where the notch at one side of them will be clearly seen. When the stud on the bar G gets into this notch, the cylinder will be driven out and in, but when not in the notch the stud can slide along the slot, allowing the cylinder to remain stationary. By pulling the cord H either cylinder can be wrought as required through the connections shown, one of the connecting-rods being raised and the other lowered. F, E are the levers for driving the rocking bar G. This machine works very well, though the principle of its construction is not all that could be desired, and it requires a considerable space. It can be made a double-lift machine by having two hooks to each needle and two griffes as in the ordinary double-lift, single-cylinder machine.

The principle of Devoge's border jacquard is shown in Fig. 103. C C is the rocking bar, for driving the cylinders, working on the centre D. It is driven by the levers F, G, and the connecting-rod E. The notches A and B fall over the studs on the cylinder frame, and can either be let down or raised, as required, by the cords K, L and the levers H, I. The machine is an ordinary double-cylinder one, and either griffe can be wrought to suit the cylinder that is in action. This machine can be used as an ordinary double-acting one, as a single-acting one raising both griffes together and bringing in both cylinders together, or as a border machine working one griffe and one cylinder at the same time.

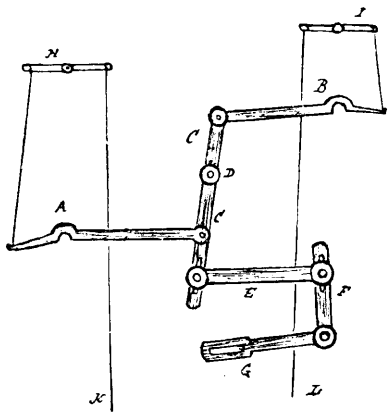


FIG. 103

Another method, similar to the above, is to have a double-cylinder machine with the cylinders wrought by the griffes, then have a stud on the crank-shaft wheel for raising one griffe, as for an ordinary single-acting jacquard, and the two connecting-rods from the griffes made so that either will work on it. A hook or catch can be put in any convenient place, so that when one connecting-rod is on the stud the other can be hooked out of the way. The rods can be made to slide on to the stud easily, and be fastened with a pin, so that the weaver can readily change from one to the other.

OPEN-SHED JACQUARDS

To obviate the vibration of the harness as much as possible, as well as to economise the wear and tear of it and to minimise the friction on the warp threads, especially in weaving patterns requiring heavy lifts, such as warp-faced patterns, Messrs. Priestley & Co., of Bradford, patented an open-shed jacquard, the principle of which is shown in Fig. 104. It did not, however, prove successful, as the tacklers found some difficulty in working it.

The machine is an ordinary double-lift jacquard with one cylinder, and works in the ordinary way. The hooks are made as in Fig. 104, where it may be observed there is a turn or catch on the lower portion of the hook, at A. Above these catches is a set of bars, *b*, like a stationary griffe, and when the hooks are raised by the upper griffe, in the ordinary way, they spring over these lower bars and rest on them when the griffe begins to fall. All the hooks raised would thus remain up, were it not that the cylinder, pressing in for the second griffe (the machine being double-acting), which begins to rise as the upper one begins to fall, presses back those hooks that are not to be raised for the following shot, and as they are held by the griffe above, they spring back at the bottom, and, clearing the bars *b*, come down with the falling griffe. In this way the hooks, when once raised, remain up till pressed off by the card, so that in the case of working a warp stripe with an 8-leaf satin binding the hooks would only fall for every seventh pick.

Another machine has since been tried, but did not work satisfactorily.

In this machine the lifting hooks are formed with loops or hooks, in addition to the top hooks. The hooks are lifted in the ordinary way by the griffes; and upper knives, made to reciprocate horizontally, catch the raised hooks and support them. By suitably timing the motions of the card cylinder the hooks may be kept up as long as required by being transferred from one set of knives to the other. The shape of the hooks and needles is shown in Fig. 105. The needles may be as at b or b^1. This machine acts as an ordinary double-lift jacquard, but has only

FIG. 104

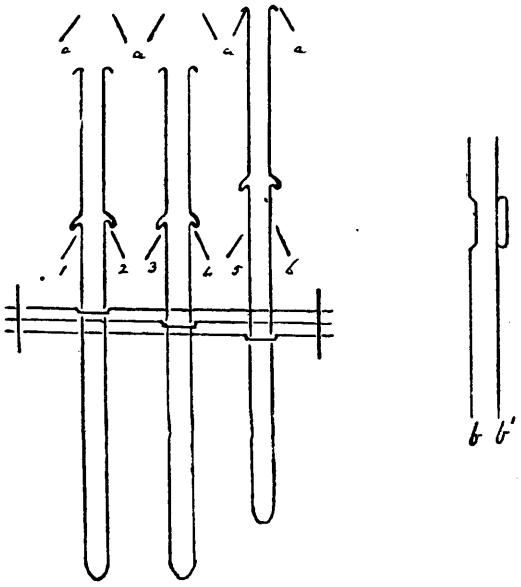


FIG. 105

one set of needles, which pass through needle boards at each side of the machine, and are acted upon by two card cylinders. No springs are required, the hooks acting as springs to keep the needles in position. The cylinders are driven by a tappet, and can be held against the needles as long as required; one cylinder must press on them when the griffes are passing, so as to prevent those hooks which are descending from being taken up by the ascending griffe. There are two griffes; three of the knives of the one are shown at 1, 3, 5, and three of the other at 2, 4, 6. When these knives lift the hooks by the lower loops

or hooks on them, they deposit them on to a set of knives, *a*, *a*, *a*, *a*, in an upper grid or grating, which has a lateral or horizontal motion.

The lower knives raise the tops of the hooks slightly above these upper knives, so as to clear them, and the upper grid is then moved sideways, taking the knives from under one set of heads of the hooks and placing them under another set. Each time the griffe rises all the hooks not acted upon by the cards will be deposited on the upper grating, and will be transferred from one knife to another at each lift, till the card acting upon the needles keeps them clear of the upper grating and allows them to fall with the descending griffe. In this machine the tugs or tail cords, as used with double-lift machines, are not required, the double hooks serving for two single ones. Other efforts have been made in this direction, but the plan of using small pulleys on the tail cords, between the pairs of hooks, to which the neck twines are hung, is the only one worth mention. The same principle will be found for working the shafts in Fig. 115, and is more suitable for a few shafts than for 400 to 600 hooks, or pairs of hooks.

THE VERDÔL JACQUARD

Everyone accustomed to work large patterns on jacquards, especially on power looms, must have found the inconvenience resulting from a large set of cards. The space taken up, the time and trouble required for changing them, to say nothing of the cost, have been sufficiently felt, but have hitherto had to be borne with as a matter of necessity.

For working fine tablecloths with from 150 to 180 picks per inch, or for curtains where from 3 to 6 cards are required for each weft line of the design, and when from 2 to 4 jacquards are used, the inconvenience and cost of a set of cards ranging from 10,000 to 50,000 are very considerable. The small jacquards described at Fig. 30 make a great saving in the space taken up by the cards, as well as in the quantity of card paper used; but it has been thought that a still greater saving could be effected.

M. Verdôl, of Paris, has for a length of time been endeavouring to perfect a system of substituting a continuous roll of perforated paper

for the cards, and has succeeded in doing so, though it is doubtful if he will be so far successful as to supersede our present method of working. These machines were taken up by Benson's Patent Jacquard Company, of Belfast, in the year 1876, but did not then give satisfaction, the greatest obstacle in the way being the effect of the atmosphere on the paper; and as the needles are very closely set together, it was found impracticable to keep the paper set so as to act correctly on them. This difficulty is now claimed to be overcome by having procured paper which is said to be less liable to be affected by the atmosphere than the brass plates of the machine. Several of these machines have been tried in Scotland, but it will take some time to prove them thoroughly and get the workmen accustomed to them, as they are much finer than the jacquards in general use.

The Verdôl machine consists of a small jacquard, the ordinary French make of machine, which is usually made with 440 and 880 hooks for the single and double machines respectively. In addition there is a frame or box attached to the front of the machine, against the needle board, containing another set of horizontal and vertical needles or wires, which act upon the ordinary needles of the jacquard, according as they are acted upon by the perforated paper. Fig. 106, Nos. 1, 2, and 3, shows the principle of the machine. B, B show the needles, and D, D the uprights or hooks of the ordinary jacquard; only four of each are given, but sixteen are used. N is the face-plate or needle board, and O is the clap-board used for bringing back the needles, which have no springs on them; but the hooks are turned up double, and the back or turned-up portion of them, coming against horizontal wires or bars, shown in section above the needles, acts as a spring to keep them steady. This portion of the machine is a complete jacquard of the ordinary French make. In addition to this there is the apparatus on which the perforated paper acts, and which communicates this action to the jacquard. It consists of a box or frame containing two sets of wires—one set horizontal, as A A, about 6 in. long, and terminated at one end by a small head, as shown separately at A^1, which are called hitting wires. The other set is vertical, as C C, of fine wire, having a loop on one end, by which they are suspended in a frame, and

a loop in the centre, which passes round the horizontal wires. These are called the vertical needles or feelers; one of them is shown separately at C[1]. The points or lower ends of these needles pass through a horizontal brass plate, G, called a guide-bar. The hitting wires pass through a guide-plate, M, placed so that their heads will come exactly against the points of the needles in the jacquard, as shown in the figure. The other ends of the hitting wires lie loosely in the loops of the vertical needles, C. Underneath the guide-bar G is the curved brass

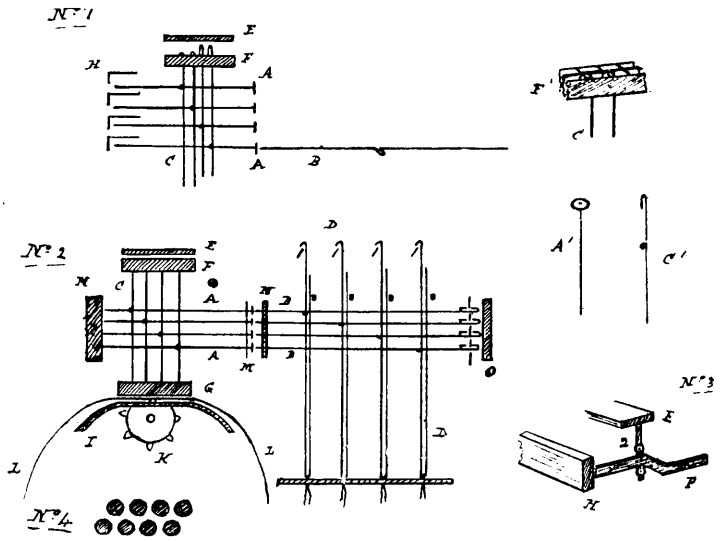


FIG. 106

plate I, which is in lieu of a cylinder. Between the cylinder and the guide-bar G the perforated roll of paper I I passes; there is just sufficient room between them for it to pass freely through, as it is moved forward by the stud wheel K. The paper may pass from one cylinder or reel to another, or may hang in folds in the same way as cards usually hang. At the points of the hitting wires is a grid or pushing frame, H, with an iron angle-bar across above each row of wires, as shown in section in No. 1 at H. There is a clap-board above the small vertical needles, which is shown raised at E in No. 1, and down in No.

2; this is raised and lowered with these needles, and serves to bring them all down when raised. E[1] shows the way in which these needles are hung in the frame that supports them. When the machine is working the frame H has a horizontal traverse coming against the ends of the hitting wires when they are pressed up by the card on the cylinder, and, pressing them against the needles of the jacquard, push them back as an ordinary card cylinder would. It may be seen in No. 1 that two of the feelers are down and two are pressed up, as they would be if two holes were cut in the paper and two uncut; the two that are up raise the hitting wires connected with them, and it will be observed that this raises the points of the hitting wires so as to come against the angle-iron of the grid H when it is coming forward; whereas the two hitting wires that are not raised will pass through, and not be pushed back. This enables the card paper to act on the needles of the jacquard in the same way as if coming directly on them, as cards do. The cylinder has a slight vertical motion, rising about $\frac{1}{8}$ in. The needles, when the cylinder is down, do not pass through the plate G; it is perforated through and raised by the cylinder ascending. When the frame H is pressed forward the clap-board O is pressed back.

The card paper is of a special make, thin and tough, and is strengthened along both sides and in the centre by strips of paper pasted along it where the stud holes fall. No. 3 shows the motion by which the clap board E is raised and lowered by the sliding of the cranked bar F between the two studs 2. No. 4 shows the size and pitch of the holes in the hard paper. These are traced from the paper, and lie diagonally, two rows of 8 making one row of 16 hooks in the jacquard.

These machines are working in large numbers in France, and appear to give more satisfaction there than here, partly because they are better known, and the French workmen are better adapted to handle the small parts belonging to them. A coarser machine is more suited for the ordinary workmen to be found in the factories of this country. But it is strange if a machine of a pitch about half-way between the French jacquards and ours would not be better than either; not taking up so much room as ours, and not so minute as the French. However,

in many cases the machines we have in use are none too large to give sufficient latitude for the errors often found cropping up in work, none of which should occur, of course, though they often do, through carelessness or otherwise. For instance, the card cylinder may be a little off the pitch, and the cards may be affected by damp, or may not be correctly cut to suit the cylinder; the points of the needles may be a little bent by the cylinder, or by the carelessness of the weaver when turning back her cards, and the cylinder may not be set quite fair for the needles. Mr. McMurdo, of Manchester, has made a very nice machine of the same pitch as the French ones, with 1,296 hooks, 16 row cards. It works as a double-acting machine with two cylinders and two griffes, but only one set of needles acting on the two sets of hooks. Two of the hooks are shown in Fig. 107; each needle clasps two hooks and passes through a needle board at each side of the machine. There is no spring on the needle, the hooks forming the spring, the tops of the hooks coming against the cross-rods at A A. Otherwise, this machine works in the usual way, and is very compact where a large number of hooks are required in a small space.

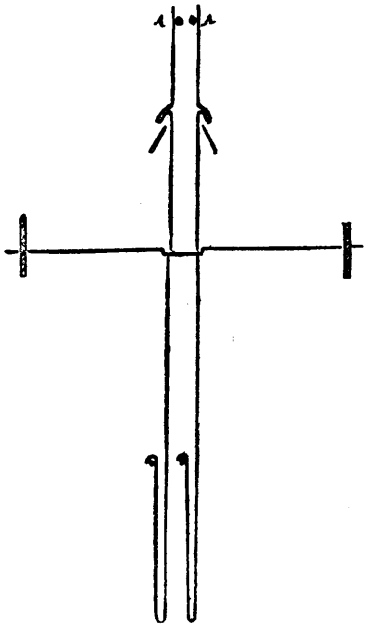


FIG. 107

The card-cutting machine used for the French system of work is a very elaborate contrivance, being more like a jacquard loom than any of our card-cutting machines, at least in so far as the harness is concerned. The principle of it is seen in Fig. 108. A shows the set of cords by which the punches are wrought. The method of preparing the pattern to attach to these cords has been referred to before, but will be repeated again further on. These cords pass over the pulleys

B and down through a reed to the lingoes C, which keep them in tension. Another set of cords pass from these over the pulleys D and down to the punches F. When any of the cords at A are drawn the punches connected with them are dropped, as raising the lingoes lets the cords pass over the pulleys D. When a punch is let fall, it is caught by one of the angle-irons of the grid G, which is pressed forwards when a card is to be cut. The card paper is on the roller H, and passes down in front of the punches at I, which, when pressed

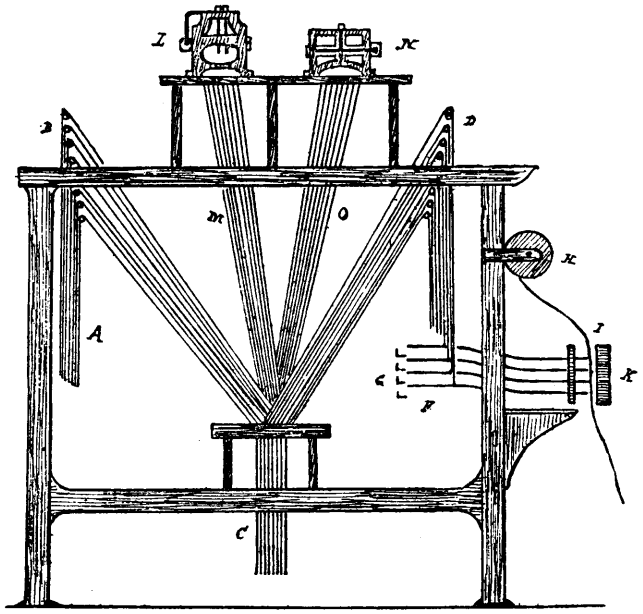


FIG. 108

forward, punch the paper between them and the block K. Any punches that are held up pass through the grid over the angle-iron bars. Only four punches are given, but sixteen are used in the machine; they are here drawn out of scale to show them more clearly. This portion constitutes the cutting machine; it is worked by two persons, one behind, to draw the cords, and another in front, to punch the paper by depressing a treadle each time a draw is made. In addition to cutting from the pattern the paper can be cut from other sets of cards, as in a repeating

machine—cut either on the English or French system. N is the French machine, and a set of cards can be put on it and copied, the cords O acting on the punches; English-cut cards can be put on the machine at L and copied, the cords M acting on the punches. Of course, when one portion of the machine is working, the other parts remain idle, and it might be better to have them separate if much work is wanted.

The pattern is prepared for this machine by hand, working one repeat of it as follows:—The design, painted on point paper, is placed on a frame in an upright position, and over each line on it is stretched a vertical cord, which is taken as warp. The picker then takes a bobbin of weft and inserts it under every cord that passes over a painted dot on the first weft line of the pattern, keeping it in front of all the cords that pass over blank spaces, just in the same order as a shuttle would pass through if the shed were to be opened by a jacquard. When this is done the next line of the design paper is picked similarly, and so on, till a complete repeat of the design is loosely woven with cords, which are made of well-twisted harness twine. This process is somewhat similar to reading the pattern for the draw loom, *which see*. For coloured work a shot would require to be worked in for each colour on any weft line, the same as it is to be woven. When this is prepared, it is taken to the cutting machine and the warp tied to the cords A, the weft showing the warp ends to be drawn for each card.

HALF HARNESS AND MUSLIN HARNESSES

So far we have been speaking entirely of 'full-harness' work. Though the principle of mounting is much the same in all classes of harnesses, there are certain deviations peculiar to each.

One drawback to the full harness is the amount of machinery required to give a large extent of pattern, an upright hook and a needle being required for each thread in one repeat of the pattern. In a half harness only half the amount of machinery is required on the same fineness of cloth to give an equal extent of pattern; but it is only for a few classes of goods that this method of working is suitable, leno

curtains and muslins being the principal. Leno curtains will be mentioned under gauzework, as they are wrought with a gauze mounting, but on the half-harness principle. Figured muslin curtains, with a plain ground and coloured flowering, are called 'crêtes,' or 'crête curtains'; these are now generally wrought in a full harness. Figured muslins are much of the same class of cloth, but are not figured with colour and tint for the half harness, known as the 'common spotting harness,' or 'book harness.' For working them the harness is mounted in the ordinary manner, but only half as many cords are required for it as there are threads of warp. Only half of the warp is drawn into the harness, the other half—every alternate end—passing through it, and being drawn into a plain leaf of heddles, which is hung close in front of the harness. In fine work two leaves of heddles may be used as one, to prevent crowding.

The ground of the cloth is a plain texture, and was formerly wrought by having two leaves of long-eyed heddles in front of the harness, into which all the warp was drawn, this probably being more convenient for the hand-loom weaver; and besides, a more even plain ground can be made with the heddles than with the harness and one leaf of heddles. Two shots of ground, or fine weft, are given to one shot of figuring, or coarse weft, usually cotton rove; but to avoid using a pick-and-pick loom when working by power, the coarse shot may be made by throwing two finer ones into the same shed. In power looms the ground is wrought by raising the plain leaf of heddles and all the harness alternately, and the figuring shed is formed by drawing the harness with a card acting on the machine. The pattern is painted solid, without any twilling or binding on either ground or flower, so that the figuring shot will be in a plain shed for the flower, but will be loose or unbound over the ground, and is afterwards cut off in a cropping machine.

The plain shed, into which the thick weft is thrown, must also contain the shot of thin weft thrown in either before or after it, according as the figuring shed follows the plain shed made by raising the harness or the heddles; for supposing the heddle shaft to be raised and a ground shot thrown in, then the shed reversed by raising the

harness and another ground shot thrown in, then the figure shed formed by raising 50 or 100 hooks of the harness, this opens portion of the last shed, and the figure weft will be thrown in along with the last shot of ground. When both wefts are white this is of but little consequence, but when using coloured wefts for the figure the ground weft would be liable to show along with them and injure the pattern. This was originally overcome by adopting the 'paper harness' from the shaft mounting for weaving paper spots. In this mounting two sets of shafts and two harnesses are used, one behind the other. Half of the warp—all the odd numbers of threads—was drawn on the back

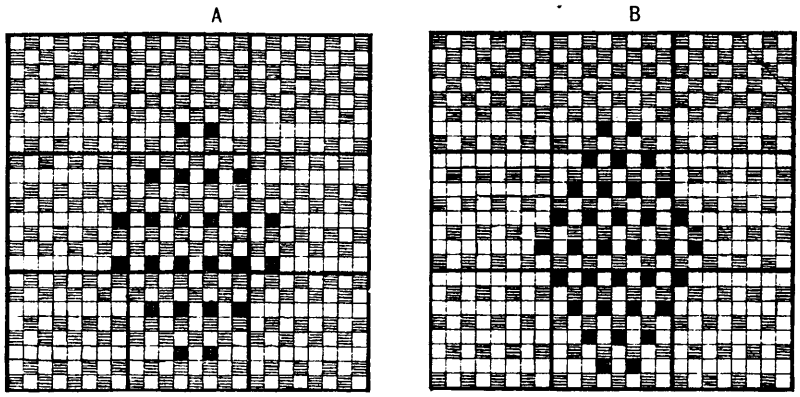


FIG. 109

harness, and the other half—all the even numbers—on the front harness; this would be sufficient to make the cloth, but a pair of leaves of long-eyed heddles were used for working the ground, acting as pressers. On this method of working, a ground and a figuring shot are thrown in alternately, as either half of the warp can be raised by the harness for the figuring shed, and a richer spot is thus given; but still, the rove or figuring shot would fall into the same shed as the ground shot, which may be seen by examining the two spots given in Fig. 109, A being wrought on the common spot or half-harness mounting, and B on the paper-spot mounting. The grey shots are the ground, and the black ones the figure. However, in the paper-spot mounting it is

not necessary to throw the rove into a plain shed; any suitable twill may be used for binding the figure, and will give a much richer effect on one side of the cloth than plain, and tie down the ground shot, which will go into a plain shed.

This principle of mounting is now done away with, as it has no advantage over the ordinary full-harness mounting, which can also have a pair of presser leaves of heddles in front for working the ground, if desired; but they are unnecessary in a power loom, except when a very level ground is required.

A twilled or flushed figure may be formed with the common half harness, but only having half the warp for binding causes it to be loose and ragged round the edges.

To work a large pattern, perhaps the most economical way, at least in the hand loom, is to use a pressure harness with two threads in the mail, and with four presser heddle leaves in front. The number of leaves regulates the twill on the figure. The cloth may be woven pick-and-pick, ground and figure, or 2 picks ground to 1 of figure. When the harness is drawn for the figure all the heddles must be sunk but one leaf, and sinking the two front and two back leaves alternately, raising the back ones when the front ones are sunk, and *vice versa*, will form plain cloth with the draft 1, 2, 3, and 4 over the leaves. A 4-leaf twilled figure can be made with this mounting, but still it will not have the advantage of the full harness, in which the figure can be varied in twill, and bound round the edges.

SPLIT HARNESS

The term 'split harness' is sometimes applied to the pressure harness when wrought with two threads in the mail, this constituting a splitful of warp, so that each cord of the harness controls a splitful of warp; but this is only the finest description of pressure harness.

The split harness, or 'shaft monture,' was invented in the silk district of Bethnal Green, shortly after the introduction of the jacquard, for weaving rich silks which have about 400 threads of warp per inch, but much less weft—perhaps about one-fifth of that number of threads.

The harness is wrought with the ordinary jacquard, but there are two mails and lingoes attached to each neck cord, as shown in Fig. 110. A, A are the neck twines, B is the cumber board, and D the mails. If this mounting were wrought with the jacquard only, it would produce the same effect upon the cloth as if two threads were drawn into each mail of an ordinary harness. This would, of course, take away the fine appearance of the cloth. To avoid this a set of shafts, C, C, are passed through loops in the twine above the mails, and are attached to a set of hooks in front of the jacquard, or at each side of it, or may be wrought by a separate dobby. Twenty-four shafts are mostly used, and are usually flat enamelled iron bars. These shafts are for working the ground of the cloth, and can raise each row of mails separately, as shown at No. 1 leash, thus splitting the pairs of threads that are connected with each hook of the jacquard. One or more of these shafts, according to the texture required for the ground, are raised at the same time that the jacquard draws the figuring shed. No ground texture is put on the pattern for the cards, but the figure must be twilled, or have the binding marks cut on the cards for it. The binding of the figure will be in pairs of threads—that is, two threads of warp must sink together under a weft shot, though on the design these two threads will appear as one, as they are wrought by the same hook of the machine. On account of the number of warp threads, rising and sinking in pairs will not much affect the appearance of the figure; though it must be coarser than if the threads were bound separately, and will also have a rougher or more ragged outline; but to get a large figure with so much warp would necessitate a great amount of machinery if the threads were drawn into separate mails with one to each cord of the harness.

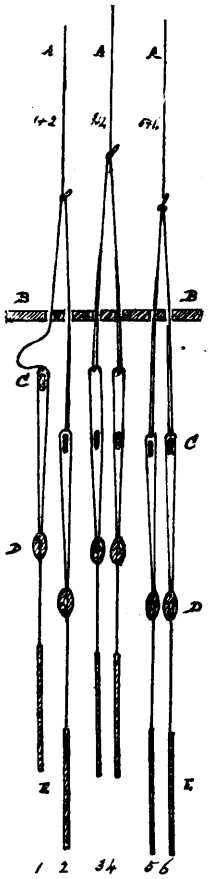


FIG. 110

This method of working is surpassed by the twilling machines now in use (see Twilling Jacquards), though they are more intricate, and would not suit well for a hand loom, as they are heavy to draw.

PRESSURE HARNESS

This is the old draw-loom system of working, and, old as it is, is still in use on our modern hand and power looms on the finest description of damasks, and is not likely to be surpassed for making a good piece of cloth. Much firmer than a harness, and producing the largest possible pattern with the least possible cards, mounting, and machinery it took up its position in the days of the drawboy, and has held itsown, with the aid of the jacquard, against all the inventions of modern times. The principal advantage of this system of working is that a much larger pattern can be produced with the same quantity of cards, mounting, and machinery, than by any other means; but the pattern wrought by a pressure harness will not compare with one wrought by a full harness for fineness of outline or detail. When weaving large tablecloths with 100 or 120 threads of warp per inch, and from 50 to 72, or even 90 in. in the single pattern—that is, when the pattern is all, or nearly all, single—the amount of machinery that would be required to work it on a full harness could not be crowded on a loom, the French system being the only one by which it might be attempted; and even then the difficulty of keeping the machinery and cards in perfect working order would be very great, not to mention the cost of mounting, patterns, cards, &c. The quantity of harness and machinery is reduced in a pressure harness by drawing two or more warp threads into each mail in the harness. Suppose we take 60 in. of cloth with 100 threads per inch=6,000 threads, and allow 3 threads to each mail in the harness, or each hook of the jacquard, 2,000 hooks, or four 500 jacquards, would be required to work the pattern. As many as six 600 jacquards are sometimes required on this description of work when very fine; but three or four 500 or 600 machines are more commonly used on either hand or power looms. To work one of these finest patterns in a full harness 10,800 hooks would be required—say, six 600 machines with

3 threads to each mail=10,800; and almost double this number of cards, even with working them backwards and forwards, would be necessary.

In early times, when the drawboy took the place of the jacquard, 6, 8, or 10 threads were put to each mail, or went to what would now be one hook of the jacquard; and patterns were not usually so extensive as they are now, so that the cords of the harness were greatly reduced in number, but with a proportionately coarser effect of pattern. The difference between a pattern wrought with a full harness and one wrought with the pressure or any of the twilling harnesses, is that the outline is clear and defined in the full harness, and the detail and points of the figures can be turned on a single thread, whereas in the others the edges of the figures will be jagged or in steps, and the points must turn on whatever number of threads are lifted together. The pattern on the cloth must therefore have somewhat of the rough, square effect of the design on point paper, though, of course, reduced in size, but will be worse in this respect—viz. that whereas the edges of the figure on the point paper are clear and well defined, on the cloth they are not so, the rough edges to some extent blending the figure into the ground, and not giving the clean, sharp effect of a full-harness pattern. Shaded effects are also coarse on a pressure harness, but can be made effective if broadly treated. Cloth with 100 or 120 threads per inch does very well to have three threads to the mail, and from 80 to 100 threads per inch suits very well for two to the mail. Any coarser set than 80 threads per inch requires to be woven in a full harness to produce good work, and for superior work nothing less than 100 threads per inch should have two threads to the mail, though 80 per inch does very well.

When several threads are put to the mail, it is also usual to put several picks to each card. The fewer picks, the finer will be the pattern; but a good method of regulating this is to make the checks formed on the cloth square, a little more or less according to the fineness of the pattern required. Thus, if the cloth is wefted square, or a little over that—say, 100 warp by 100 to 110 weft threads per inch—paint the design on, say, 8 × 8 or 8 × 9 paper, and give as many shots

to the cards as there are threads in the mail. If the cloth is to be wefted one-half over square (100 × 150) the same pattern will still do, but with half as many more shots to the card than there are threads in the mail. If there are two threads in the mail there will be three picks to the card, but if there are three threads to the mail there must be four picks to one card and five to the next one. This would be for a pattern on 8 × 8, or square paper. If painted on 8 × 9 paper, which would give an extra card to every eight, and if the weft must not be increased, then four or five picks must be taken off the number given to the eight cards and put to the ninth one, for four cards with four picks to each and four with five picks to each = 36 picks, and thirty-six picks put to nine cards would allow four picks to each. This would make the edges of the pattern a little finer; and if the design was painted on 8 × 10 paper it would be finer still, as there would be more cards to a given number of picks.

In this way any alteration required can be made on the number of picks per inch given to cloth woven on a pressure or twilling harness, without distorting the pattern by varying the number of picks given to each card to suit the shotting. Neither is it necessary to have the same number of threads in each mail; the warp might be mailed 2's and 3's or 3's and 4's, but the more regular they are, the better. If the fineness of the cloth requires to be altered, it may be woven in the same harness without any alteration by varying the number of threads in the mails. For instance, a warp of ninety threads per inch mailed 3's and one with 120 threads per inch mailed 4's would work in the same harness. Similarly, the same set of cards would suit for making different widths of cloth by making the harness narrower in the cumber board and altering the mailing so as to keep the cloth the same set, or it may be made a finer set and not alter the mailing. In either case the pattern would be reduced in size.

Fig. 111 shows a portion of a pressure-harness mounting which is similar to that of the draw loom. It is mounted in the same manner as described for full harness, only that the warp must be divided by the number of threads to be drawn into each mail in order to find the quantity of harness required. The kinds of mails used are shown at A

and B, Fig. 111; it does not do to have more than two threads drawn into each eye of the mail, as they are liable to twist round each other; two will separate easily, but a greater number will not. Ordinary full-harness mails answer very well for a two-thread harness. The mails are levelled in the same position as for full-harness work, viz. about $1\frac{1}{2}$ in. below the level of the back and front beams for hand-loom work, and a little lower for power looms. The lingoes are heavier than those required for a full harness; the weight depends upon the strength of

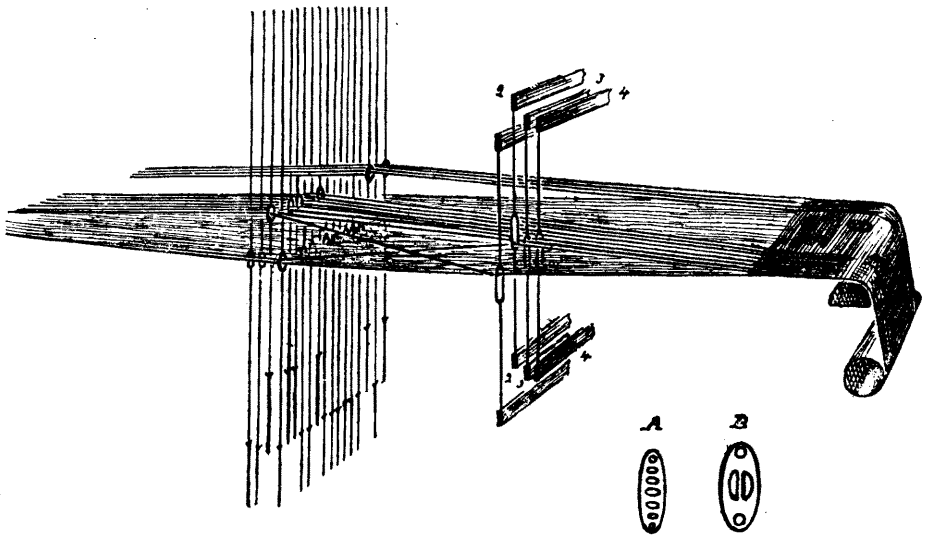


FIG. 111

the yarn and the number of threads in the mail; 10 to 12 to 1 lb. are used in power looms for linen damask with two threads in the mail, having about eighty to one hundred threads of warp per inch. For hand looms they are usually made of lead, thicker and shorter than the wire lingoes, and called 'leads'; 11 to 15 per lb. suits for three- or four-thread harnesses. Light cotton work, such as muslin curtains, only requires lingoes of about sixty or seventy to 1 lb. for hand looms, but from twenty-five to thirty per lb. are used in power looms for two-thread harnesses.

The principle of working the pressure harness is best explained by

the diaper mounting shown in Fig. 2, where a back set of heddles takes the place of the harness, and a set of ground leaves of long-eyed heddles stands in front of the back ones. After the yarn is drawn into the harness or back mounting in the usual way, it must be drawn into the front or presser heddles, using, generally, a straight draught for a satin ground. If Figs. 2 and 111 are examined, it will be seen that when the shed is opened by the harness or back mounting, the heddles in front sink part of the raised warp and raise part of the sunk warp. The mounting raises all the warp of the figuring portion on each card or line of the design paper, and leaves down all the ground warp, so that it is necessary to have the heddles in front to bind the warp and weft, or form the texture of the cloth. For an 8-leaf satin eight shafts are required ; one of these must be raised and another sunk for each shot, so as to raise the binding threads of the sunk warp and sink those of the raised warp, the harness forming the outline of the pattern, or raising the warp of it in a mass. The other six leaves of heddles stand in a middle position, and the long eyes allow the warp drawn by the harness to rise. When the machine is drawn it is held up till as many shots as are to be given to the card are thrown in, but the shed formed by the heddles must be changed for each shot. In working bars up the cloth one card would be sufficient, and when the machine is drawn it would be held so, and the cloth wrought with the heddles ; of course, no machine would be required in this case, one leaf of heddles with the stripes of warp drawn into it would be sufficient for the back mounting. For dices two leaves of heddles would be sufficient for the back mounting, the warp of one dice to be drawn on one leaf, and that of the other on the other leaf; then one leaf would be raised and held up till one dice was wrought, when it would be lowered, and the other one raised and held up for the other dice. For fancy dices and diapers the plan of mounting in Fig. 2 is very suitable and simple, but for a variety of figuring or flowering the jacquard is necessary.

It will be seen that the presser heddles have three positions, viz. a sunk, a raised, and a middle position. The length of the eyes is to allow the harness to open the shed when the heddles are stationary, or in their middle position. They must be a little longer than is required

to open the shed at the back leaf of the heddles; for a 2-in. shed a $2\frac{1}{4}$-in. to $2\frac{1}{2}$-in. eye is used. When the heddles are stationary the lower loop of the eye should be fully $\frac{1}{8}$ in. under the sunk warp, and there should be the same clearance at the top when the shed is drawn; some allow more. The shed for a pressure harness is usually very small in front of the reed, and requires a very small shuttle to be used, from $\frac{1}{2}$ in. to 1 in. deep being the usual sizes. The depth of the shed that can be made depends principally on the elasticity of the yarn. With a linen warp a very small shed can be made, as the yarn has but little elasticity, and if overstrained will hang slack. For it the distance between the harness and the back shaft of the front mounting should be 10 in. to 12 in., and there should be a stretch of 27 in. to 34 in. behind the harness. The draw of the harness may then be 3 in. to $3\frac{1}{2}$ in., and the shed at the back shaft will be $1\frac{3}{4}$ in. to 2 in.; this will allow a shuttle of $\frac{3}{4}$ in. to $\frac{7}{8}$ in. deep to be used. For hand looms the shed is about $1\frac{1}{4}$ in. at the back shaft, and a shuttle of $\frac{1}{2}$ in. deep is employed. The shed must be made very clear and regular, and the smaller it can be kept, the better. With a good cotton warp 7 in. is a sufficient distance to have between the harness and heddles, and will admit of a larger shed being formed; but it is not desirable to have too large a shed, as there is a considerable strain on the yarn, and a small, clear shed is more satisfactory. This would be assisted by bringing the harness as close as possible to the heddles.

One drawback to this method of working is the distance which separates the harness from the fell of the cloth, or even from the reed; and if there is any obstruction to the warp rising or falling, such as roughness in the heddles or reed, or lumps on the yarn, it will not, unless very tight, fall into its proper place, and the shuttle may pass over or under it when it should not do so, giving a picked or darned effect to the cloth; slack threads may cause the same.

The warp must be kept as tight as possible, and all the threads should be at a uniform tension, the heddles straining each thread alike; the harness should be as close to the heddles as the yarn will permit it to be. The space occupied by the harness, heddles, and traverse of lay should be no greater than is necessary; then, with a small but clear

shed satisfactory work can be produced. When drawing a warp into the harness, a boy or girl sits behind, and hands the threads to the drawer-in, who takes them into the mails with a wire hook, and then either hands them to a second drawer-in sitting in front of the heddles, to be drawn into them, or passes them over and under a pair of rods tied across the harness so as to form a lease as she draws them in; and when she has all drawn into the harness, she begins to draw them into the heddles, a straight draught being mostly used for a twill or satin.

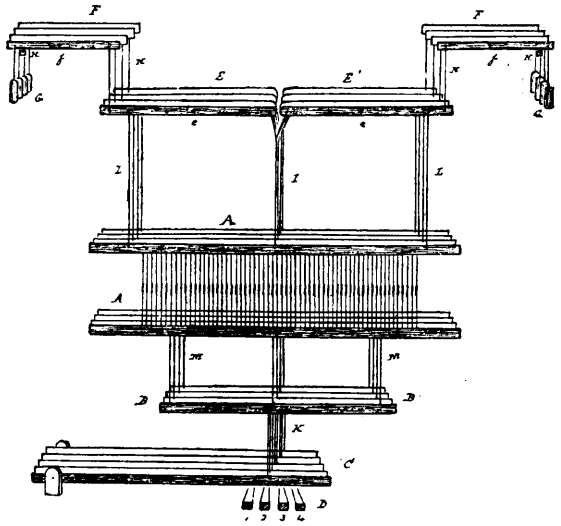


FIG. 112

The front mounting of a damask hand loom is shown in Fig. 112. A, A are the shafts, four in number, but eight are generally used for an 8-leaf satin; B, B are the jacks; C the lams, which require to be one more in number than the leaves of heddles; D the treadles; E, E^1 the upper marches or jacks; F, F^1 two sets of coupers or levers, with their fulcrums at *f*, and loaded at the outer ends with the weights G. Under the ends of these levers is a bar N, to which the weights draw them, and keep the heddles up to their middle position. The cords I are not fastened to the heddles, but pass down through them to the

lams C. The cords L connect the coupers with the heddle shafts. Each lam has two cords tied to it, except the two outer ones—*i.e.* the first and last one—which together act as one, to avoid crossing the cords. One of the cords I is tied to each lam, and also one from the jacks B ; but the first and last lams have only one cord tied to each of them, one having the cord I, and the other that from B. Both these lams are connected with one treadle, and the others are each connected with a treadle. Of course, the cording is made in the usual way, agreeably to the pattern, two methods of twilling being shown in Fig. 113. When the weaver presses down a treadle, one leaf of heddles is raised by the cord I connected from one of the levers E, E^1 to one of the marches or lams C, and one leaf is at the same time sunk by the cord connected from one of the jacks B to the lam connected to the treadle. The other treadles act similarly when corded for a twill or satin.

The cording generally used for an 8-shaft satin is shown at A, Fig. 113. Sometimes the twill is run in the reverse direction. In either case it will be observed that the twill on both ground and figure run in the same direction, which makes one a sateen, or coarse twill, and the other a satin, or fine twill. In order to have both twills alike they require to be run in the opposite direction on the cloth, as shown at B, which will give a fine twill on both ground and figure, on both sides of the cloth, with single yarn. This does not hold good with every twill. When weaving, the weaver presses down the treadle which is connected with the jacquard (another treadle being required for this purpose) with his left foot, then works over the twilling treadles with his right foot, holding down the machine treadle till he gives as many shots to the cards as are required. When the card is to be changed the weaver lets down the machine and draws another shed, striking up the weft again without throwing in a shot or taking his right foot off the treadle. This clears up the shed, and makes the yarn steady before he springs

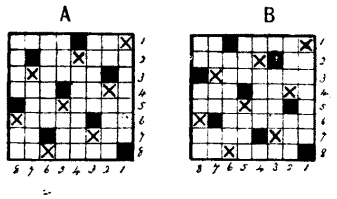


FIG. 113

another shed with the presser leaves, giving a regularity and firmness to the work which it is impossible to get otherwise, but which has to be done without in the power loom. The weft is struck up on the open shot, or before the heddles have closed the shed. Sometimes a sort of dobby is used below the lams, which enables the weaver to work the heddles with one treadle. In power looms a similar principle of front mounting is sometimes adopted, substituting a wyper tappet for the weaver's foot; but a better plan, as it avoids having the cords passing through the yarn and heddles, is to have a box tappet, on the Woodcroft style, made with solid plates, and struck to give the rising and falling motion. The connections from the tappet to the heddle shafts are made in the same way as the ordinary Woodcroft tappet. The jacquard may either be a single or double-lift one. Some prefer the one, some the other. The single-lift is more easily fitted up, especially if the number of shots to the card varies. When the shots on each card are alike, perhaps the steadiest method of lifting the machine is to have a box tappet struck one up and three down, or one up and two down, according to the number of shots on the card. This tappet acts on a bowl on a treadle, to which the rod for raising the machine is connected. For a double-acting machine there must be two treadles and tappets acting alternately. The cylinder can be driven from the rising and falling of the machine with a swan-neck or lever motion, or may be driven from an eccentric on the loom with a pinion on the crank shaft turning it one to three or four shots, as may be desired. When the shotting to the card is irregular there are several methods adopted for lifting the machine griffes, one of the best of which is shown in Fig. 114 for a single-lift machine.

A is the treadle to which the connecting-rod from the machine is fastened by a bolt through the slot at H, or the slot may be in any desirable place. B is a rack in which the end of the lever works, which keeps the treadle bowl steady to the tappet. E is the tappet on the tappet shaft of the loom, and is made so as to act at every shot. D is the fulcrum of the lever, and C is the stand, which is bolted to the ground and fastened to the side of the loom. This portion of the motion working alone would raise the griffe for every shot, the same as

would be required for a full-harness, single-acting jacquard; but when the griffe is raised by the tappet E, it can be held up as long as is desired by letting the bell-crank catch F fall in over it as shown. When the treadle A is in this position the tappet merely touches the bowl, depressing it about $\frac{1}{8}$ in., so as to clear it off the catch; this is to allow the catch to be easily pushed off when it is required to let the treadle up, or to drop the griffe. The catch is moved by the cam or tappet G acting on the bell-crank F. This tappet can be driven by a pinion on the crank shaft or by a catch on the slay. It may be a tappet struck to suit, or a barrel with a set of lags or pins on it, so that the machine griffe may be raised and lowered in any order that is desired.

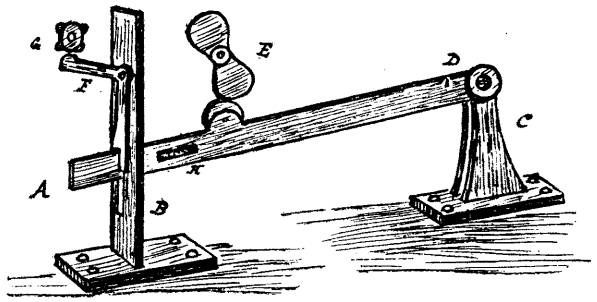


FIG. 114

An ingenious method of working the heddles of a pressure harness by the jacquard was invented in Bethnal Green shortly after the introduction of the original machine. It was used for weaving the richest silk damask, which had 400 threads of warp per inch and about one-fifth that number of weft shots, so that five threads of warp might be drawn into each mail without making the pattern appear any coarser in the warp than in the weft. A sketch of this mounting is given in Fig 115. A shows the hooks for working the heddles, and B those for working the harness. Eight hooks are given for working four leaves of heddles. It will be seen that a cord from two hooks passes round one of the pulleys C, and each of the heddle shafts is attached to one of these pulleys. These hooks may be raised by the griffe of the jacquard, which would require to rise and fall for every shot, or the

griffe may be held up for the number of shots to the card, and the hooks for working the shafts may be wrought by a small dobby. When one of each pair of the hooks A is raised, the heddle shaft connected with it is raised to the middle position, as shown by the pulleys

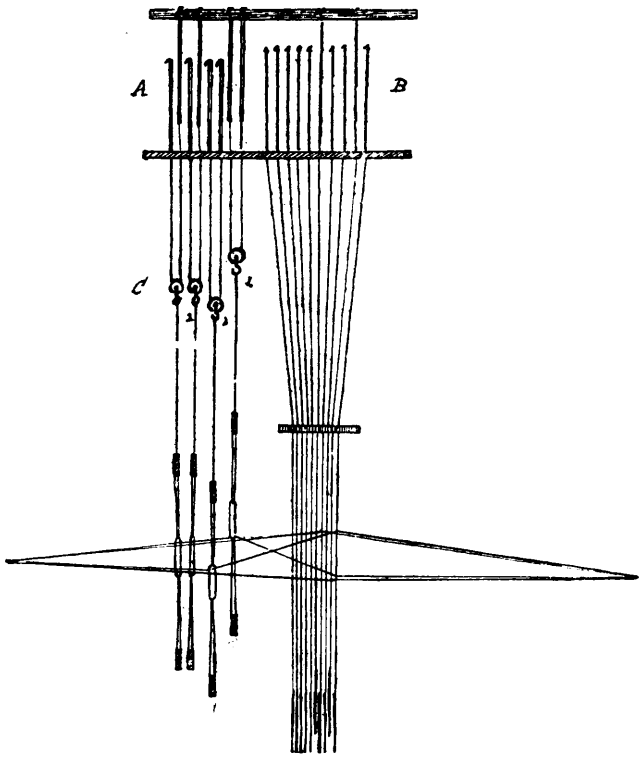


FIG. 115

1 and 2, and the leaves connected with them. If neither of the hooks is raised for any shaft, it will remain sunk, as shown in No. 3; and if both the hooks are raised, the leaf will be raised to its top position, as No. 4. The leaves are drawn down by weights or springs.

TWILLING JACQUARDS

As has been stated before, one of the drawbacks to a pressure harness is the strain which the warp has to undergo when forming the shed. This necessitates having a good warp, which adds to the cost of the cloth, and in low-class goods this consideration may hinder the sale. Many methods have been adopted for working the ground of the cloth without using a pressure mounting. Some of these are explained under 'half harness' and 'split harness,' but none of these methods would produce cloth like the pressure harness. A twilling jacquard to act similar to the pressure harness, but without using the front mounting, or by dispensing with the leaves of heddles, was patented by Mr. Shields, of Perth, in 1859. This machine underwent several improvements, and now there are two varieties of it in use, one known as the Irish or Bessbrook machine, being patented by Mr. Barcroft, of the Bessbrook Spinning Company Limited, county Armagh; the other as the Scotch machine, the improvements being made by Mr. Shields and others. The principal difference between the two machines is that the blades or knives of the griffe have a horizontal or sliding motion in the Scotch machine to enable them to get clear of the heads of the hooks, whereas in the Bessbrook machine they turn out of the way or partly revolve. A full description of the Bessbrook machine is here given. Fig. 116 is a view of the framing of the machine. K is the cylinder, which may be wrought by the swan-neck motion, as shown, but it is better to be wrought by a separate motion from the loom. D is a cord attached to the handle of the shears for reversing the cylinder; E is a brass bushing through which a shaft passes for raising the griffe. The shedding of this machine is exactly the same as that of an ordinary single-acting jacquard. The griffe rises and falls for every shot; the cylinder travels out and in, but does not turn till two or three or whatever number of impressions required are given by each card. To prevent the cylinder turning it is only necessary to raise the shears so that they will not catch it. This is done by means of the tappet A, shown

in Figs. 116 and 117. The roller H on the shears rests on the tappet, which is turned by means of the rack wheel, which is fast on it, and the lever L, which is loose on the stud. This lever is pushed backwards and drawn forwards by the rod I, which is connected to an arm, either on the shaft for raising the griffe, or on one for working the cylinder, and the catch on the lever takes a tooth of the ratchet wheel at each draw, so that with four divisions on the tappet, and 12 teeth in the ratchet, three shots would be given to each card. If it is required to work the cylinder the reverse way, it is only necessary to tie the cord D on the end of the shears to a spiral spring made

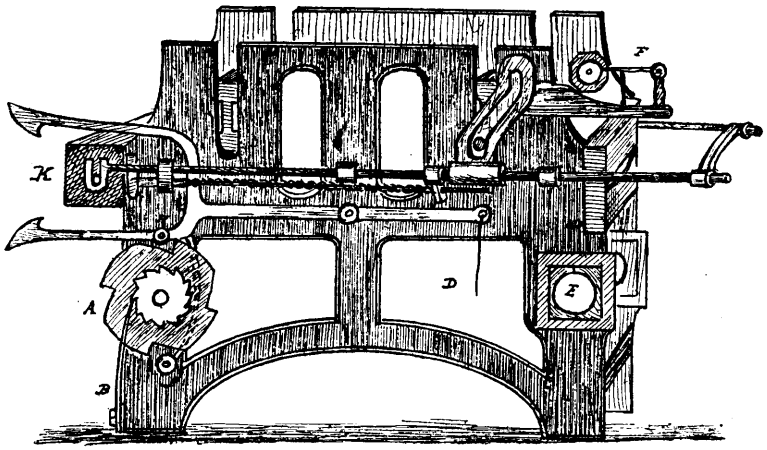


FIG. 116

fast to any convenient part of the loom, then the roller C will be acted upon by the underside of the tappet, and the under hook of the shears will turn the cylinder when required. B is a spring acting as a pawl to keep the ratchet from moving backwards, and there is also a spring shown over the catch which moves it forward; both these springs serve to keep the tappet steady. There are two sets of hooks and needles in this machine—the ordinary set for working the harness, as shown at A (Fig. 118), and a set of twilling hooks, one row at each side of the machine, which are much stronger than the others. The ends of the twilling hooks are hooked round bars, which pass

through the loops at the lower ends of the ordinary hooks, as shown at C (Fig. 118). These bars are kept in their places by a grid D, which is between the ordinary hooks and the twilling hooks. Each of the needles of the jacquard is connected with two or more of the ordinary hooks, as shown at A. The twilling hooks have also needles on them, but they are only for the purpose of keeping them in their places, and are not acted upon by the cards. The springs of these needles are on the ends next the cards, or at the back of the faceplate or needle, as shown at E. The centre support for the knives of the griffe is shown at F, with an end view of two knives GG. The ends of the knives enter the griffe frame at each side, so as to allow them to oscillate or partly revolve. This motion is given to them by a set of bars or flat needles, as shown at A (Fig. 119). A single needle is given at A^1. These needles have each the notch in them over the top edge of two or more of the knives, and are acted upon by a barrel C with studs in it, set to the twill. This barrel rises and falls with the griffe, and is turned from one row of pegs or studs to the next one each time the griffe falls by the head or lantern on it coming down on a finger, as shown at A (Fig 120). B in the same figure is a strong spring to keep the barrel steady and make it turn the correct distance.

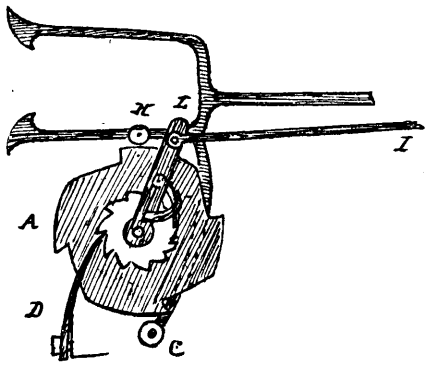


FIG. 117

The number of knives in the griffe must be regulated to suit the twill to be put on the cloth ; they must be a multiple of the twill, and this to some extent regulates the number of needles that must be in each upright row. For example, an 8-leaf twill may have 16 or 24 knives, which would be twice or three times over the twill. If there are 8 rows of needles to 16 knives, or 16 rows of hooks, that would be 2 hooks to each needle, or if there are 24 rows of hooks there must be 3 hooks to the needle ; but if only 2 hooks to the needle are required,

there must be 12 rows of needles to 24 rows of hooks. The same principle holds good for a 5-leaf, or any twill. Eight or 12 rows of needles would not be suitable for a 5-leaf twill, neither would 10 rows of needles be suitable for an 8-leaf twill, if the same number of hooks have to be connected with each needle; but 10 rows of needles with 20 rows of hooks or 20 knives will answer for a 5-leaf twill with 2 hooks to the needle, or would answer for an 8-leaf twill with 24 rows

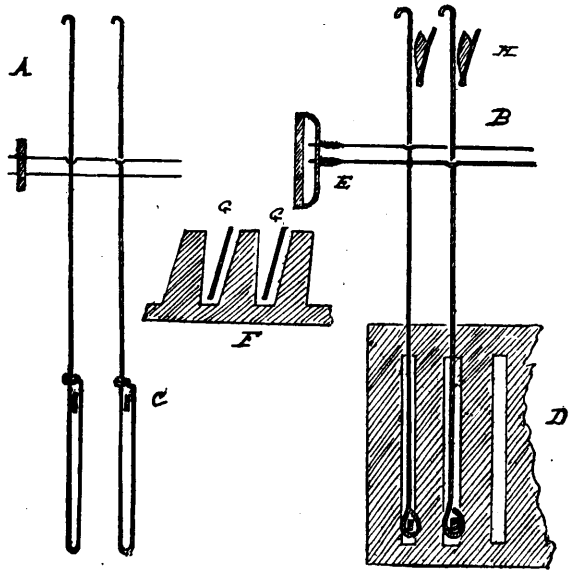


FIG. 118

of hooks, 4 of the needles to have 3 hooks to each, and 6 of them to have 2 hooks to each.

Each of the twilling needles, A, Fig. 119, must be connected with as many of the knives as there are repeats of the twill; thus, for 24 with an 8-leaf twill, the 1st, 9th, and 17th knives would be acted upon by the one needle, and so on with the others.

Now as to the action of the machine. When the pattern card presses upon the needles the griffe begins to rise, and when rising it must lift all the hooks required for the pattern except $\frac{1}{8}$th part of them

which must be left down (in an 8-leaf twill) to form the binding or texture of the cloth. In addition to this, $\frac{1}{8}$th part of the ground warp must be raised for the weft to pass under it and form the ground texture. This is all accomplished by the one rising of the griffe. When the griffe is down, one of the twilling needles, A, Fig. 119, is pressed back by a peg or stud in the barrel, which causes the knives

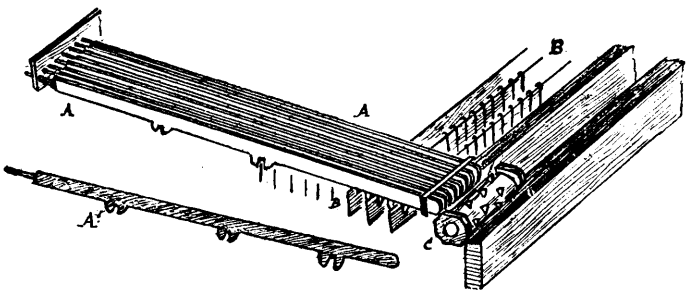


FIG. 119

connected with this needle to turn out of the way of the heads of the hooks, so that when the griffe is rising these knives will pass clear of them, leaving every eighth row of hooks down to form the binding of

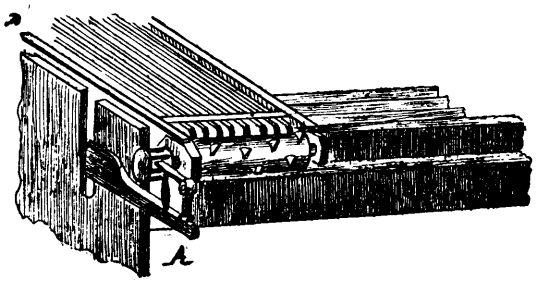


FIG. 120

the raised or pattern warp. In the Scotch machines the knives slide back instead of revolving. As shown at H, Fig. 118, there are projecting pieces of brass fastened on the knives between the twilling hooks. These hooks stand clear of the knives, but when the latter revolve the projections on them push the hooks forward to the next knife, which lifts them when the griffe is rising. The hooks draw up the bars to which their lower ends are looped, and raise the rows of

ordinary hooks through which the bars pass, thus forming the twill on the ground in the same way, but in the reverse direction, that the knives passing clear of the adjoining rows of hooks form the twill on the figure.

The working of the texture requires the griffe to fall for every shot, which would be otherwise unnecessary, and the card must come in against the needles each time to push off the hooks that are not to be raised. This causes wear and tear, which cannot be avoided with this machine, but they work very well, though they are not by any means perfect. There is a good deal of friction on the needles, which causes them to wear quickly; but being so much easier on the warp than the pressure harness, and more easily managed, they are extensively used for large patterns in the fine linen damask trade. They will not make so firm a cloth as the pressure harness, and have the objection that all twills formed with the harness have when there is a gathered tie—viz. that a portion of the cloth will have the twill running in one direction and a portion in the reverse direction.

Like all single-acting jacquards, these machines have no counterpoise in themselves, and being very heavy require one added to assist the loom to raise them. Sometimes this is accomplished by means of a carriage spring placed on a beam or on the top rail of the loom frame; and an arm from the shaft, which raises the griffe resting on the spring, will form a sufficient counterpoise, the spring being made as strong as is required for the purpose. Unless the springs, which are made similar to those used for carriages, are nicely tempered, and the different pieces made so as to slide freely on each other, they are liable to snap when the loom is running quickly. The griffe is generally driven from the fly-wheel on the crankshaft in the same manner as for ordinary single-acting jacquards. It is, however, a better plan to drive it from a crank on a stud wheel gearing into the tappet-shaft wheel. This does away with the necessity for a counterpoise unless the machinery is very heavy, in which case a few strong spiral springs will suffice. The horizontal shaft for raising the griffe, or griffes if two or more machines are used, must be very strong, so as not to twist with the tortuous strain, which is very great. Three of these machines, with 500 or 600 needles to each,

are required for tablecloth mountings when tied up for centred patterns —one machine to work the border, one the centre, and one the portion between the border and the centre ; or two machines to work the double

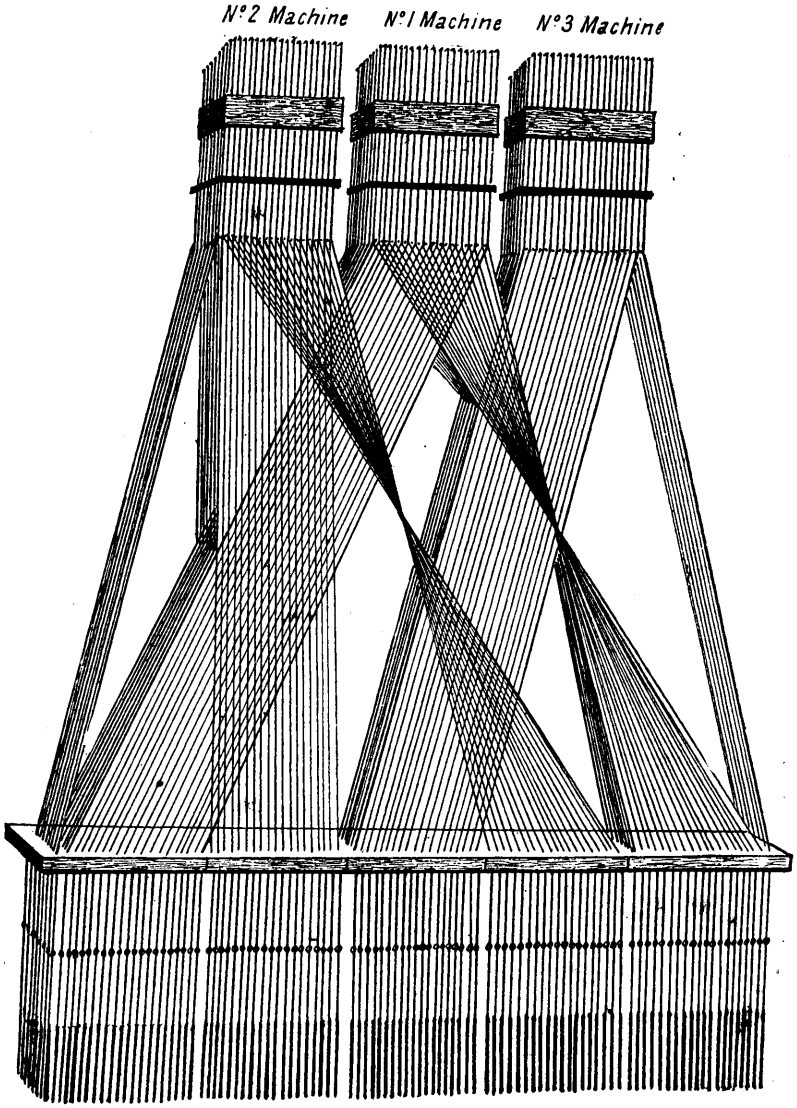


FIG. 121

portion, and one the single portion. Fig. 121 gives a view of a mounting tied up in this way, Nos. 1 and 2 machines being double mounting and No. 3 single.

The Karl Wein Jacquard.—This machine is a twilling jacquard on the same principle as that last described, but performs its work in a more scientific manner. It was patented by Messrs. J. Tschörner and K. Wein, Kesmark, Hungary, and was first introduced into this country at the Glasgow Exhibition of 1888.

The following is a description of the machine exhibited there: The principal feature of this machine is perhaps that each knife acts independently in a grid, and is wrought by a tappet at the side of the loom, so that any row of hooks can be raised or lowered at pleasure, and this without any change of card. Fig. 122 gives an end view of the framing, showing the upper and lower grids in which the knives or lifters slide. An end view of four of the lifters is given at A, 1 and 3 belonging to the top set, which work in the upper grid, and 2 and 4 to the bottom set, which work in the lower grid.

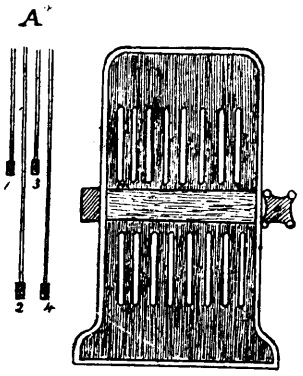


FIG. 122

A perspective view of eight of these lifters is given at B C, Fig. 123, with upright slide bars D attached to them, which slide in the rack or frame E. These bars are for the purpose of making the lifters rise steadily and horizontally, as (which may be seen) they are not all lifted at their centre. Only one connection is fair in the centre, which would no doubt be an objection with a heavy harness to lift; but this arrangement is made to suit for the machine sitting across the loom, for a London tie, and some method of making vertical connections from the levers to the lifters is necessary. The above does very well for a narrow harness if light.

If the machine was fixed on the loom for a Norwich tie, or with the cards to hang over the back, then the connections from the levers might all be at the centres of the lifters and the bars D would only be

required to steady them. The levers for raising the lifters are shown at F, with their fulcrum at I. G is a spring, one of which is attached to each lever to keep it down, as the tappet has not a positive rising and sinking motion, only raising the levers and allowing their own weight and the draw of the springs to recover them. One of the connecting rods from the lever to the tappet is shown at I. Fig. 124 gives the principle of this tappet. A is the lever or treadle with its fulcrum at A; the connecting rod B connects the point of it to one of the top levers F (Fig. 123), and C is a bowl at the other end of it which travels

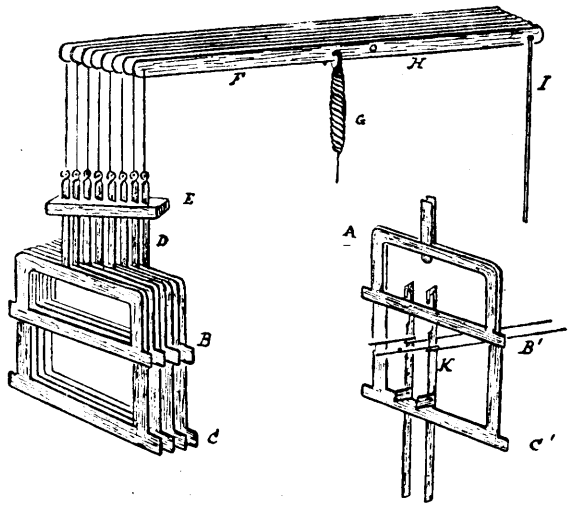


FIG. 123

on the tappet plate D. The tappet is made up of 17 plates struck to suit; 16 of these are for working the lifters and 1 for the cylinder; it sits at the side of the loom like a Woodcroft tappet. For an 8-end satin twill 16 levers are required, 8 for the bottom set of lifters and 8 for the top set. Fig. 123 A shows two lifters B^1 and C^1 with hooks and needles. A hook and a needle on a larger scale are shown in Fig. 125. The hooks are flat pieces of iron cut to the shape shown, with small projecting pieces, as *a*, riveted to them, by which they can rest on the bottom lifting knives, as at C^1 (Fig. 123 A), so that when

any of these knives are lifted a row of hooks will be raised by them. As before explained in reference to the Bessbrook machine, it is necessary when the pattern card presses on the needles for all the knives except one to act, and also for one of the bottom lifters to rise to form the texture of the cloth; the same must be in this machine, and can easily be regulated by the tappet, which should hold up the warp required for the pattern and work the ground texture as well. This is done in the following manner: Suppose there are 16 lifters, 8 top and 8 bottom ones. When the card presses on the needles, 7 of the top and 1 of the bottom lifters should be raised by the tappet, and the top lifter, which is left down, should be raised so far as to catch the heads of those hooks in the row belonging to it that are not pushed back by the card. For the next shot this lifter is raised and another one let down, but it is not let down far enough for the hooks to get off it, stopping at the same height that the first one was raised to, which is easily regulated by the tappet. If there are 3 shots to the card, another similar change takes place; then for the fourth shot all the lifters are dropped, the cylinder presses in, and all but one of the top lifters and one of the lower ones are again raised, and the twill proceeded with as before. It will thus be seen that the shedding for the twill acts as in a double-acting jacquard, but the lift at the change of card is similar to that of a single-acting jacquard. Of course the tappet must be struck to change the lifters according to the twill required on the cloth. In the Bessbrook machine there could be 16, 24, or 32 rows of hooks to 8 rows of needles by having 2, 3, or 4 hooks to each needle, or the number of hooks to each needle might vary and any number of needles might be used. There must be a knife for each row of hooks, but all the knives belong to the one griffe. In the Karl Wein machine there must be 2 lifters for each row of hooks, and 16 of them are enough to have for convenience. In the machine exhibited, 16 hooks, or 2 rows of 8, were attached to 6 needles, 4

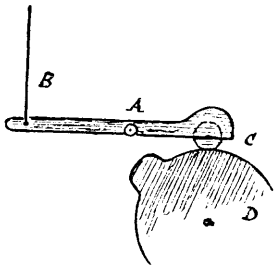


FIG. 124

needles having 3 hooks to each and 2 needles 2 hooks to each, as shown at B (Fig. 125), the thick vertical lines representing 1 row of hooks, and the thin lines the next row. There were 6 rows of needles in the needle board, and the point of each needle was cranked as shown at C; each row of holes for the needles in the needle board, or face-plate, stood between 2 rows of hooks: the first 3 needles were connected with 1 row of hooks and the second 3 with the next row, the cranks of the first and second set of needles being turned in the opposite direction so as to enable them to fall in with the rows of hooks. Of course there might as well have been 8 rows of needles with 2 hooks to each, or 4 needles to each row of hooks.

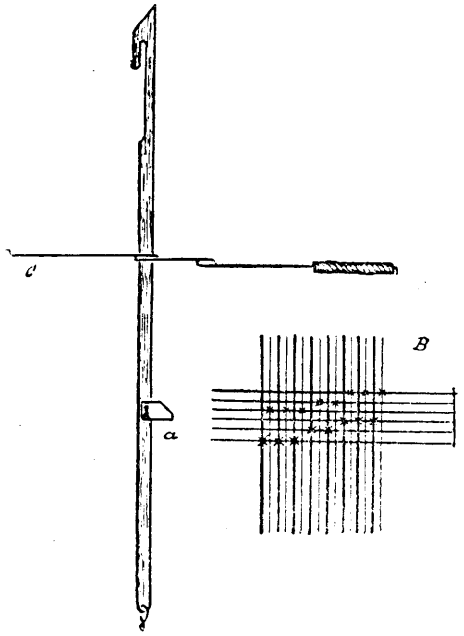


FIG. 125

If necessary to use more than one machine, some arrangement would require to be made for lifting them. It might be done by using a double set of levers with connecting rods similar to those used for twilling looms.

The twilling of the ground might be wrought by a griffe and hooks as in the Bessbrook machine, thus doing away with seven treadles and seven tappet plates, but this would make the twilling a single-acting shedding motion.

Since this was written the machine has been altered so as to make it more suitable to the requirements of the work in this country, but does not appear to gain favour, and this class of weaving is not very extensively used.