If 72 needles are utilised for the satin stripes or strips, as these parts are technically called, the harness-tie arrangement for the two methods illustrated in Fig. 42 would be as tabulated below :

1st Method

| | | | | | | |
|---|---|---|---|---|---|---|
| 600 | needles and | 1200 | hooks for | double | | |
| { 72 | ,, ,, | 144 | ,, | ,, | satin | |
| { 528 | ,, ,, | 1056 | ,, | ,, | | |
| { 180 | ,, ,, | 360 | ,, | ,, | | |
| { 420 | ,, ,, | 840 | ,, | single | | |
| 1800 | | 3600 | | | | |

2nd Method

| | | | | | | |
|---|---|---|---|---|---|---|
| 900 | needles and | 1800 | hooks for | double | | |
| 72 | ,, ,, | 144 | ,, | ,, | satin | |
| 408 | ,, ,, | 816 | ,, | ,, | | |
| 420 | ,, ,, | 840 | ,, | single | | |
| 1800 | | 3600 | | | | |

The cloth was woven in what is known in Dundee and the East of Scotland as a 55-porter reed, with 3 threads per split, equal to an $82\frac{1}{2}$-porter reed, with 2 threads per split. Therefore, if 77 in. reed width were required for a 72 in. finished cloth, termed an eight-quarter cloth, and written 8/4 cloth, there would be

$$\frac{55 \times 20 \times 3 \times 77}{37} = 6868 \text{ threads.}$$

55-porter 3's, or $82\frac{1}{2}$-porter 2's, is equivalent to $11^{\circ\circ}$ sett (eleven hundreds) on 37 in. scale. For full particulars on setting, see the author's work on *Healds and Reeds for Weaving : Setts and Porters.* This sett represents 89 threads per inch in the reed.

With either of the above harness mountings there are 1308 needles and double the number of hooks for the double or centre-tied part of the ornament, and 420 needles and double this number of hooks for the single or straight part of the ornament. Hence, we have

$$\begin{aligned} 2\ (1308 \times 2) &= 5232 \\ 1\ (420 \times 2) &= \ \ 840 \\ \hline &\ \ 6072 \end{aligned}$$

$\therefore$ 6868 threads − 6072 threads = 796 threads to be utilised for the satin strips and for the tape-edges and selvage threads of the cloth.

The tape-edges and the outer selvage threads are operated by the spare rows of the jacquards ; some of these needles and hooks—in addition to the 72 mentioned specifically in this case—are usually utilised for the above-mentioned satin strips.

$$\frac{6868 \text{ threads}}{72 \text{ in. finished cloth}} = 95 \text{ to } 96 \text{ threads per inch in the cloth.}$$

The number of cards can be calculated from the design in Fig. 37 by comparing the lengths of the parts G, H, and G, with B, A, or C: each of the latter represents, in this example, 600 vertical rows of small squares. (These vertical rows of small squares are often called " cords " by designers.) Each part B, A, or C measures 43 units (millimetres in photograph), and part G measures 57 units. Therefore, since the design-paper was 12-by-12, it follows that

$$\frac{600 \times 57}{43} = 800 \text{ cards approximately for G;}$$

while part H, being 104 units in length, should contain approximately

$$\frac{600 \times 104}{43} = 1451, \text{ say } 1450 \text{ cards.}$$

The cards for part G would be used twice in each cloth as explained; hence the number of picks of weft in the figured portion of the cloth is

$$(800 + 1450 + 800)\ 3 \text{ picks per card} = 9150;$$

and, since this section of the cloth occupies 66 in., it will be seen that there are

$$\frac{9150 \text{ picks}}{66 \text{ in.}} = 138 \text{ picks (approximately) per inch in the finished cloth.}$$

A number of uncut cards would be used to weave the required length of simple " satin " between successive figured portions, this length being utilised for the end of one cloth, the beginning of the next, and the part allowed for hemming both ends after the cloths are separated. See Fig. 38.

The allocation of the number of needles for the single and the double parts can be made by a similar calculation. Thus, in Fig. 37 we have

| | |
|---|---|
| Distance from edge of figure to end of single part . . | = 124 units |
| Width of single part . . . . . . . . . . | = 30 ,, . |

And, since the double and single parts combined contain $1800 - 72 = 1728$ needles, we have

$$1728 \times \frac{30}{124} = 418, \text{ say } 420 \text{ needles,}$$

because

$$\frac{420 \text{ needles}}{12 \text{ needles per row}} = 35 \text{ complete rows for single part.}$$

And this is the arrangement shown in Fig. 42, the upper part of which is exhibited below in a different manner :

| Machine B. | Machine A. | Machine C. |
|---|---|---|
| 600. | 72 + 528. | 180 + 420. |
| Double part for ornament and satin strips. | | Single part. |

In order to demonstrate the difficulties which would be encountered in arranging a harness mount to produce an absolutely perfect representation of all parts of the ornament on the cloth, and to compare the various methods explained in the foregoing discussion, we append particulars of the number of jacquard machines, needles, hooks, and cards required for the four distinct ways of mounting and weaving.

| Harness Mount and Type of Weaving. | No. of Machines 600's. | Needles. | Hooks. | Cards for Figure Portion only. |
|---|---|---|---|---|
| By actual method adopted in common harness | 3 | 1800 | 3600 | 2250 for each machine, or 6750 in all. |
| For perfect reproduction in common harness | 5 | 3000 | 6000 | 3050 for each machine, or 15,250 in all. |
| For similar effect to Fig. 37 in full harness | 6 | 3600 | 3600 | 6750 for each machine, or 40,500 in all. |
| For perfect reproduction in full harness | 10 | 6000 | 6000 | 9150 for each machine, or 91,500 in all. |

If there are 14 cards per pound for the 600's machines, ordinary pitch, it is evident that the weight of cards for the latter method would be

$$\frac{91,500}{14} = 6536 \text{ lbs., or nearly 3 tons,}$$

and the cost, say only at 4d. per pound, amounts to

$$\frac{6536 \times 4}{240} = \text{nearly £109.}$$

The reason for the word "impracticable," apart altogether from the consideration of the mounting of the machines and harness, is therefore quite apparent. The designs illustrated in Figs. 39 and 41 are intended to be woven by the aid of three 600's twilling jacquard machines, and Fig. 43 illustrates a weaver at work with a loom mounted with three such machines and weaving a fine wide linen damask. It will be observed that the three distinct sets of cards (one set for each machine) occupy a position at the front of the loom and over the weaver's head. In Fig. 44, however, which illustrates a somewhat similar three-machine loom, the cards are at the back of the loom and above the warp threads. We shall have occasion to refer later to these two methods of accommodating the cards, and to deal exhaustively with them.

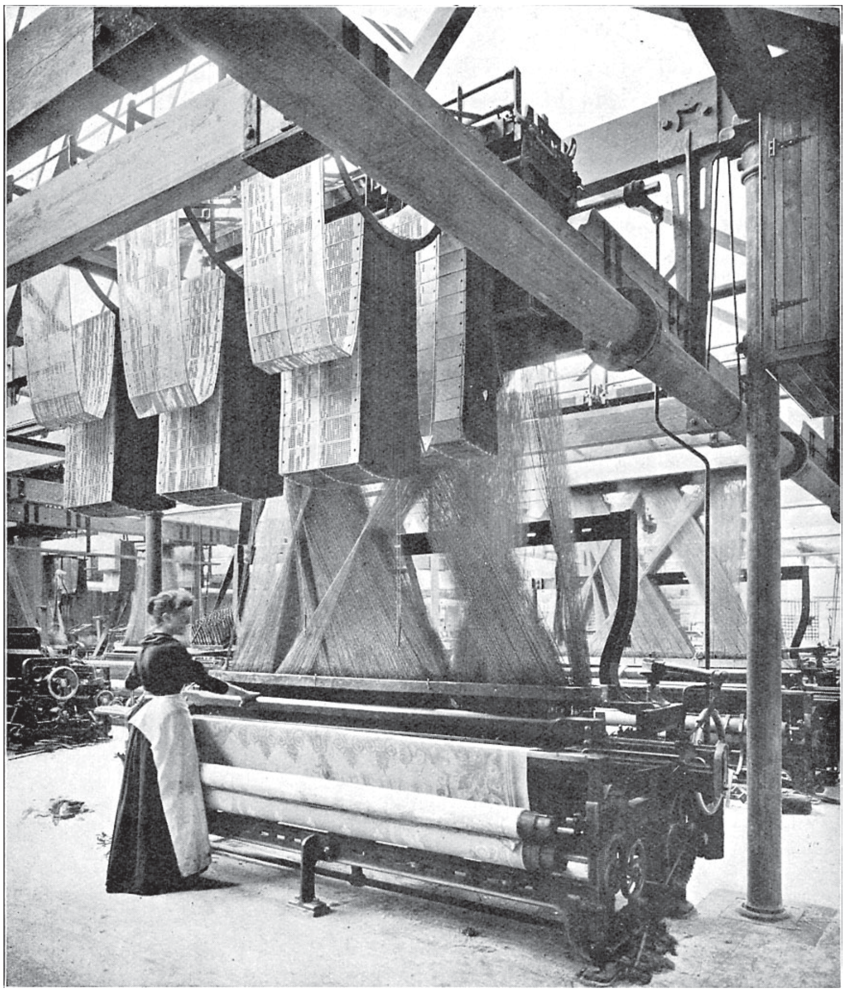

FIG. 43.

As a final illustration referring to this particular class of work, we introduce Fig. 45, which is a view of the back of a wide loom mounted with four 600's twilling jacquard machines. Altogether there are 4800 hooks employed, and the illustration shows very well the directions which several of the harness cords take from several of these hooks to the harness reed

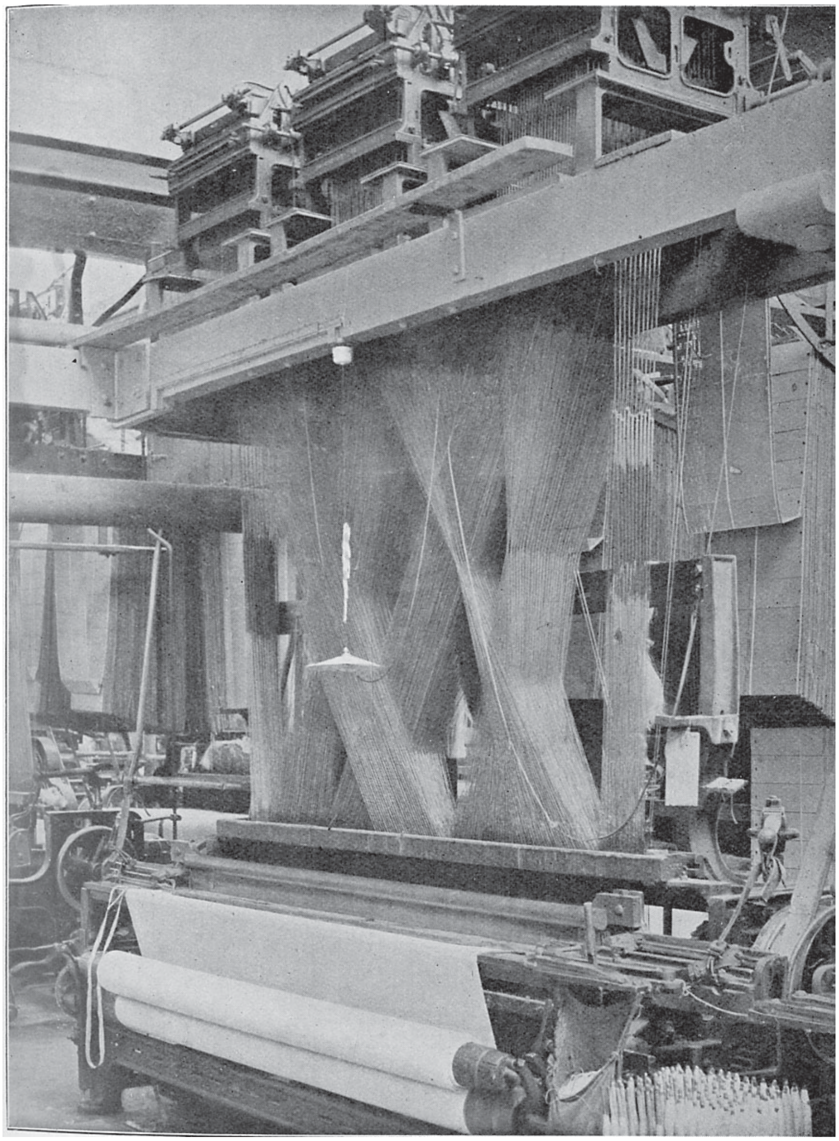

Fig. 44.

or comberboard, and their vertical direction from the latter to the mails through which the warp threads pass on their way to the cloth.

We have already stated that the simplest conditions obtain in the harness mounting when the number of hooks and needles used for the development of any particular portion of a design is a multiple not only of the number of short rows in the jacquard, but also of the number of threads in the weave which it is intended to use. This does not imply that it is

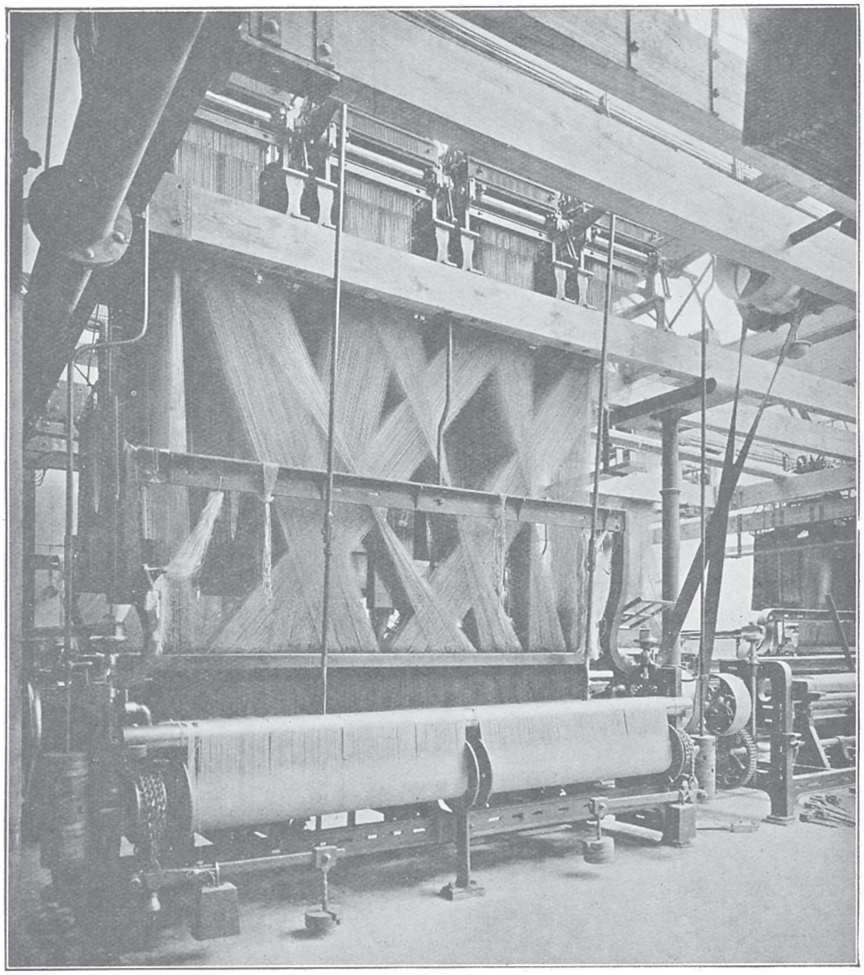

Fig. 45.

impossible for other numbers to obtain ; as a matter of fact, many different values are used, each of which involves the use of a certain number of complete rows plus a part of a row. It is a more common practice to use a number of needles and hooks which is not a multiple of the number of hooks in a short row of the jacquard, than it is to use a number which is not a multiple of the number of threads in the weave, and occasionally a number of hooks is used which is neither a multiple of the weave nor of the number of hooks in a short row.

In very fine work the addition of one or two squares in the length of the float is comparatively unimportant, but in coarser goods the same addition to the normal length of float may prove disastrous. Except under very special circumstances, the twill in one side border is opposite in direction to the same twill in the opposite side border, while in many fabrics the direction of the twill is reversed in other parts of the cloth—parts in which this alteration in the direction of the weave appears more pronounced, and is thus calculated to injure the appearance of the fabric more than when confined solely to the borders. When such conditions obtain it is possible slightly to minimise the defect by paying attention to the way in which the oppositely directed twills join. In order to emphasise this fact we have prepared Fig. 46, which represents in the solid portions in the two outer blocks of each design the ordinary eight-thread sateen weave, starting in each case on the same thread; the middle blocks, shown in crosses, are composed of the same weave, but in each of the eight designs the centre weave commences on a different thread, and of course twills in the opposite direction to that shown in solid marks. The maximum float or floats will be found between two dissimilar marks. By inspection we find the following:

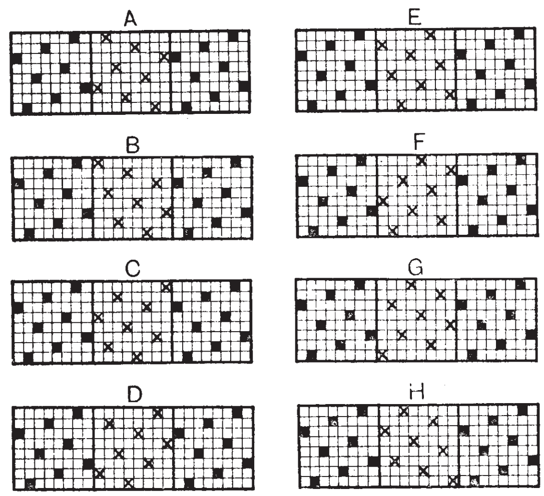

Fig. 46.

| Design Letter. | Weave in Solids commences on | Weave in Crosses commences on | Maximum Length of Float. | Pick Nos. which contain Max. Float. |
|---|---|---|---|---|
| A | 1st thread | 1st thread | 14 | 3 and 6 |
| B | ,, | 2nd ,, | 13 | 6 ,, 8 |
| C | ,, | 3rd ,, | 12 | 5 ,, 6 |
| D | ,, | 4th ,, | 11 | 2 ,, 6 |
| E | ,, | 5th ,, | 10 | 2 ,, 6 |
| F | ,, | 6th ,, | 11 | 3 ,, 7 |
| G | ,, | 7th ,, | 12 | 3 ,, 4 |
| H | ,, | 8th ,, | 13 | 1 ,, 3 |

If, therefore, the choice of the least imperfect joining involve no serious difficulties in the mounting and in subsequent work, it is certainly an advantage to consider this particular phase of the question. Although a haphazard joining is scarcely perceptible in fine work, we prefer to illustrate the method of choosing the best point in connection with a mounting which is intended for such work—the principle being, of course, applicable more or less to all setts. Before doing this, however, we propose to illustrate one or two points which bear not only upon this question, but upon the method of duplication. The great advantage which accompanies the centre-tie or doubling of the harness is that of keeping the number of needles at a minimum, and consequently of obtaining the desired pattern with a com-

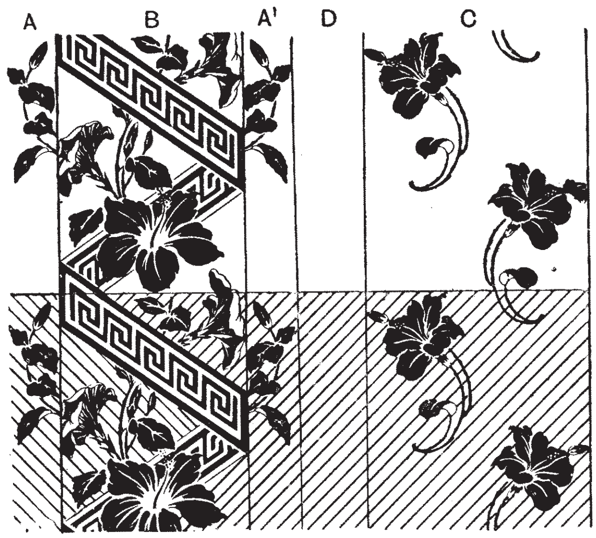


Fig. 47.

paratively small outlay in the cost of cards. Otherwise, all such duplication affects in a greater or less degree the beauty of the fabric, and to obtain the nearest approach to perfection in the joining, or in a subtle manner partially to hide the joining, is one of the aims of the designer, and often demands considerable skill.

Fig. 47 shows practically two repeats in the way of the weft, as well as complete units of the border and filling of a geometrical and floral design for full-harness weaving. The two parts marked A and A[1] are operated from the same hooks and needles ; but one part, A[1], is doubled over in the harness in the usual way to form a centre-tie on a small number of hooks ; part B is the central or main portion of the border ; C is the filling or repeat ; while D is a strip of simple satin inserted between the two chief portions of the design. The geometrical or key pattern is almost continuous, and thus effectively separates the two triangular parts of each repeat of the border. Whenever such conditions obtain—that is, whenever the figured portion of the border is unbroken—the ground twills may be satisfactorily inserted as indicated by the diagonal lines in the lower half of the design. In this way all the ground part of the border on the right of the key pattern, as well as the simple satin stripes and the ground of the repeat portions, may be developed with a twill running to the right. The doubled-over portion on the left, marked A, naturally twills in the opposite direction, to the left, and the remainder of the ground on the left of the key pattern must also twill to left. The right-hand twill should, of course, join perfectly at the vertical lines between B and $A^1$, between $A^1$ and D, and also between D and C; but it may proceed towards the key pattern without regard to the method of joining up to the central part of the border. From the very nature of the tie it will be evident that the twill in the left-hand border will be oppositely directed to that in the corresponding part of the right-hand border, and there is bound to be a fault somewhere near the latter border. The break or joining part in this case may be made between the last thread of the last repeat and the first thread of the simple satin stripe, or between the last thread of the simple satin and the first thread (left-hand thread) of the right border. The latter method would probably be the better, and if adopted the two simple satin portions would be tied up in the straight-through repeating order. Let us suppose that two 600's machines are desirable for the successful development of the above design. The widths of the various sections show that the following arrangement would be satisfactory:

| 1st Machine, for Borders. | 2nd Machine, for the Repeating Part and the Simple Satin Parts. |
|---|---|
| 2 hooks idle.<br>2 ,, plain.<br>8 ,, twill.<br>132 ,, double for outside borders.<br>468 ,, single for central parts of borders.<br>—<br>612 | 12 hooks idle.<br>24 ,, for simple satin parts.<br>576 ,, for repeat.<br>—<br>612 |

Each simple satin portion D would contain about 180 threads, but if both stripes are made to occupy identically the same number—and this almost invariably happens—it will be found that the joining near the right border will be imperfect, and indeed identical with the arrangement shown at A, Fig. 46. If, however, 184 cords—*i.e.* $184 \div 8 = 23$ repeats of the weave—be tied up for the left-hand stripe, and 180 cords, or $180 \div 8 = 22$ repeats plus 4 cords, be tied up for the right-hand stripe, the joining will be

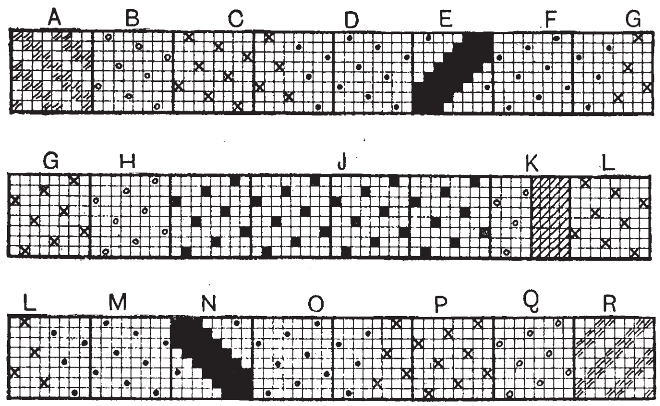


FIG. 48.

more perfect. Figs. 48 and 49 have been prepared to show how the various sections will join if the following order is adopted :

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | threads for | tape, selvages, etc., | marked | A and B | (16 | shown) |
| 132 | ,, | outside border | ,, | C | 12 | ,, |
| 468 | ,, | inside ,, | ,, | D E F | 32 | ,, |
| 132 | ,, | outside ,, | ,, | G | 12 | ,, |
| 184 | ,, | simple satin | ,, | H | 8 | ,, |
| 3456 | ,, | six repeats | ,, | J | 32 | ,, |
| 180 | ,, | simple satin | ,, | K | 4 | ,, |
| 132 | ,, | outside border | ,, | L | 12 | ,, |
| 468 | ,, | inside ,, | ,, | M N O | 32 | ,, |
| 132 | ,, | outside ,, | ,, | P | 12 | ,, |
| 40 | ,, | tape, selvages, etc. | ,, | Q and R | 16 | ,, |
| 5364 | | | | | | |

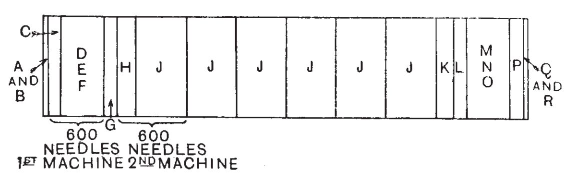


FIG. 49.

This number of threads for a damask $77\frac{1}{2}$ in. wide in the reed would require a 64 porter 2 per split, or between 69 and 70 threads per inch in the reed, and about 74 threads per inch finished.

Parts E and N in Fig. 48 are intended to represent the geometrical pattern B in the border in Fig. 47, and the distinctive weave marks indicate where the various sections join so far as the weave is concerned—the blocks do not represent rows of the jacquard. The four shaded threads at K represent the ones which are omitted purposely to improve the effect at the joining between K and L; it will be seen that the longest float is 10, and the joining is relatively the same as that shown at E, Fig. 46.

If the cloth for Fig. 47 were required to be developed with 5-thread weaves, and according to the arrangement indicated with reference to Fig. 49, the following arrangement would be suitable:

| | | | |
|---|---|---|---|
| 2 | threads | plain | A and B |
| 16 | ,, | twill | A and B |
| 30 | ,, | simple satin | A and B |
| 130 | ,, | outside border | C |
| 470 | ,, | inside ,, | D E F |
| 130 | ,, | outside ,, | G |
| 180 | ,, | simple satin | H |
| 3450 | ,, | six repeats of 575 | J |
| 182 | ,, | simple satin | K |
| 130 | ,, | outside border | L |
| 470 | ,, | inside ,, | M N O |
| 130 | ,, | outside ,, | P |
| 30 | ,, | simple satin | Q and R |
| 16 | ,, | twill | Q and R |
| 2 | ,, | plain | Q and R |
| 5368 | | | |

By introducing 182 threads instead of 180 in part K a better joining is effected between the simple satin stripe K and the outer border L, the maximum float being six.

Fig. 50 illustrates the mounting of the jacquards for the design shown in Fig. 47. Each section is lettered immediately below the comberboard or harness reed to correspond with the similar sections in Fig. 49, and the first and last harness cords only in each section have been drawn between the neck cords and the comberboard. The harness cords for the plain and twilled threads of each selvage are not shown in the drawing, but these may be tied up to the last ten hooks of the first row of the jacquard on the left of Fig. 50 and as indicated in the particulars referring to the allocation of the hooks in the first machine, or, if desirable, the first machine may control the harness cords for the left-hand selvage, and the last ten hooks of the first row or the last ten hooks of the last row of the second machine may control the harness cords for the plain and twilled threads in the right-hand selvage. The whole of the simple satin in parts B, H, K, and Q is controlled by the two rows of 24 hooks in the second machine; the use of two full rows, or three repeats of the weave, obviates the necessity for cramming the harness reed or the comberboard at these portions, but it naturally diminishes the figuring capacity of the machine, which is used,

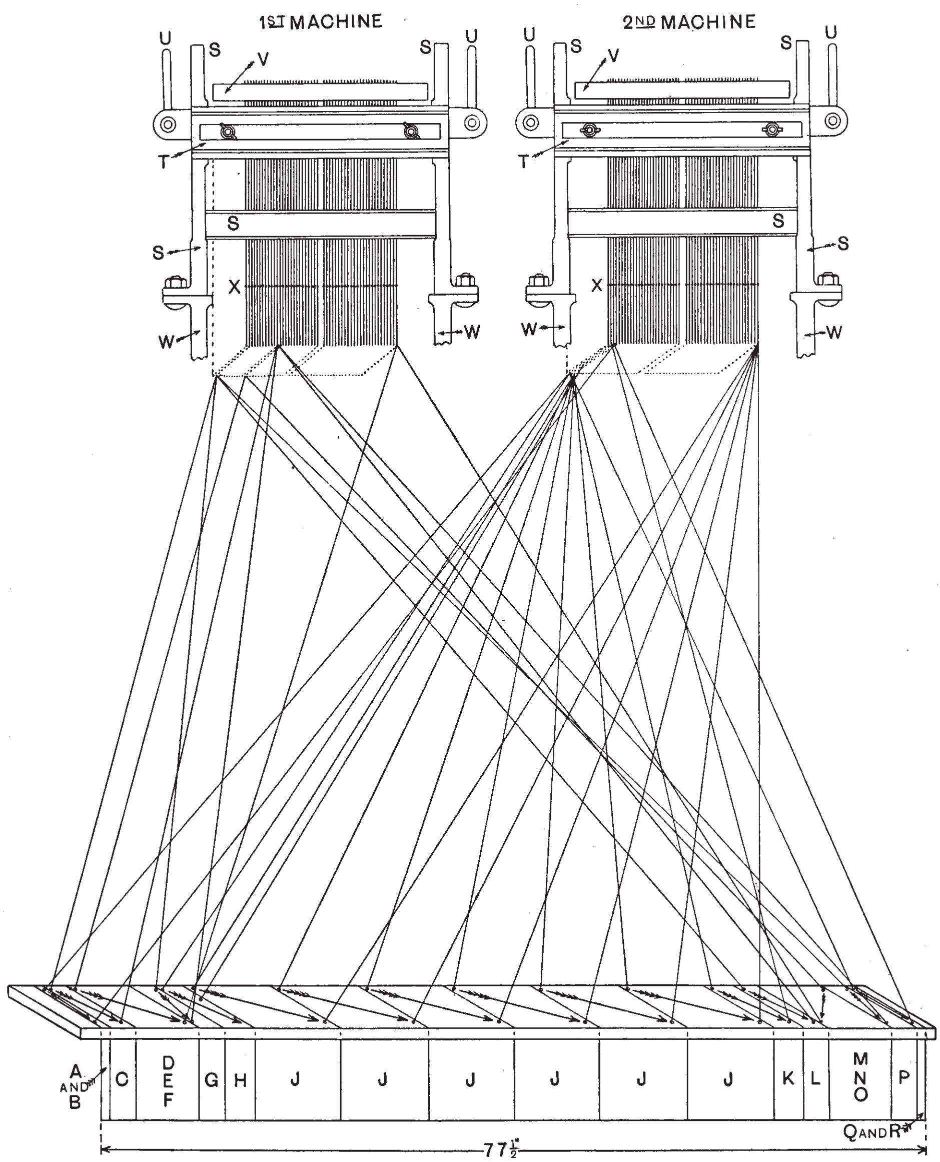


Fig. 50.

in this case, for the development of the filling or repeating part of the design. In Fig. 50 we have inserted the framework of both jacquards in order to show the relative positions of the various parts. Although the tie-up is for a full harness, we have introduced the back framework of twilling jacquards: this for two reasons—first, because it shows the maximum width required for two 600's machines with 3 in. between them; and second, because most ordinary 600's machines are only about 4 in. narrower than the twilling jacquards, while some ordinary machines, especially those with swinging cylinders, occupy approximately the same width as those illustrated. It will be seen that S is the framework at the back of the machine, or front of the loom in this case, T the spring-boxes, U the swan-necks, V the griffes or knives, and W the stools which support the jacquards, and which are themselves supported by long girders not shown. The bottoms of the hooks are at X; from this point to the point of connection with the harness cords represents the neck-cords, near the ends of which is situated the heck-box.

The complete border design, as well as the complete unit of the repeating part of the design, appears in the upper portion of Fig. 47, but, although this represents more than is actually required by the draughtsman who transfers the sketch to point-paper, it is usual to make at least one and a half repeats in the way of the weft of the complete border, and also a similar proportion of repeats of the filling in the way of the warp and of the weft. Such an arrangement enables one better to judge the merits and defects of a design, and for this reason sketches for textile work are often displayed as illustrated in Fig. 51. This design is of the same nature as the one which has just been considered—*i.e.* the two outer portions of the border are obtained by doubling the harness, the central part of the border by a straight-through tie, and the filling by repeating the unit as many times as it is necessary to make up the desired width of cloth. The dimensions of this design are as follows:

| | | |
|---|---|---|
| Left-hand outer border . . . . | $2\frac{3}{16}$ in. | $10\frac{3}{16}$ in. |
| Inner border . . . . . . | $5\frac{13}{16}$ ,, | |
| Right-hand outer border . . . . | $2\frac{3}{16}$ ,, | |
| Filling or repeat . . . . . | 8 ,, | |

If two machines were utilised for this cloth, one for the border and one for the filling, each straight part of the design—*i.e.* without doubling—would require 75 hooks per inch of pattern; thus

75 hooks or needles $\times 2\frac{3}{16}$ in. $=$ 164 hooks for outer border,
75 ,, ,, $\times 5\frac{13}{16}$ in. $=$ 436 ,, inner ,,

600 hooks.

75 hooks or needles $\times$ 8 in. $=$ 600 hooks for repeat.

If desired, the same method of twilling as that described in connection with Fig. 47 may be employed, since the central ornament of the border design is continuous. It is very often a difficult matter to make a satisfactory joining between two borders and the repeating pattern, if one


figure overlaps the other as is the case in Fig. 51. When, however, the various figures in the repeat do not overlap, little or no difficulty is experienced with regard to the floral sections, and the only defect may be that caused by the unsatisfactory joining of the twills as emphasised with respect to Figs. 47, 48, and 49. The complete ornament in the repeat portion of the design in Fig. 51 includes a small turnover of all three leaves, and one of these turnover parts in each figure overlaps as shown where the dotted vertical line AB cuts the points. Now, it is quite evident that if the two extreme edges of the repeat or filling finished with the tips of these leaves, we should have alternate and almost complete figures in the way of the weft joining up to the border on both sides; but we should also have the tips of the next vertical row of figures joining up to the border. These tips have been omitted near the border in the design, but on the left-side border they would appear at points C. The omission of the tips would simplify the subsequent operations considerably, although it may detract from the beauty of the ornament. If the tips D were left out, the complete design would be identical with that on the left of the vertical line AB, except for the two tips which appear at present on the left of this dotted line.

A slight modification is possible without seriously affecting the tie-up—namely, by leaving out the tips in one horizontal row and retaining them in the other, a method which would still allow the figures to overlap in the main portions of the filling. Thus, if the tips on the left of the figures in the odd horizontal rows were omitted, the repeating design would join up to the left-hand border exactly as illustrated. The tips on the right of the figures in the even horizontal rows would remain, and would appear in all the figures in those rows except in those which formed the last vertical row joining up to the right-hand border. In order to make this joining correspond with the almost perfect joining on the left, it would be necessary to omit the harness cords in the last repeat in that part which develops the tips—*i.e.* for about three-quarters of an inch in the 8-in. repeat, or $75 \times \frac{3}{4}$ in. $=56$ cords, or 7 repeats of the weave.

The complete figures could be retained, if desired, on both sides, but only by the addition of 112 cords to the border parts, 56 of these to be utilised for the special purpose of operating the extreme narrow section adjoining the left border, where the tips, which would otherwise appear at C, would be omitted from the design, and the remaining 56 cords for operating a similar number of threads on the right; it would also be necessary, when tying up for the repeats, to omit a corresponding number of harness cords at the beginning of the first repeat, and a similar number at the end of the last repeat to make up for those which are introduced specially for the purpose of securing a perfect design on the cloth. It need hardly be mentioned that provisions of this kind involve more labour, more hooks, more designing, and more care than are required for the reproduction of practically the same design in which the joinings are not so carefully considered. It is only on special occasions that precautions are taken to eliminate these incomplete portions of a figure from the first and last repeats of the filling design.

The method of producing borders by doubling over a certain number of harness cords, and retaining a larger number of cords for a straight tie, as exemplified in the last two examples, is a favourite one in several branches of the textile industry, and it is certain that such a procedure enables the designer to make good use of the number of hooks and needles at his disposal with almost negligible defects in the resulting fabric. The economic utilisation of the hooks and needles may be carried still further, and, although for obvious reasons one can never expect to employ the great variety which obtains in connection with shaft or leaf work, there is considerable scope for ornamentation without increasing sensibly the number of needles at one's command. Take, for example, the design and tie-up illustrated in Fig. 52, an example of what is technically known as a " lift-in " pattern, because the central part C of the outer or wider border is, as it were, lifted in, or at least reproduced, to form the inner border F. The narrow extreme part B is doubled over to form part D ; then the whole, except the simple satin part E, is doubled over to obtain the complete combined border H, K, L, and M on the right. The simple satin part E is operated from the second machine on the left, while the simple satin part J is operated from the first machine. A and N naturally represent the selvages and the narrow strips near the selvages, only the sateen parts of which are shown in the tie-up ; part N is often developed by hooks on the right hand of the first machine instead of by hooks on the left, as illustrated. The filling is represented by two repeats G only, although more repeats may be necessary according to the type and width of cloth which it is intended to produce with this ornamentation developed on it—in the case under notice six repeats would be essential. Such designs as this are often intended for table decoration, and the cloths are so constructed that the central part from about the middle of E to the middle of J lies upon the table, while the remainder hangs over the sides.

The positions of the machines differ from the preceding example, inasmuch as the border machine is in this case on the right ; this is done, as previously mentioned in connection with three machines, to obtain the most satisfactory disposition of the cords with respect to the angles formed by the cords with the harness reed, and to keep most of the doubled-over portion clear of the repeating part. The proportions of the design, if arranged for two full-harness machines, as illustrated, require the following number of hooks for each :

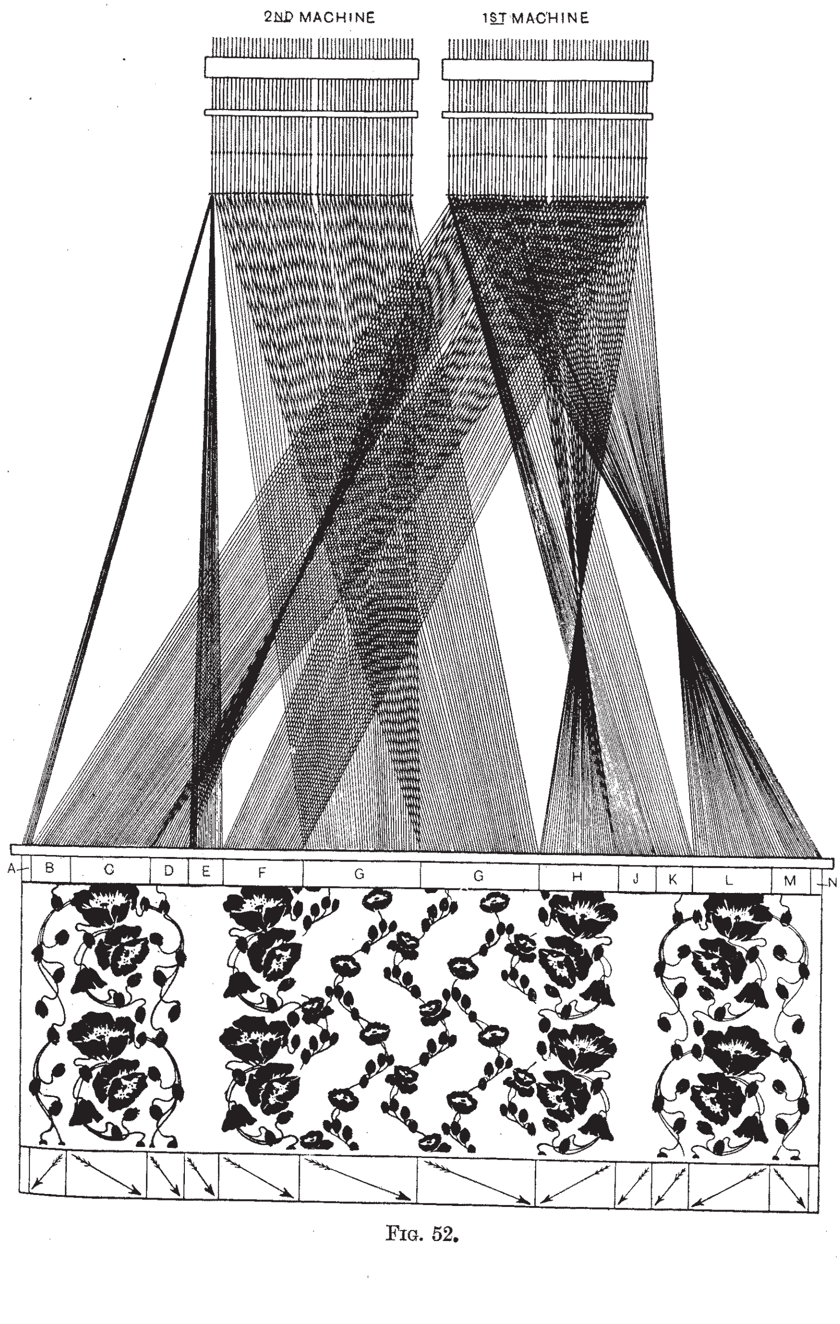


Fig. 52.

| First Machine | | | Second Machine | | |
|---|---|---|---|---|---|
| 4 | hooks | twill or tape. | 4 | hooks | twill or tape. |
| 8 | ,, | simple satin. | 8 | ,, | simple satin. |
| 196 | ,, | double border. | 600 | ,, | for 6 repeats (2 only shown). |
| 404 | ,, | single border and lift-in. | | | |
| 612 | | | 612 | | |

$196 \div 12 = 16$ rows + 4 hooks for doubled-over part,
$404 \div 12 = 33$ ,, + 8 ,, single and lift-in,
$600 \div 12 = 50$ ,, for repeating portion.

In Fig. 52 the front rows in the harness reed in these portions are represented by 16, 34, and 50 cords respectively, while the warping arrangement for a finished cloth 72 in. wide is as follows :

| | Marked. | Operated by Needles and Hooks. | Machine. |
|---|---|---|---|
| 2 threads plain | .. | Special needles | 2 |
| 16 ,, twill | A | 1 to 4 | 2 |
| 48 ,, simple satin | A | 5 to 12 | 2 |
| 196 ,, double border | B | 13 to 208 | 1 |
| 404 ,, single ,, | C | 209 to 612 | 1 |
| 196 ,, double ,, | D | 208 to 13 | 1 |
| 192 ,, simple satin | E | 5 to 12 | 2 |
| 404 ,, lift-in | F | 209 to 612 | 1 |
| 3600 ,, six repeats | G | 13 to 612 | 2 |
| 404 ,, lift-in | H | 612 to 209 | 1 |
| 192 ,, simple satin | J | 5 to 12 | 1 |
| 196 ,, double border | K | 13 to 208 | 1 |
| 404 ,, single ,, | L | 612 to 209 | 1 |
| 196 ,, double ,, | M | 208 to 13 | 1 |
| 48 ,, simple satin | N | 12 to 5 | 1 |
| 16 ,, twill | N | 4 to 1 | 1 |
| 2 ,, plain | .. | Special needles | .. |
| 6516 threads | .. | .. | .. |

$$\frac{6516}{72} = 90\tfrac{1}{2} \text{ threads per inch finished ;}$$

and approximately

$$\frac{6516}{77} = 84\tfrac{1}{2} \text{ threads per inch in the reed}$$
$$= 52^3 \text{ porter reed.}$$

Following the plan adopted in Fig. 48 with regard to the joinings of the various parts in Fig. 47, we illustrate at Fig. 53 the similar plan for Fig. 52. Here, again, the letters correspond to similar parts in both. The first three rows of designs represent all the sections from selvage to selvage, the middle row showing the six repeats G between the two parts F and H of the lift-in portions. The bottom row shows an alternative method for the repeating part. From A to the end of F, and from H to N, the maximum lengths of floats are:

| | | | | | |
|---|---|---|---|---|---|
| 10 | between | sections | C | and | D |
| 10 | ,, | ,, | E | ,, | F |
| 14 | ,, | ,, | F | ,, | G |
| 10 | ,, | ,, | H | ,, | J |
| 10 | ,, | ,, | K | ,, | L |
| 10 | ,, | ,, | $F^1$ | ,, | $G^1$ |
| 11 | ,, | ,, | $G^1$ | ,, | $H^1$ |

Hence, if the design for the repeating part—*i.e.* that for the second machine—be twilled as shown at $G^1$, a less defective joining would result; and

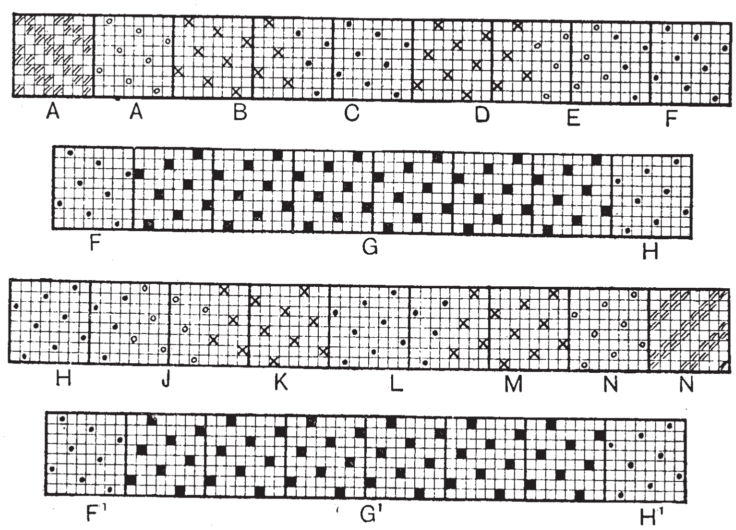


Fig. 53.

although this may not be the usual method of starting the weave, there appears no reason why it should not be adopted in certain cases if less imperfect junctions obtain. Although the principle suggested above would effect an improvement as compared with haphazard joinings, and may be necessary in comparatively coarse setts, it is often neglected in fine work, simply because a float of even 14 may not be unsightly. It is, of course, understood that 8-thread weaves are seldom used in coarse setts, the 5-thread weaves being almost invariably employed. The same principle, however, obtains; but we have not considered it necessary to introduce other examples. The maximum float in all similar cases will be found to be $2n-2$, where $n$ is the number of threads in the unit weave.

The principle of improving the junction of the central part of a design and the right-hand border or doubled-over section of the harness is applicable without much additional trouble to all stripe designs which contain a comparatively large number of threads in the simple satin stripe. It may also be employed in connection with those full-harness designs which do not possess a satin stripe, but in these cases it is more difficult to arrange, and perhaps not worth the trouble, since the majority of these cloths are in fine setts where, as already stated, a float of 14 is not particularly objectionable. Suppose, however, it were necessary for some reason to keep the float at a minimum in such a design, the following would be one method of meeting the difficulty: If the design were made in the ordinary way, and four threads dropped at the junction, the effect would be equivalent to withdrawing the narrow stripe marked A in the simple sketch in Fig. 54, in which case there would obviously be an imperfection in the cloth.

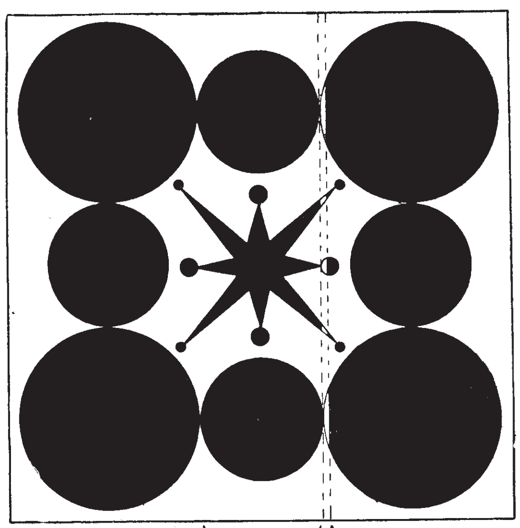

Fig. 54.

Circles have been drawn purposely to show up this defect clearly, for there is perhaps no kind of ornament which is more difficult to reproduce in cloth than that of a perfect circle. If, therefore, as mentioned, the 4 threads were dropped or omitted, as was found feasible in the satin stripes, it is evident that two of the large circles and a small circle of the right-hand border would present flat sides to the adjoining part of the design, and also that two tips of the star would be out of line with their stems. If, however, the small section at A be drawn and painted at the right-hand side of the central portion B, the joining of the weaves would present a

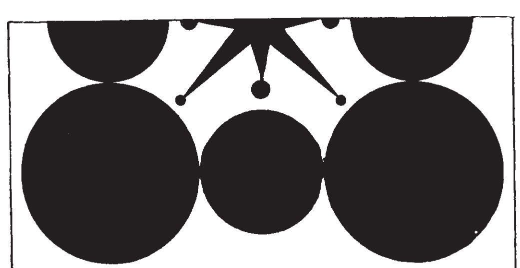

Fig. 55.

minimum float, and the pattern itself would be continuous and perfect except in so far as concerned irregularities which might occur in consequence of incorrect numbers of picks per inch with respect to the number of threads per inch. The perfect reproduction would then be as illustrated by the half-design in Fig. 55. Suppose, for example, that 1200 needles and hooks were utilised for a pattern of similar proportions to those illustrated in Fig. 54. We should have

720 needles for borders,
480 ,, centre,

which would give

| | | |
|---|---|---|
| 720 | threads for | left-hand border, |
| 480 | ,, | centre, |
| 720 | ,, | right-hand border. |
| 1920 | | |

And the small part of the pattern which has been omitted from the right-hand border in consequence of dropping four cords from this section would have to be introduced on to the central design, in order to make the pattern continuous, as in Fig. 55, and thus use the same number of threads.

Another, and certainly simpler, method of arriving at a similar result would be to double all the 720 threads over to the right, and then make the central design on 476 needles or 484 needles, and in both cases a minimum float would be obtained.

Although such a method is practicable and applied without much difficulty to patterns in which the central part is not repeated, it is scarcely practicable in those designs where two or more repeats of the filling are required, unless the design is of a nature somewhat similar to that illustrated in Fig. 51; but in all such cases as the latter the result would scarcely justify the means employed to secure it.

For twilling jacquard work the same number of threads would have to be dropped, but the number of needles involved would naturally depend upon the number of hooks which each needle controlled. Thus, if each needle controlled two hooks, and the weave was the 8-thread sateen, two needles more or less than some multiple of four would be a satisfactory number to use.

The upper part of Fig. 56 is a plan of the harness reed for the design illustrated in Fig. 52, while the lower part, which shows part of a table T, indicates where the different parts of the ornament would appear when the damask cloth in Fig. 52 was laid on the table. The chief defect in the arrangement of the threads in the harness reed is the fact that the large number of threads in the simple satin stripes F and J have to be crammed

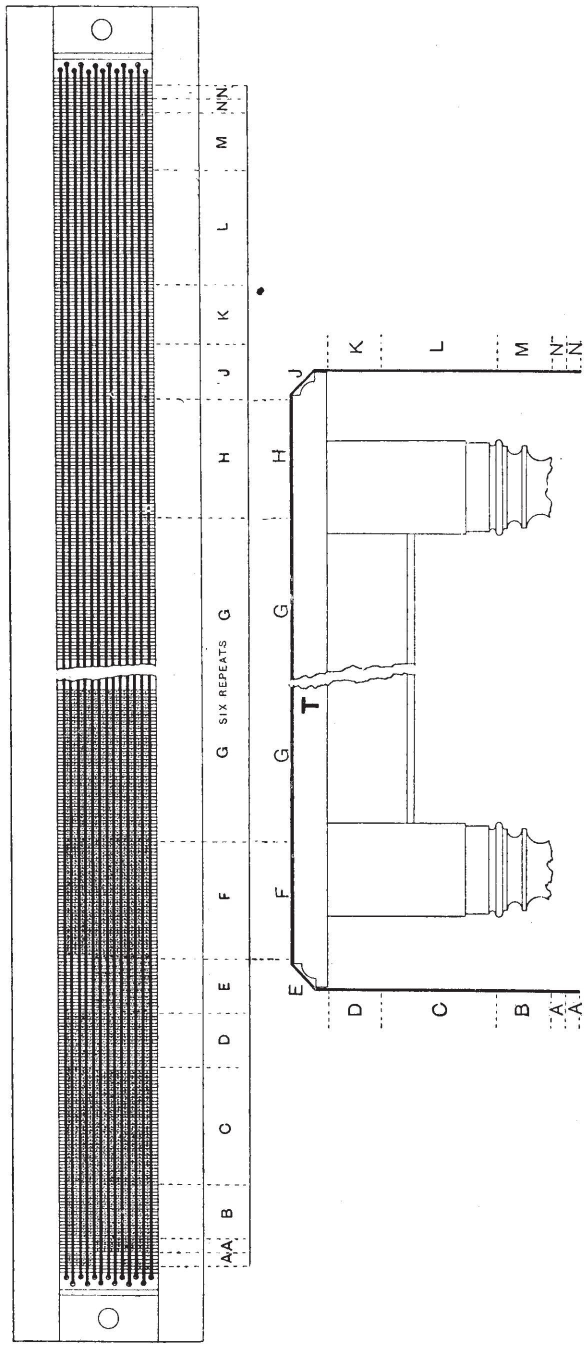


Fig. 56.

into 8 rows of the harness reed on account of the employment of only 8 hooks for this portion. With the method of tying-up as illustrated, the defect is irremediable, but if all the plain and twill threads in both selvages be operated by special needles and hooks outside the control of the cards, as is often done, two rows of needles and hooks—the first row in both machines, or other suitable rows, that is, 24 hooks in all—could be used, in which case no cramming in the simple satin stripes would be necessary. It is evident, however, that there is an objectionable feature in both cases, and the choice of one or other method depends upon those in charge of the mounting. A much better method would naturally obtain if two rows from each machine could be employed for this purpose ; with this arrangement the left-hand satin could be worked from one machine, and the right-hand satin from the other machine. And, if even only two rows from one of the machines be used for both stripes, there will be three repeats of the weave in the two rows. In the latter case the repeating pattern would probably be designed on 588 needles instead of on 600. The left-hand side of the harness reed in Fig. 56 is complete, but the right-hand side contains only the first and last cords in each section.

In all the cases illustrated, and in all similar cases, the only parts which need be transferred to the design-paper for the use of the card-cutter are complete units of the outer and inner borders for one machine, and one unit of the repeating part for the other, with, of course, corner-pieces and cross-borders if the cloth is intended to have a border on all sides.

Fig. 57, which is a similar design, and one in which complete units appear for the two machines, will illustrate this phase sufficiently. A is the outer border, B the inner border, and C is the repeating part. When the cloth is woven, part A will appear on both sides of B, but in reverse directions, A being doubled over, the three sections thus producing a complete border. The duplication of the whole of this border is essential for the border at the other side of the cloth. It will be noticed that the central portion B of this design is unsuitable for a " lift-in " such as is illustrated in Fig. 52, because the two tulips near the top of the design would be broken if this part were detached from the two outer sections A. When the two parts A and B have been transferred to point-paper, painted in, and the weaves introduced, the work is ready for the card-cutter. Part C is prepared in the same way on a separate sheet of design-paper, because it is to be cut on cards for the second machine.

The designs illustrated in Figs. 47, 51, 52, and 57 are all intended for full-harness work, where, for wide cloths in fine setts, it is necessary to introduce a number of repeats into the filling. When twilling jacquards are used, rarely less than double the width of pattern is obtained as compared with full or brocade harness for a given number of needles. For cloths of this type (see Fig. 37) the combined borders invariably occupy a greater width than the centre or filling of the cloth, and nearly all the wide figures in fine setts are woven by the aid of these jacquards. Consider, for example, the artistic heraldic design illustrated in Fig. 58. This was designed by Mr. Philip R. Paul, formerly of Dundee Technical College, and later of the Royal School of Art, South Kensington, and is intended for a table napkin. To weave this in a reasonably fine sett, say from 76 to 80 threads per inch finished and 27 in. wide, would require in the full or brocade harness jacquard about 1050 needles and hooks, or approximately two 600's machines, and this for a comparatively narrow fabric. And to reproduce this pattern successfully it is essential that the full-harness method of weav-

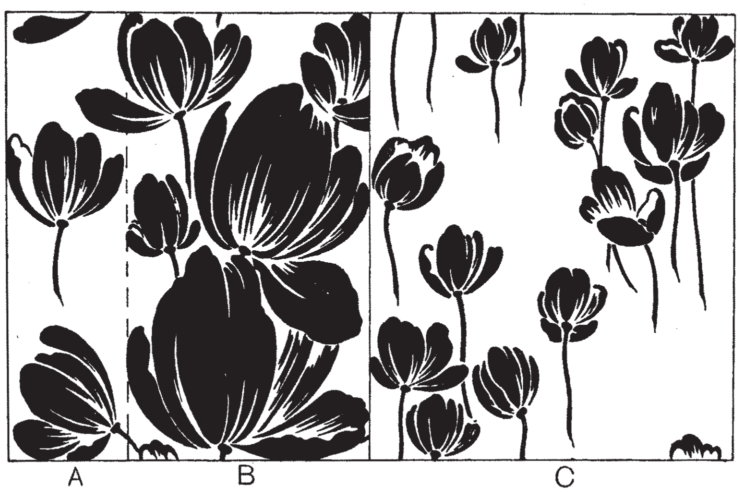


FIG. 57.

ing should be used, for the straight-lined ornament which adds so much beauty and contrast to the other elegant parts of the design can be reproduced only, with any degree of success, by this method. We have already come across difficulties in the joining of weaves even in the full harness, but the difficulties to be met in the reproduction of such line work are increased considerably and are really insurmountable in the method of weaving which is common to all twilling jacquards. The dark, light, and grey portions of the armoured knight and his steed and pennant, as well as the motto, "Absque labore nihil," can be successfully reproduced by the twilling jacquard, and, if the border were any form of ornament other than that of horizontal and vertical lines, the whole pattern could be woven with one 600's twilling jacquard, with two hooks per needle arranged as follows :

| | | | | | | |
|---|---|---|---|---|---|---|
| 72 needles idle. | | | | | | |
| 480 | ,, | double, operating | 960 | hooks | = | 1920 threads. |
| 60 | ,, | single, ,, | 120 | ,, | = | 120 ,, |
| | | | | | | 2040 threads. |

Or, as arranged in a previous example of this work (see Fig. 29), make the single portion a little wider so that it could be utilised not only for the design

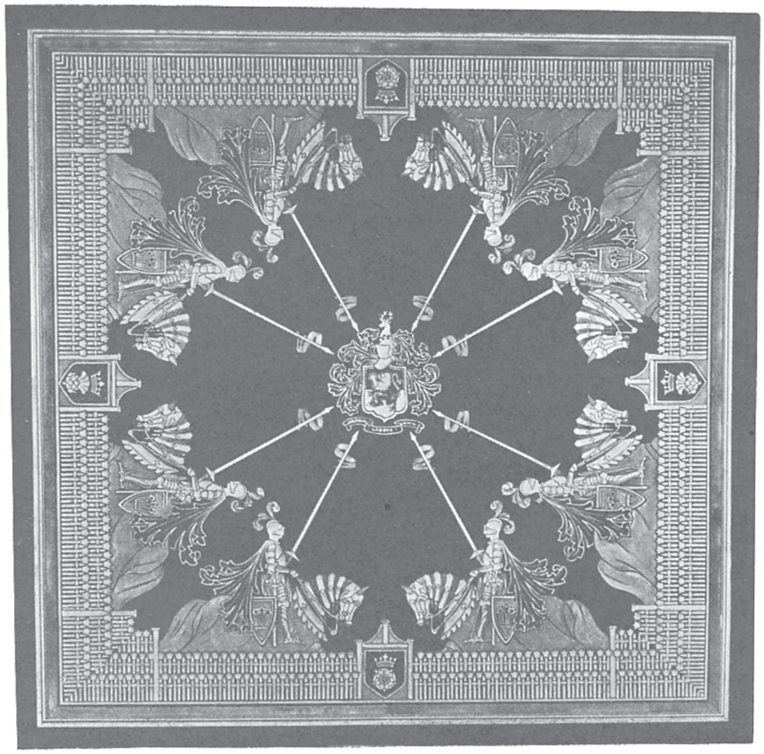

Fig. 58.

under notice, but also for others where the extreme central figure happened to be larger. Indeed, it is an excellent plan to utilise all the needles in the machine by leaving the maximum number of hooks for the comparatively narrow unsymmetrical part, and employing fewer hooks and needles for the doubled-over portion. Thus, in those similar designs which are illustrated in Figs. 26 and 28, 360 needles are used for the double portion and 240 needles for the single portion, giving approximately the same number of threads and sett, with no increase in the number and size of the card. The advantage of employing one machine instead of two is small compared with the advantage obtained with respect to the cost in cards. If the design paper be 12-by-16, and two picks inserted for each card, the total number of cards will be

$\frac{480 \text{ needles} \times 16}{12} = 640$ cards to work forward and backward for the symmetrical part,

and $\frac{60 \text{ needles} \times 16}{12} =$ 80 cards to work forward only for the unsymmetrical part,

720 cards irrespective of those required for that part which is to be hemmed.

720 cards at 14 cards per pound and 4d. per pound

$$= \frac{720 \times 4}{14 \text{ per pound}} = 206 \text{ pence nearly};$$

whilst the corresponding values for the full harness would be four times as much: thus

$\frac{960 \text{ needles and hooks} \times 16}{12} = 1280$ cards for each machine to work forward and backward for the symmetrical part,

$\frac{120 \text{ needles and hooks} \times 16}{12} =$ 160 cards for each machine to work forward only for the unsymmetrical part,

1440

—*i.e.* 1440 cards for each machine, or 2880 cards in all.

$$\frac{2880 \times 4}{14 \text{ per pound}} = 823 \text{ pence nearly.}$$

In addition to the extra attention demanded, and to the extra expense in cards and one extra machine, there is at least four times the expense incurred in transferring the sketch to point-paper. It is for these important reasons that twilling jacquards, in spite of their defects, are used for weaving those cloths upon which elaborate designs are developed.

Designs such as those already dealt with, elaborate though they be, require only what may be considered as comparatively simple methods of harness ties, involving as they do the simple repeating tie, the centre-tie, or a more or less extended combination of the two. Except in special cases, and then only for very narrow portions, the sett of the fabric is the same throughout, and the threads in the fabric, as well as the vertical rows of small blocks on the design-paper, form successively a perfect continuation of the design. This is typical of practically all damasks—silk, wool, cotton, linen, and jute—and of nearly all kinds of fabrics in which a single series of threads forms both the ground and the figure of the texture. And, under certain conditions, the production of many types of tapestries and other decorative fabrics may proceed according to an arrangement based on somewhat similar lines.

Consider, for example, Fig. 59, which is a photographical reproduction of a fancy tapestry fabric developed by several colours of warp yarn. This fabric may be woven in a loom provided with one jacquard and mounted with a simple repeating tie. The full width of the pattern is $8\frac{3}{8}$ in., and as there are 160 threads per inch, it follows that 1340 hooks and needles, independent of those required for the selvages, will be necessary. Sections A and B are formed with one series of warp threads, but of different colours, whereas sections C and D are formed by two distinct series of warp threads—one series being utilised for the ground and the other series for the floral, curved, and straight-lined parts which are developed with diverse coloured warp yarns on the plain ground. The ground part in sections C and D, however, contains only $53\frac{1}{3}$ threads per inch, the remainder, or $107\frac{2}{3}$ threads per inch, appearing as extra warp threads, as shown by Fig. 60, which represents the back of the fabric. Now, although this cloth may be reproduced in the loom arranged with an ordinary repeating tie, it is evident that with this arrangement some difficulties would be met in the preparation of the point-paper design—difficulties which have already been discussed in Chapter II.

Parts A are developed with the 8-thread sateen in single warp and triple weft as illustrated at G, Fig. 61; hence, if some arrangement could be found to operate these threads independently of the jacquard, a considerable saving in the number of hooks, needles, and cards would be effected. These parts A, Fig. 59, occupy $2\frac{7}{8}$ in. of the pattern, and require 460 threads; therefore, if this number be deducted from the total number of threads in the pattern, it will be found that an 880's jacquard would be ample: $1340 - 460 = 880$ needles and hooks.

Somewhat similar conditions obtain in the pattern illustrated in Fig. 62, which represents another multi-coloured and extra-warp tapestry. Although this pattern is not so elaborate as that shown in Figs. 59 and 60, its production would probably involve more trouble, unless the cloth were woven with a simple repeating tie. The total width of the pattern in the cloth illustrated in Fig. 62 is $6\frac{9}{32}$ in., and the various parts indicated by letters immediately under the design are made up for one repeat as shown in the table on page 94.

[Table

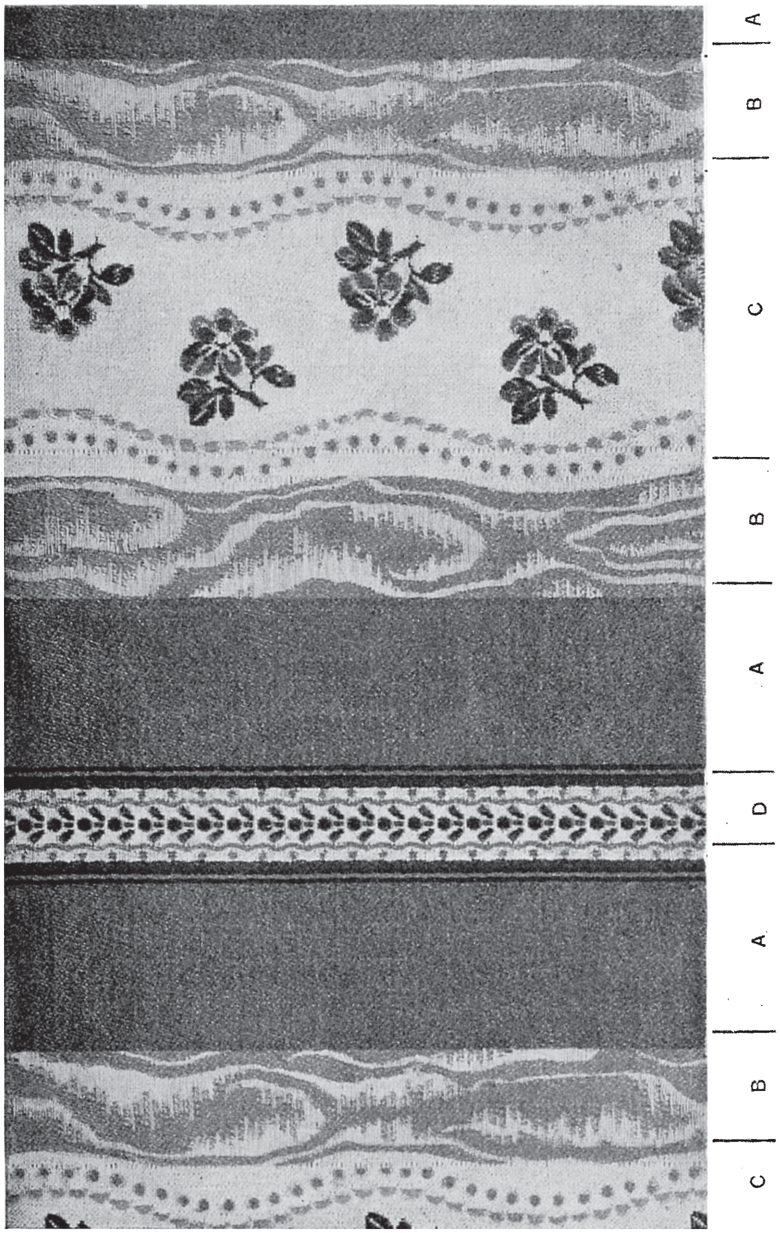


Fig. 59.

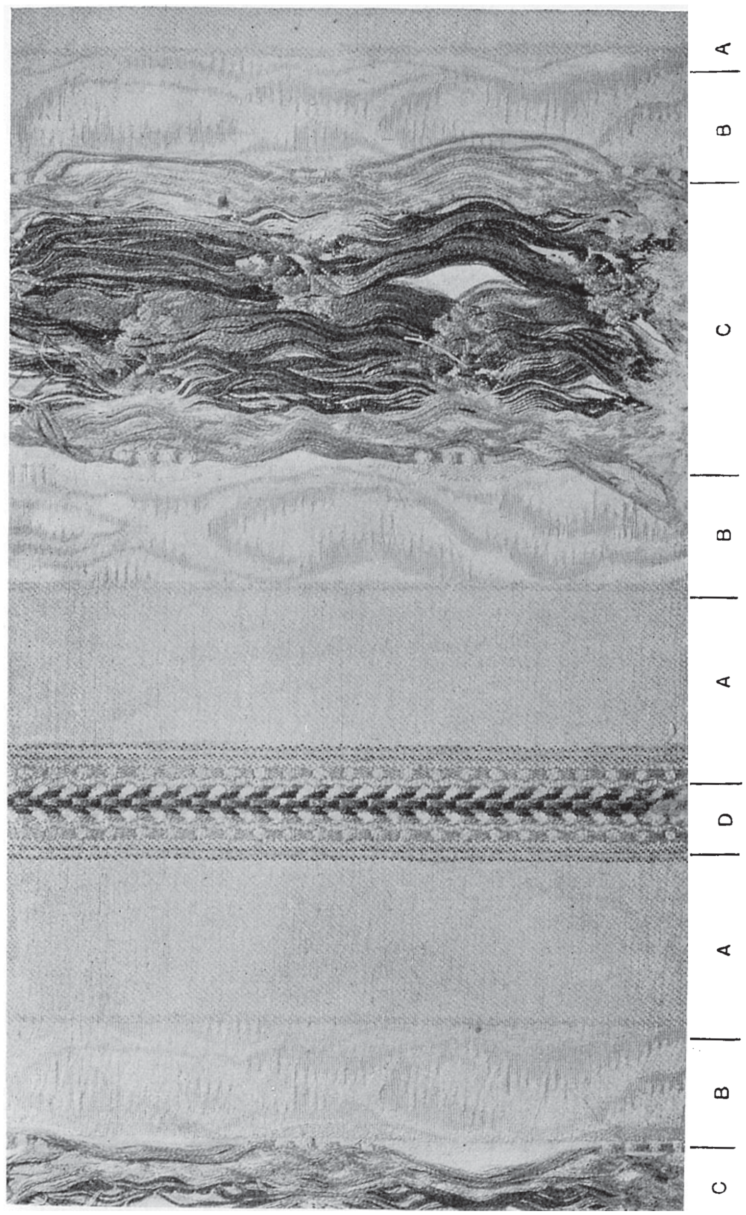


Fig. 60.

| Parts. | Units of $\frac{1}{32}$ of an Inch. | Sateen Weave : Number of Threads. | Figure Weave : Number of Threads. |
|---|---|---|---|
| A | 7 | 42 | |
| B | 23 | | 140 |
| A | 7 | 42 | |
| C | 5 | | 30 |
| A | 14 | 84 | |
| D | 5 | | 30 |
| A | 28 | 168 | |
| E | 12 | | 60 |
| A | 11 | 66 | |
| F | 14 | | 84 |
| A | 11 | 66 | |
| E | 12 | | 60 |
| A | 28 | 168 | |
| D | 5 | | 30 |
| A | 14 | 84 | |
| C | 5 | | 30 |
| | 32 ) 201 | 720 | 464 |
| | $6\frac{9}{32}$ in. | 1184 threads. | |

It will thus be seen that out of a total of 1184 threads in each repeat there are no fewer than 720 which are developed in the simple 5-thread weave, double warp, double weft, illustrated at J, Fig. 61. The remainder of the ground weave, except that immediately under the floral portions, is developed in the rib weave shown at H, with two double threads and one double thread alternately. Apart from the above 720 threads of sateen, there are 464 figuring threads. Even if these threads were controlled independently of the jacquard, there are too many for a 400's machine with a straight tie, but they could easily be operated by a 500's machine. The two parts marked E are, however, symmetrical, and since each part contains 60 threads, it follows that if these two sections were operated by the same hooks with a centre-tie we should require only $464 - 60 = 404$ hooks and needles, or an ordinary 400's jacquard. It is nevertheless quite apparent that unless these styles were typical of a number of others with the same proportions, the separation of the plain and fancy figuring threads, as indicated, would not conduce to economy.

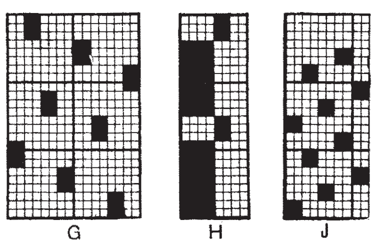

Fig. 61.

The separation of two or more series of threads for the purpose of employing a minimum number of needles, hooks, and cards naturally involves more complications in the operations of mounting and weaving, no matter what method is resorted to. Such a procedure very often, but not always, simplifies the method of card-cutting ; and since the operation

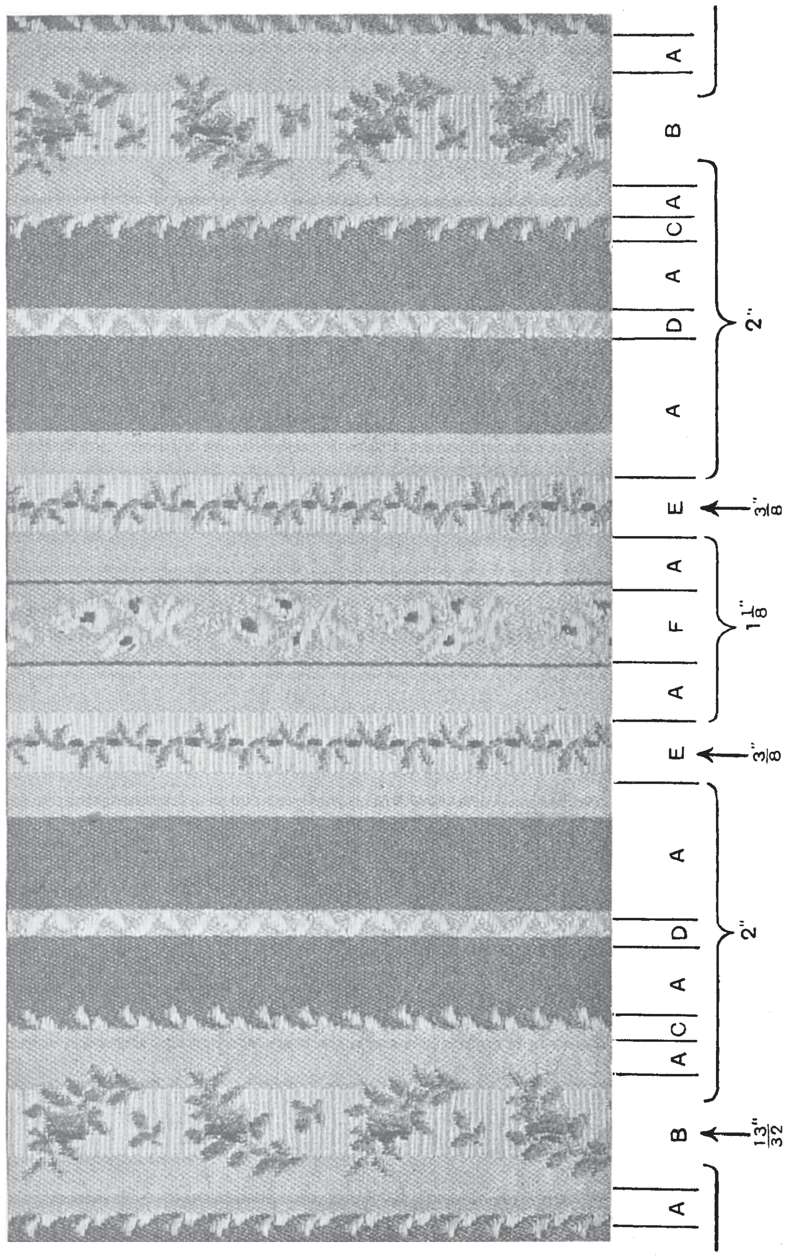


Fig. 62.

of preparing the cards is very similar for practically all the ordinary kinds of fabrics, we propose to deal with this branch at once.

# CHAPTER IV

## THE PREPARATION OF JACQUARD CARDS BY HAND-PLATES AND BY ORDINARY PIANO CARD-CUTTING MACHINES

THE preparation of jacquard cards for the loom may be a comparatively simple process, or it may be a more or less complicated process, depending, as it does, upon the size or pitch of the jacquard machine, the number of machines in use upon one loom, the character of the design, and the machine or apparatus in which or by which the cards are cut. In all cases the process consists of cutting or punching holes into certain parts of the card, and leaving the remainder uncut, so that when the card operates upon the needles of the jacquard, they may, through the medium of the hooks, cords, mails, and lingoes, result in the formation of two layers of threads to form the shed.

When complicated and large designs are required, and when several sets of cards from the same design have to be prepared for a number of looms, it is natural to expect that the mechanism will be much more extensive than what is required for the production of cards intended for actuating the needles of a small jacquard and for the development of simple designs on the fabric. For the latter type, and particularly if a very small number of jacquards are installed, a simple cutting plate, or hand-plate, may serve the purpose, although the process of preparing cards by the aid of such a plate is very slow.

Figs. 63, 64, 65, and 66 illustrate two simple hand-punching plates. Fig. 63 is a front elevation, Fig. 64 is a sectional front elevation, and Fig. 65 is a plan of one type of hand-plate, while Fig. 66 is an elevation of another type. Fig. 63 shows that the card A is held between two steel plates B and C. The holes in both plates coincide with each other, and are identical with those shown in the plan view in Fig. 65. The dimensions of the card A are indicated in the latter figure by the dotted rectangle, and it will be seen that there are 26 complete rows of holes, 8 in each row, commencing at D and finishing at E, or *vice versa*, or 208 holes irrespective of the 6 holes in each extreme row marked F. The 208 holes indicate that this represents the maximum number of needles ; the largest jacquard machine for which this plate can be used is what is termed a 200's jacquard. The large holes

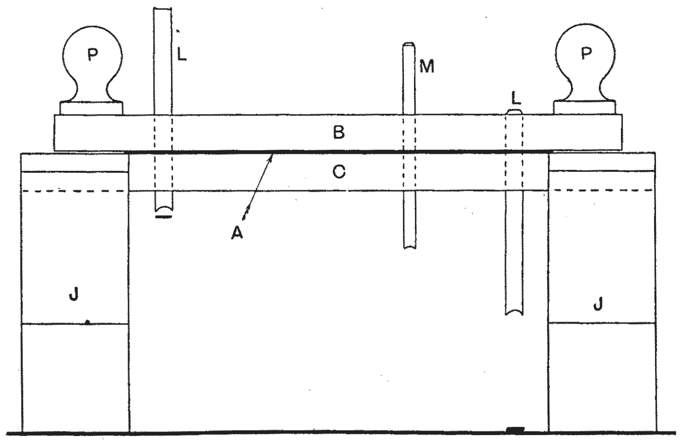


FIG. 63.

G are for the pegs of the card cylinder, the two extreme rows F of 6 each are for special work, to be utilised when necessary, while the four holes H, two near each end, are for the purpose of lacing the cards together.

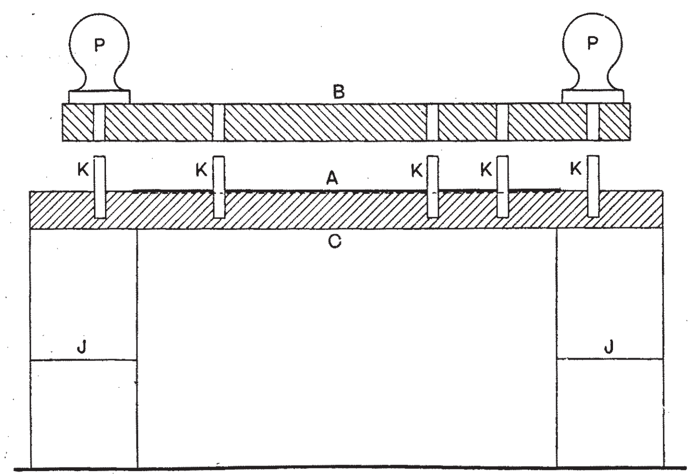


FIG. 64.

Plate C is fixed in a simple wooden framework J, and projecting from the upper side of this plate is a series of pins K, Fig. 64, which fit into corresponding holes drilled in the top movable plate B. A rectangular recess in the fixed plate C corresponds to the size of the card, and when the card and the upper plate B are in position, as shown in Fig. 63, all is ready for the cutting to commence. When the card used is a short one, such as the one illustrated, it matters little which end of the card operates the first row of needles in the jacquard, hence the card-cutter may commence to cut either from the left-hand side or the right-hand side. A right-handed person would probably prefer to start on the right hand of the plate, in which case D may be taken as the first hole for the first needle in the jacquard. Assuming this to be the case, the design would be turned through 180 degrees so as to bring the junction of the first thread and the first pick to the top right-hand corner. The card-cutter would then read from right to left on the top row of the design, and proceed from right to left on the plate, taking the short rows of 8 in regular succession, starting with hole D. If the card-cutter started at the point E it would be unnecessary to turn the design as in the above case; the design would be the right way up, and the cutter would read along the bottom line from left to right, and take the short rows of holes in succession from left to right. The card would be numbered at the end where the cutting was started. A slightly different method is necessary for the larger cards.

It is a usual plan to prepare point-paper designs so that the bulk if not all of the painted part represents the sections which are to be cut, although in special cases the principle may be departed from. It is much easier, however, to cut marks, as it is technically termed, than to cut blanks, and we shall always assume, unless it is specially mentioned otherwise, that the painted portion of the design represents the threads in their highest position, or warp on the surface, and consequently represents cut portions of the cards for most classes of jacquards.

The card-cutter first takes the large punch L, Fig. 63, enters it in turn into each of the two large holes G, Fig. 65, near the ends of the plate, and drives it through the card for the peg holes as indicated in Fig. 63. He then takes the smaller punch M, punches two holes H at each end of the card for the lacing twine, and then with the same small punch proceeds to cut the card at those points which correspond to the marks on the design-paper. It will be evident from Fig. 63 that the punches L and M must pass entirely through both plates and be withdrawn from the underside. This is the chief drawback with regard to this particular type of hand-plate, and although it is used successfully for cutting cards for dobby machines, it is not so satisfactory for the hand-cutting of jacquard cards; there is a tendency for the card-cutter to lose the position in the various rows. The cutter illustrated at N, Fig. 65, is much more satisfactory for this purpose, since it is unnecessary for the punch to pass through the plate, and the card-cutter can transfer the punch from hole to hole in any row with greater accuracy. The actual cutters are secured to the handle by a small screw or set-screw.

It is absolutely essential that the holes in the two plates B and C should coincide, not only with each other, but with the pitch of the needles in the jacquard. In order that the two plates may always be in the same relative positions, the pins K may be irregularly spaced, or more pins may be placed in one half of the plate than in the other half; when this arrangement is adopted the plate cannot be turned end for end. Any arrangement of pins will do, and one system is illustrated in Figs. 64 and 65, where five pins are shown in each long side, three on one side of the centre and two on the

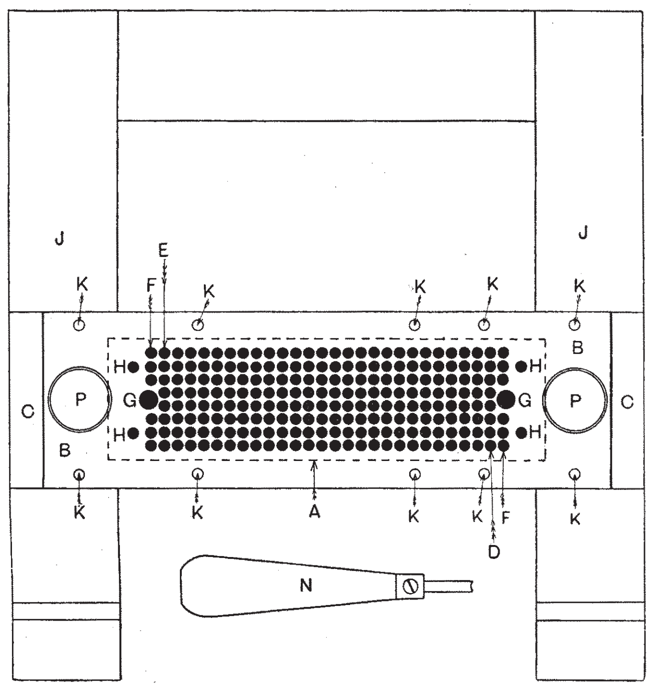


Fig. 65.

other. In Fig. 64 the upper plate is shown lifted clear of the pins, and the card is in its proper position on the bottom plate C.

Fig. 66 represents an elevation of a frame of a simpler nature, for which punch N in Fig. 65 would be used. The upper plate B in this frame projects over both ends of the lower plate C and the framework, so that the overlapping parts may provide means for removing the upper plate in order to insert the card, and also to replace the plate ready for cutting. Knobs P in Figs. 63, 64, and 65 serve the same purpose for the frame illustrated in those figures.

This simple method of cutting cards is practised only in exceptional cases, for it is evident that the work, even at its best, is performed exceedingly slowly, and the process is suitable only for the cutting of cards for use on small jacquard machines and in cases where a comparatively small number of cards are required for each machine. Practically all card-cutting for cards which are intended for ordinary jacquards, as well as for many special types of jacquards, is done on what is termed the piano card-cutting machine.

Although piano card-cutting machines by different makers vary slightly in detail, the chief features in all these machines are very similar, and Fig. 67 is a general view of the machine made by Messrs. Devoge & Co., Manchester. The point-paper design is shown clearly on the reading board, and the partially punched card is shown with the fore-end gripped by the rat-trap of the carriage, and the rear-end in the guides near the front of the machine. All the other parts will be recognised in connection with the line drawings, of which Figs. 68 and 69 illustrate side and front elevations. In this machine, as in most others, one short row of 8, 10, or 12 holes represents

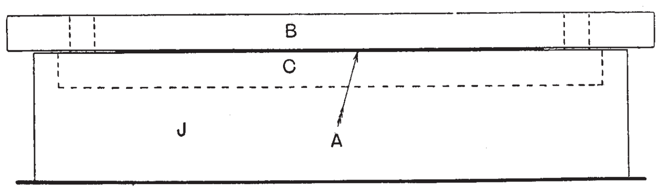


Fig. 66.

the amount which may be cut at one operation, and since this is the case, it is necessary that the successive positions of these short rows shall be placed in regular order immediately under the 8, 10, or 12 punches. The punches are held in position in the headstock A, which will be described later, and this headstock controls the punches in such a way that any desired order of cutting may be easily achieved. The card B to be cut is placed between a fixed guide C and a movable guide $C^1$, and is supported by and slides along the ledges of the two guides. When the headstock A is in its highest position the card B is entered through the slot D between the top and bottom plates E and F, both of which are drilled to correspond with the pitch of the needles in the short rows of the jacquard, and the holes are naturally just large enough to allow the punches clearance for working. The card, as stated, passes between these two plates, and the end is gripped by a suitable rat-trap catch G fixed to and moving with the carriage H. Now after each short row or the necessary part of a row has been cut, it is clear that those punches which have been forced through the card and into the holes of the lower plate F must be withdrawn before the card can move, and that the carriage H must also draw the card backward a sufficient distance in order that the position of the next short row shall be under the punches. This double action is performed by the action of the card-cutter's feet on the treadles J and K, both of which are fulcrumed at L.

In the position shown in Fig. 68 the treadle J is in its lowest position,

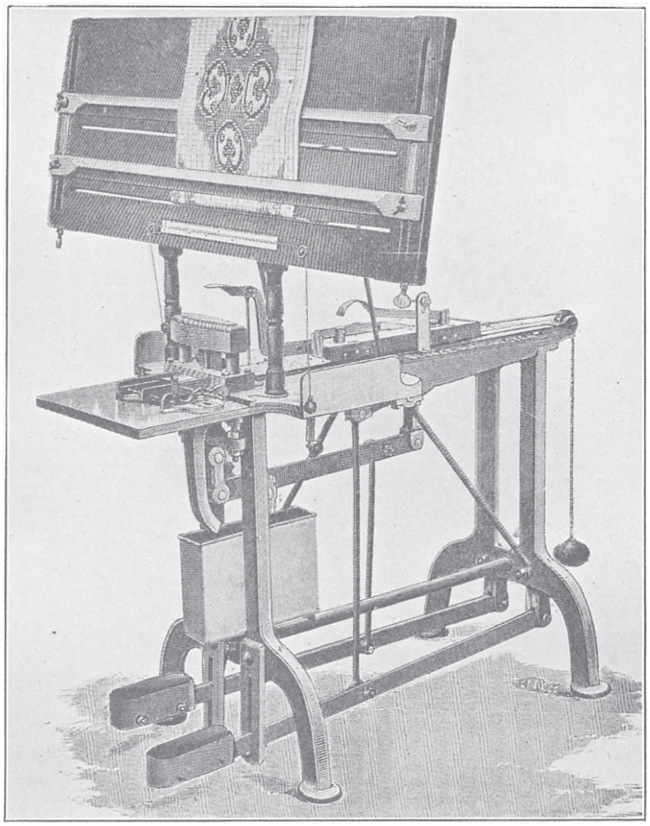

FIG. 67.

and the treadle K in its highest position. These are the positions occupied by the treadles :

(a) When the card is entered through slot D ;
(b) When the card-cutter selects the necessary keys and therefore the punches for each short row ;
(c) Immediately before the punches are carried down by the head-stock A.

It will be seen that the downward movement of treadle K will impart a similar but shorter movement to rod M, which in turn will pull down the end N and raise the opposite end O of the short lever fulcrumed at P.

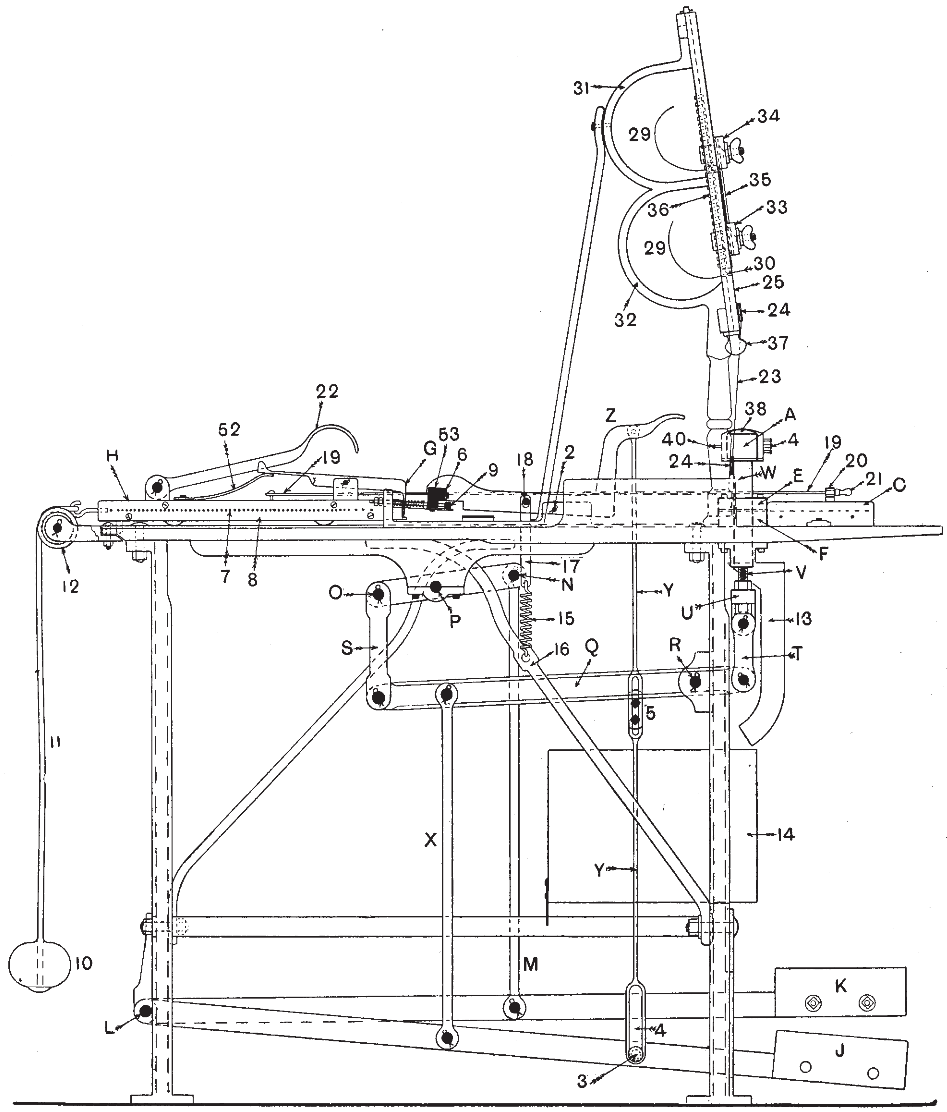


Fig. 68.

Simultaneously, the long arm of lever Q, fulcrumed at R, will be raised through link S and the short arm of lever Q; the latter is attached by link T to cross-bar U. The two ends of cross-bar U carry the two bolts V, which are fixed to and operate the headstock A. It will thus be seen that when the right treadle K is depressed, the cross-bar U will cause the two slides W to move downwards in their sockets, and the headstock A will move with them. In virtue of the decreased leverage of the various levers, it follows that the cross-bar U and the headstock A will move downwards through only a short distance—actually a quarter of an inch—which, however, is quite sufficient to force the punches through the card. It will be observed that the left treadle J is also connected to lever Q by means of rod X, and attached by the adjustable rod Y to the handle of the escapement lever Z, fulcrumed at 2.

It has been shown that a downward movement of treadle K imparts an upward movement to the long arm of lever Q; hence the latter, through rod X, raises treadle J, and as treadle J rises, the stud 3 moves upwards in slot 4 of rod Y without imparting any movement to the latter or to the end of escapement lever Z. Treadle J will now be in its highest position, and, in virtue of the connections shown, it is evident that a downward movement of treadle J will impart an upward movement to treadle K, and hence an upward movement to the headstock A. When the left treadle J is approaching its lowest position, the stud 3 comes into contact with the bottom inner curved part of slot 4 in rod Y, and imparts a slight downward movement to the latter. The extent of this depression is accurately adjusted by means of the connection 5, and is just sufficient to lift the top catch 6 of the escapement on the end of lever Z clear of the pins 7 in rack 8. A special and essential provision is made in this escapement, and in all similar ones, to ensure that when the carriage is liberated by the withdrawal of the above catch 6 from between the pins 7, a similar catch 9, fixed to a sliding block, will prevent the carriage from being drawn too far back by weight 10, which is attached to the back of the carriage H as shown by means of a rope 11 passing over pulley 12. In Fig. 68 the whole of the carriage is clear of the escapement. The small discs of cardboard which are punched out of the card drop into a funnel-shaped chute 13, and ultimately into a box 14.

The lever Z, which carries the escapement, is thus positively moved in one direction by stud 3 in treadle J, and it is negatively returned to its normal position by spring 15 attached by one end to stay-bar 16, and by the other end to link 17. The latter is hooked on a stud 18, which projects from the face of the lever Z.

A cord 19 is attached by a screw to carriage H, is passed through a brass eyelet 20, see also Fig. 69, in the movable guide $C^1$, and has a knot tied on, or a handle 21 attached to its end. This cord is for the purpose of drawing the carriage forwards and into close contact with blocks E and F when starting to cut a new card, or for altering the position of the carriage for any other reason. The carriage is shown in Fig. 68, very near the back of the machine in order that a full view of all parts may be seen. In practice, however, the carriage never reaches this extreme position; indeed, in this and nearly all other machines a horizontal rod is supported by a bracket from the table (see Fig. 67), and this rod, which overhangs the narrow part of the carriage, arrests the handle 22 and thus stops the carriage soon after the last pin of the row 7 leaves the catches of the escapement. A thin cord 23, seen best in Fig. 69, is also attached to the carriage, and passes over suitably arranged guide pulleys 24, and across the front of the reading board 25. A small weight 26 is attached to the end of this cord, and a metal or other pointer 27, or else a knot tied on the cord itself, passes in front of a numbered index card 28, so that as the carriage recedes during the cutting operation, the pointer moves from right to left and from hole to hole on the index card 28. In Fig. 69 the pointer 27 is near the right end of the index card 28, whereas in Fig. 67 it is not far removed from the left end.

Practically a full sheet of design-paper is shown in Fig. 67 pinned to the reading board, but only a small piece 29, Fig. 69, is shown on the reading board 25 in the latter figure. There are two slots in the board (see Fig. 67), but only one, marked 30, is shown in Fig. 69. The design-paper may be passed through both slots, or through only one as indicated in Fig. 67. If it goes through both as shown in Fig. 68, it is first placed in the semicircular part of bracket 31, passed through the top slot 30, down the face of the board, and as the cutting proceeds the end is entered through the lower slot 30 and then into the semicircular part of bracket 32. In many of the latest machines these semicircular parts are dispensed with.

The straight edge 33 is joined to its companion 34 by flat iron strips 35, and the two straight edges being thus joined can be moved up and down the board as required by means of the square threaded vertical screws 36, which are operated by thumb-screws or milled heads 37. The latter are sometimes grooved, and a cord passes round both so that the cutter may move the straight edges by drawing the cord in the desired direction.

A good general idea of the mechanism of the headstock A will be gathered from Figs. 70 to 73. The wooden cap 38 is shown in position in the three latter figures, which are sectional end views, but in the plan view, Fig. 70, it has been removed, and thus practically all the mechanism of the headstock is exposed to view. The sectional views are taken from the left, as indicated by the large arrow in Fig. 70.

Twelve ordinary punches 39, each approximately $\frac{1}{5}$ in. in diameter, and the majority 4 in. long, appear in the same plane, and each is provided with a shoulder similar to those shown in Figs. 71 to 73, by means of which it is prevented from dropping out, and also raised when required by the

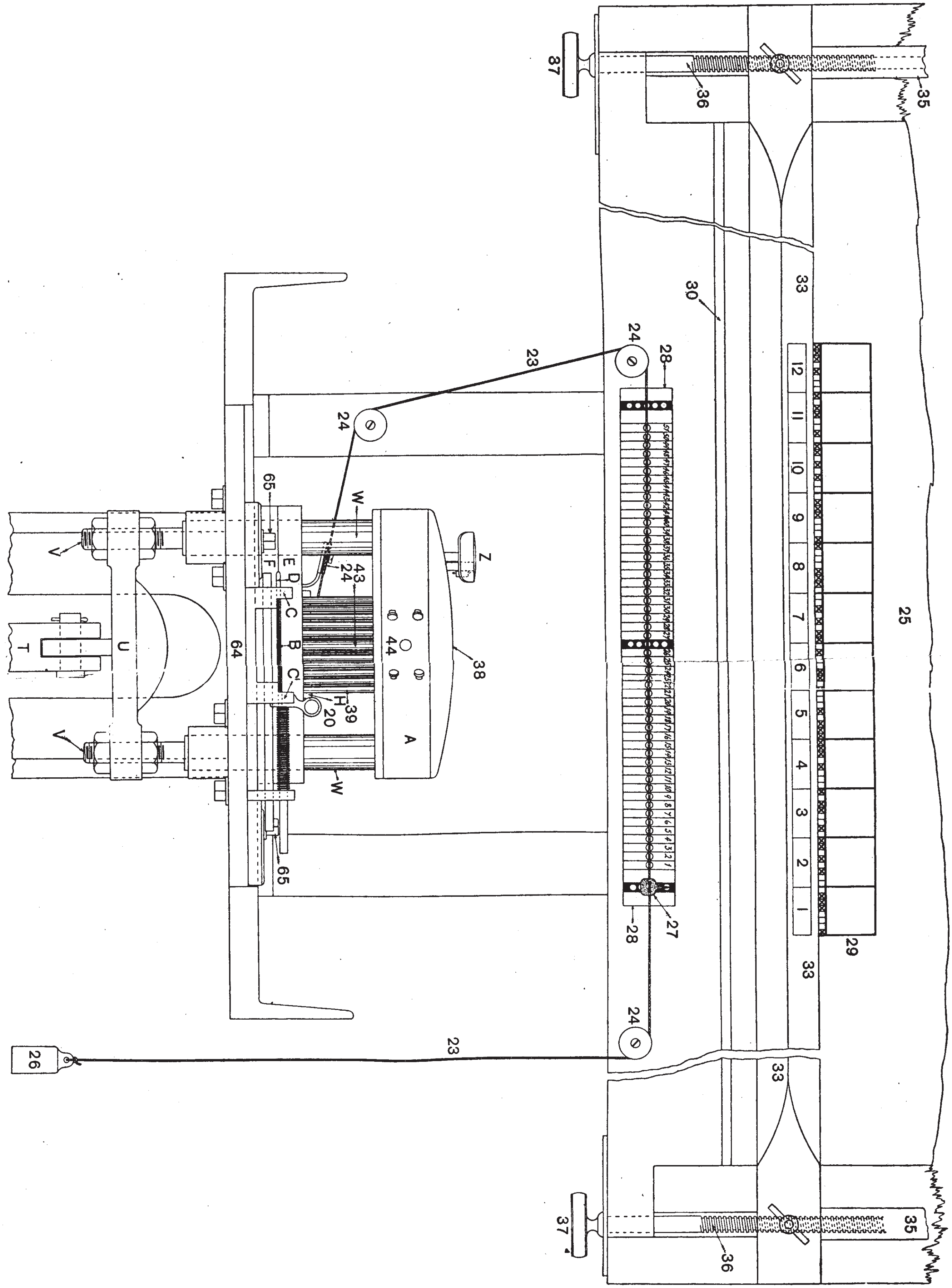


Fig. 69.

To face page 104.

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headstock A. Each punch 39 has its corresponding key 40, 41, or 42, which is kept in position by a spiral spring 46 on the stem of the key. A larger punch 43 is also provided immediately in front of the twelve ordinary ones,

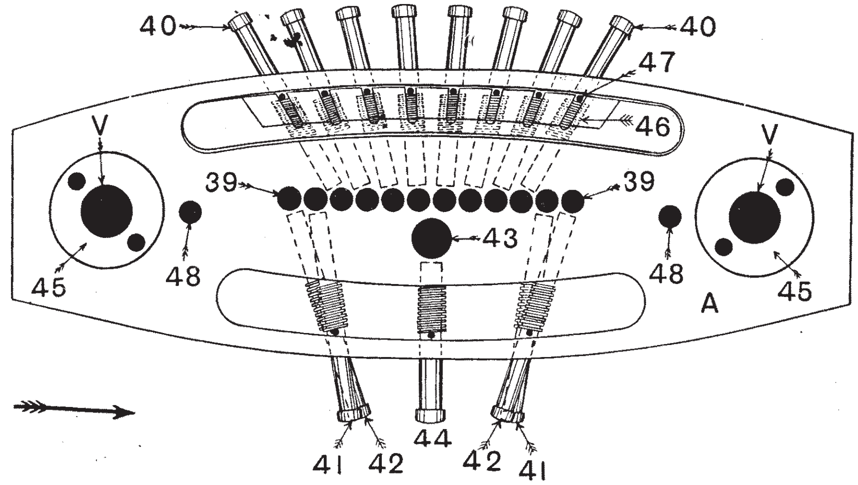


FIG. 70.

and this also has its key 44. The upper ends of bolts V (see also Fig. 69) are secured by circular nuts 45, which may be unscrewed or screwed by means of a two-pronged turnscrew and the two holes in each nut.

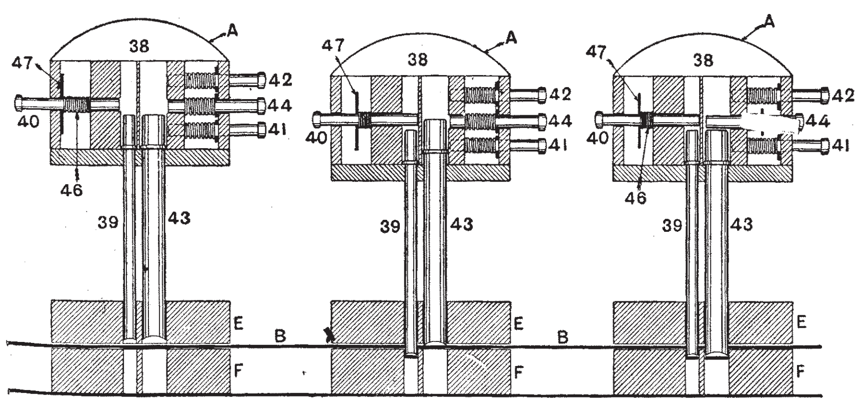


FIG. 71. FIG. 72. FIG. 73.

The middle eight punches are for 400's or 8-row cards, and they are operated by the eight keys marked 40 at the back of the headstock A. For a 500's or 10-row machine ten punches and ten keys are required; in this case the two keys marked 41 at the front of the headstock operate the second and eleventh punches in the row. Finally, for a 600's or 12-row machine all the punches 39 and keys 40, 41, and 42 are utilised. Some 600's machines are made with short rows of eight, and the cards for these would naturally be cut with the eight middle punches; in this case, however, the carriage H is considerably longer than the one shown in Fig. 68. Although there may be certain advantages in such a card, it is not considered to be as useful a size as the 12-row cards, which are most common for this size of machine.

The action of the mechanism is as follows: When the headstock A is up, as shown in Fig. 71, the tops of the punches 39 and 43 are below the level of their respective keys. It will be understood that the punches for those keys in the low position, and the punches for those keys in the high position, are shorter and longer respectively than are those for the keys in the middle row, and the punches shown are representative only of this row. When the headstock A is in the highest position, as indicated in Fig. 71, the selection of keys, according to the marks on the design-paper, is made, and these keys are pressed inwards. This action will clearly place the inner ends of the selected keys immediately over the tops of their respective punches, and when the headstock A is drawn down by the right treadle K and the connections indicated in Fig. 68, it follows that the punch, say 39 in Fig. 72, will be forced through the card B by the key 40. At the same time the punch 43, and all others which are not under the control of their respective keys, will simply rise in their holes, or at least will rest stationary upon the card B, while the headstock A moves downwards; the position of the shoulder of punch 43 in Fig. 72 shows that this is the case.

In Fig. 73 an ordinary key and the peg-hole key have been pressed over the tops of the punches 39 and 43, and both the latter are shown as having passed through the card B. (A clearance is shown between the key and the top of the punch, but it will be understood that the two are in close contact when cutting is taking place.) The cutting face of each punch is concave in order that it will enter the card gradually, and thus effect the cutting more easily. When the fingers are removed from the heads of the keys, the springs 46, which are compressed by the pins 47 that pass through and move with the keys, exert their force on the pins 47 and thus place the keys in their inactive position. The pins 47 are kept vertical and out of each other's way by being caused to move in the slots of the brass plate which covers the springs.

Two pins project from the underside of wooden cap 38, and enter the holes 48 in the headstock A, Fig. 70. The small or ordinary punches are used for the design and for the lacing holes, whereas the large punch 43 is used solely for cutting the holes for the pegs of the cylinder.

Before describing the remaining parts of the machine, it will probably be best to indicate how the design is read, and the manner in which the holes are cut. We have already stated that the card B is drawn backwards by the carriage H a distance equivalent to the pitch of the short rows every time the left treadle J, Fig. 68, is depressed. We have also seen that the downward movement of the right treadle K results in a downward movement of the headstock A. Now since all the punches are held by their shoulders in the headstock A, it follows that when no card is in the slot D, Fig. 69, the punches will partially close the slot when the headstock is down; consequently, the left treadle J must always be down and the headstock up before a new card can be entered through the slot D. But when the parts occupy these positions the carriage H cannot be kept in close contact with the back of plates E and F—*i.e.* in the full forward position—but always moves back a short distance when released by cord 19. This is because at this time the catch 9 is between two of the pins 7, and when the cord is released the weight 10 pulls the carriage back until the said catch reaches the next pin. This motion will be explained fully shortly.

In order that the carriage may be kept in close proximity with the plates E and F—*i.e.* when the pointer 27, Fig. 69, is opposite the right-hand black band of index card 28, as illustrated—it is necessary that both treadles should be moved slightly until both catches 6 and 9, Fig. 68, are in contact with the pins 7 while still leaving the headstock A in such a position that the keys may be easily pressed in if required; if the treadles are moved too much the catches and pins may still be in contact, but the tops of the punches may be above the level of the key holes, and thus prevent the keys from entering. Commencing operations, then, with the pointer 27 in the place indicated, three keys, the second and the seventh in the back row of Fig. 70, as well as the middle one, 44, are pressed in for a 400's card, and the right treadle depressed. This combined action cuts the three holes marked 49 and 50 in Fig. 74. The left treadle J is now depressed, which, by the connections, allows the carriage to recede and to take the pointer 27 to a position approximately midway between the black band and the hole marked 1, Fig. 69, on the index card 28—actually a little nearer to 1 than to the black band. This position corresponds to the place in the jacquard where extra needles are often inserted, and is the same as that occupied by the 6 holes marked F in Fig. 65. The right and left treadles are again depressed in the order mentioned, when the corresponding movement of the carriage H places pointer 27 opposite No. 1 on the index card. If we assume that all the 51 rows are utilised for the design, the cutting for the latter will start with the pointer at No. 1.

In Fig. 69 the straight edge 33 is immediately underneath a greatly enlarged section of design-paper 29, the large squares representing the blocks of 8-by-8, and the small squares representing the line which is to be cut.

The card-cutter reads 8 of these small squares, those between the heavy vertical lines, at a time, and since bar 1, which corresponds with 1 on the index card, shows marks on the first, fifth, sixth, and seventh squares, the keys for these numbers will be pressed in and the right treadle then depressed ; holes will thus be punched in these four positions on the first row of the card immediately below the large peg-hole 50, Fig. 74. The left treadle is then depressed, which allows the carriage to recede and to draw the card with it, as well as to take the pointer 27 opposite No. 2 in the index card 28, Fig. 69. Bar No. 2 on the design-paper 29 is now taken, and the right and left treadles pressed down alternately. This order is continued, taking the proper readings from the design-paper until the pointer 27 reaches the black band between Nos. 26 and 27 on the index card. At this point the second and seventh are cut for the centre lacing of the cards ; the cutting for the pattern then proceeds as usual from No. 27 until the pointer reaches No. 51, at which point the keys for the last bar on the design-paper, as well as the large key 44 for the peg-hole, are pressed in and the card cut. Finally, when the pointer reaches the last black band, the second and seventh keys are again pressed in, and the card cut for the third line of lacing. Then, with the right treadle still down, the card-cutter takes hold of handle 21, Fig. 68, pulls card guide $C^1$ a little to the right so as to allow free movement to the card, presses down lever Z to withdraw catches 6 and 9 from pins 7, depresses the left treadle J to lift punches out of card and above slot D, and then pulls the carriage forward by handle 21 and cord 19—an action which obviously forces the card in advance of the carriage. Since a complete card is cut in about a minute, it follows that the whole operation is done in less time than it takes to describe even the movements which are performed for withdrawing the card. When the carriage has been thus drawn forward, lever Z is released, so that the carriage may be kept stationary by the catches, and lever 22 is pressed down in order that the card may be removed from the grip G.

The holes in the successive rows in the card would then represent the marks on the design-paper. Thus, the holes in card B, Fig. 74, represent the marks in the squares immediately above the straight edge 33 in Fig. 69.

Fig. 74 is a plan of the front part of the machine, and it shows distinctly that twelve short rows of the card B have been cut, and that the thirteenth row is immediately under the punches. The card in Fig. 74 shows that the cutting started as mentioned on the first row, but the actual starting point will naturally depend upon which particular row of the jacquard controls the first eight threads in the design, and this in turn is to some extent dependent upon the weaves to be used and the disposition of the ornament on the design-paper. It has already been pointed out that with detached figures the number of needles in use must be a multiple of the ground weave, and although there are several things which prevent ideal conditions obtaining, it is evident that under certain circumstances the most desirable number of needles to be in work is that one which contains the greatest number of factors, and still keeps in use practically all the needles in the

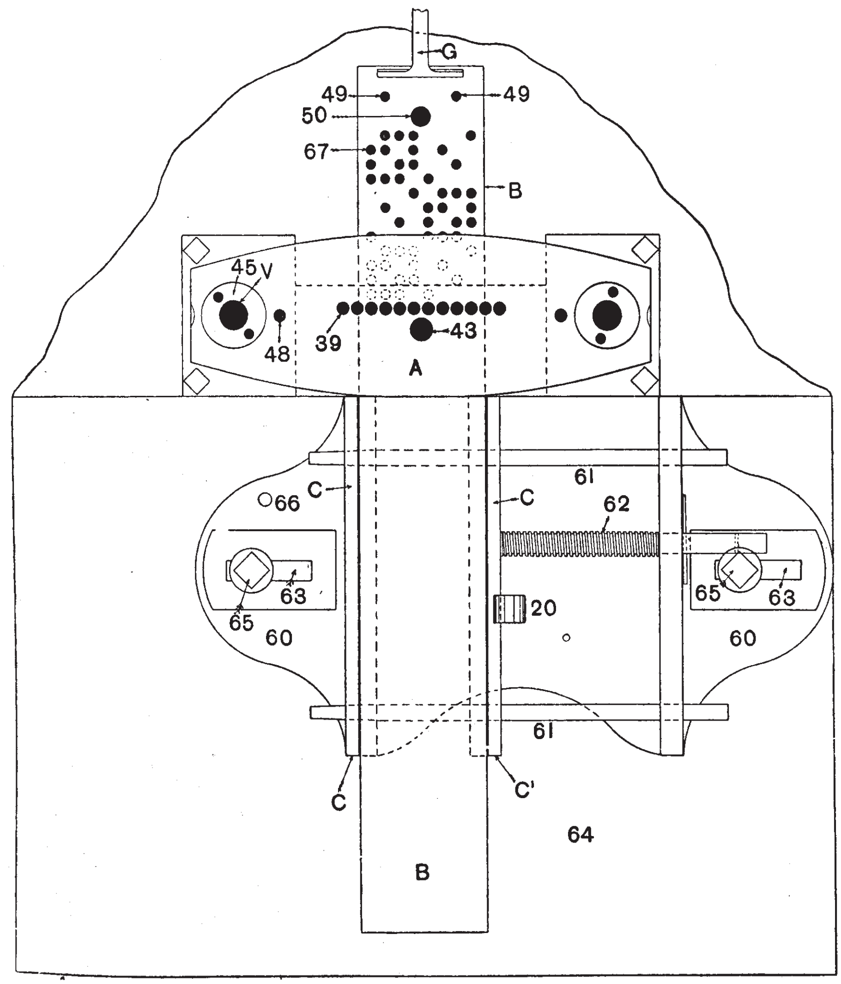


Fig. 74.

jacquard. Thus, with a constant sett of the warp, and with the jacquard mounted or tied up for 384 needles and hooks, a larger number of different ground weaves could be employed for different designs than is possible with any other number in a 400's jacquard. It is evident, however, that, except in special circumstances, this number would be unsuitable for 5-thread weaves ; indeed, for practically all kinds of designs intended to be developed in 5-thread weaves, the number of needles employed would be a multiple of 5.

Although the marks on the single line of design-paper in Fig. 69 (facing page 104) are not representative of any particular design, but have been taken irregularly to show the method, we may assume that the twelve blocks of eight squares each represent the first pick of a design which is complete on 96 threads. There will therefore be four repeats of each pick on its corresponding card.

96 thds. per pattern × 4 repeats = 384 needles to be used.
408 needles − 384 needles = 24 needles and 24 hooks not required for the figured part of the cloth.
= 3 full rows of 8.

If one of these three rows is reserved for selvages (say, the first row), then two rows must be left idle, and these may be at either end. A suitable arrangement would be as under :

Row No. 1 = selvages.
„ 2 to 49 = for design.
„ 50 and 51 = idle.

If the draft in the harness reads from back to front as illustrated in Figs. 5 and 9, and in the upper diagram in Fig. 3, it is necessary to turn the design through 180 degrees, so that the first thread and the first pick will start on the right as shown in Fig. 69. Then the bars or blocks of eight small squares are read in regular succession from right to left, and the pointer 27 in Fig. 69 must also move from right to left as the carriage H, Fig. 68, recedes, in order to indicate on the index card the exact position or block of the design paper for the guidance of the card-cutter when he or she desires to compare the two. When the first thread in the warp is through a mail of the harness cord at the front of the comberboard or harness-reed, as indicated in the lower diagram in Fig. 3, and the warp threads drawn from front to back, the bottom needle of the jacquard controls the first hook and thread. In this case the pointer 27, Fig. 69, would be attached to the carriage H in such a way that as the latter receded the former would move from left to right in front of the index card 28. It would then be unnecessary to turn the design through 180 degrees. In both cases the cards would be numbered consecutively, and at that end which was cut first.

When the designs to be reproduced are intended to occupy a large area on the cloth, as, for example, in table damasks, crumb-cloths, curtains, floor covering, and similar textures, it is a common practice to utilise as many needles and hooks as possible ; consequently, with 5-thread weaves and a 400's jacquard there are usually 400 hooks out of the 408 tied up for figuring purposes, and the odd row or first row reserved for the selvages and the narrow stripes which adjoin the selvages. Let us assume, for example, that Fig. 75 represents 8 picks of a design on 400 threads. The first bar or block, marked 1 on the design-paper, represents the first row of needles and hooks in the jacquard; but the design shows that the first, second, and third vertical rows of small squares are unmarked, and consequently the first, second, and third needles and hooks are idle, unless they happen to be utilised for, say, the two outside threads at each selvage, or for the $\frac{2}{2}$ basket border, or for some such simple but necessary work, independent of that represented on the design-paper. The fourth to eighth threads inclusive in the first bar or block represent the weave for the narrow stripes, and these stripes in damasks are termed the simple satin part; they adjoin the selvages, and sometimes appear in other parts of the fabric. This weave is naturally continuous throughout in the way of the weft. Bars or blocks, Nos. 2 to 51, of which only up to 7 are illustrated in Fig. 75, are for the figure, and, although in certain sections of the 8 picks illustrated the weave is shown continuous, it will be understood that the weaves in all parts except bar No. 1 change from point to point, somewhat as illustrated in bars 5 and 6, and are therefore quite different from that marked in bar No. 1. For cutting purposes the design would be turned through 180 degrees if intended for the arrangement shown in Fig. 69.

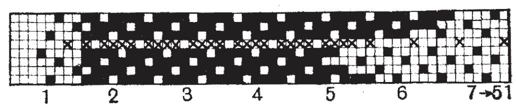


Fig. 75.

It will be noticed that when the point-paper design is painted in solid black or in any other opaque or very thick paint, it is impossible to distinguish the heavy dividing lines, so that no design should be made as shown in Fig. 75. The same design appears in Fig. 76, turned through 180 degrees ready for cutting, but dots have been introduced instead of solid squares; this certainly enables the marks in the heavy sections to be seen more clearly in conjunction with the heavy dividing lines, but in practice neither method would be adopted, on account of the difficulty involved and the time taken in introducing the weave into the figured portions. The usual practice is to paint all over the figure with red, introduce the ground weave in red, and then with either white or black paint insert marks on the already fully painted figure to indicate where the threads are to be left down. In cutting, the operation is then to cut all

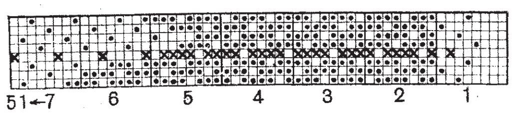


Fig. 76.

red in ground and figure, and to leave everything else uncut. The line in crosses in Fig. 76 is represented on the card B in Fig. 78.

Figs. 77 and 78 represent on a large scale an elevation and a plan of the carriage H, together with the parts which control the movements of the carriage. As already mentioned, a blank card is placed between the fixed and movable card guides C and $C^1$, Figs. 68 and 69, the left treadle J being down and the headstock A being up. The punches are in consequence above the slot D, and therefore the card can be pushed easily through the slot until it comes into contact with the end of the carriage H or the rat-trap grip G. It is, of course, necessary that the card B should be firmly gripped between the small projecting part 51, Fig. 77, and the teeth of the grip G after the card has been placed between these parts. In order to enter the card B, it is necessary to press down the end of lever 22, the latter in turn forces down the left-hand end of lever G and raises the right-hand end of the latter, then when the card has been placed between the points of G and the piece 51, handle 22 is released and the spring 52 causes the rat-trap G to grip the card B.

Attention has already been called to the fact that the cutting is done by pressing down the right treadle K, Fig. 68, while, on the other hand, the downward movement of the left treadle J allows the carriage H to be drawn back a distance equal to the pitch of the pins 7 in rack 8. Thus, when the treadle J is nearly at the bottom of its stroke, the pin 3 comes in contact with the bottom of slot 4, Fig. 68, and causes a slight downward movement to be imparted to rod Y. This causes the right-hand end of lever Z to move in the same direction against the pressure of spring 15; the left-hand end of lever Z, which carries the escapement, consequently rises slightly. In Fig. 77 the escapement is down, while in Fig. 79 it is up.

The escapement is composed of a block 53 on the end of lever Z and this block carries the fixed catch 6. The sliding catch 9 is fixed on the end of a bolt 54 supported by and free to move in the block 53 and the projecting part 55 at the end of lever Z (see Fig. 78). A spiral spring 56 encircles the bolt 54, and tends to keep the catch 9 to the right as shown in Figs. 68, 77, 78. In this position it will be seen that the fixed catch 6 is between two of the pins 7 of the rack 8, thus preventing the carriage H from being drawn backward by the weight 10, Fig. 68; while at the same time the sliding catch 9 is under and quite clear of the pins 7.

Immediately rod Y is depressed, however, the catch 6 is lifted clear of the pins 7; but simultaneously catch 9 is placed in the position which has just been vacated by catch 6. The pull of the weight 10, Fig. 68, now draws the carriage H backwards until the sliding block 57, Figs. 77 and 79, which carries the catch 9, comes into contact with the recess in part 53. When this happens, both catches 6 and 9 are in one plane, as shown in

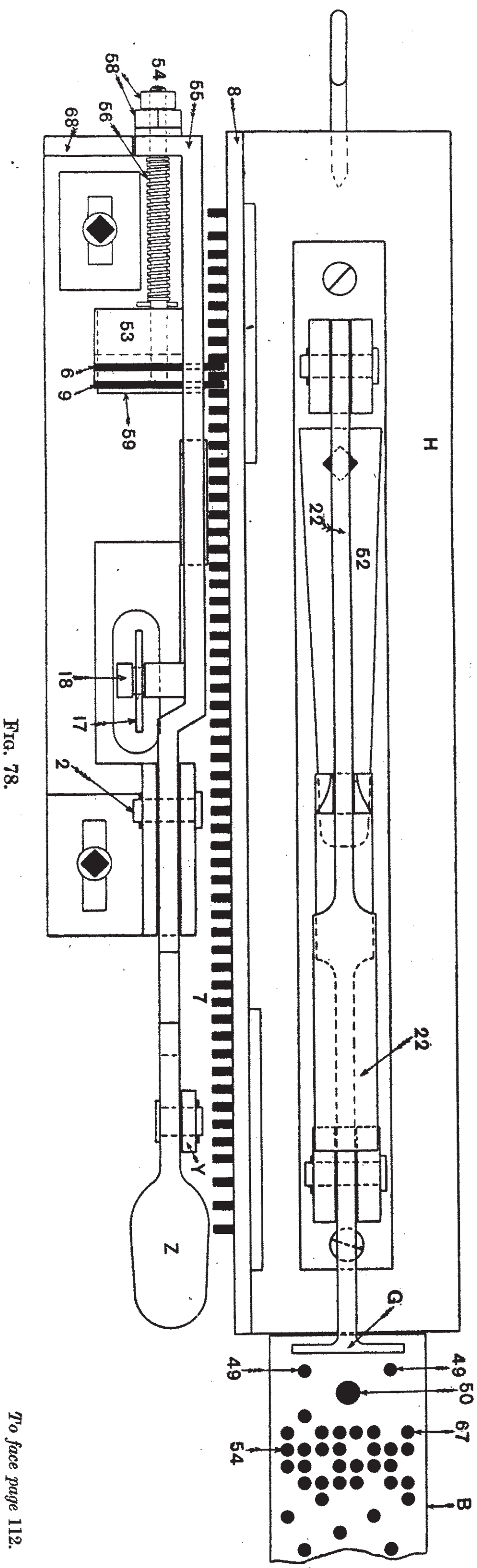


FIG. 78.

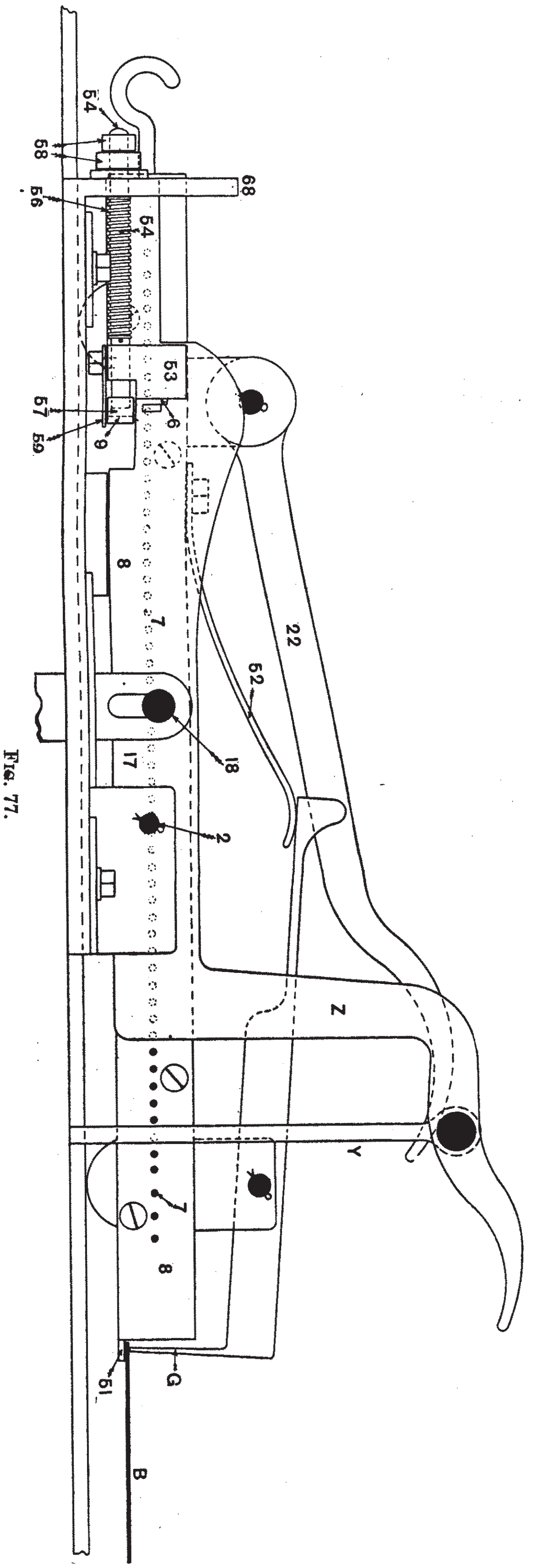


FIG. 77.

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Fig. 79. The distance through which the carriage H moves is the pitch of the pins 7, and the necessary adjustment to obtain the correct distance is made by nuts 58 on the end of bolt 54.

From the connections shown in Fig. 68 it will be clear that the two treadles J and K always move in opposite directions, so that immediately the treadle K is pressed down, the stud 3 rises in slot 4, and hence the spring 15 and link 17 draw the left-hand end of lever Z downwards until the escapement assumes the position indicated in Fig. 77. Thus, in Fig. 79, where the pins 7 are shown rectangular instead of round—both kinds being in use—it is clear that catch 6 will enter between the pins 7 just before the sliding catch 9 leaves them; and immediately the sliding catch 9 leaves the pins, the spring 56 forces forward the block 57, and therefore the catch 9, into the position shown in Fig. 77, the under surface of block 57 sliding along plate 59, which is set-screwed to the block 53 as shown.

Attention has already been called to the partially cut 400's card in Fig. 74. It will be clearly seen that the middle eight punches of the headstock, Fig. 70, act on such a card. The fixed card guide C and the two soleplates 60 form one piece, while the movable card guide $C^1$ slides on rods 61, and is kept in close contact with the card by means of the spring 62. It is essential that the side of the card should be in contact with the full length of the fixed guide C, so that the cutting will correspond exactly with the longitudinal rows of needles in the jacquard, and thus ensure a correct selection of needles according to the pattern on the card.

Slots 63 in baseplate 60, Fig. 74, provide means for adjusting the card guides for the different widths of cards. Thus, for a 500's

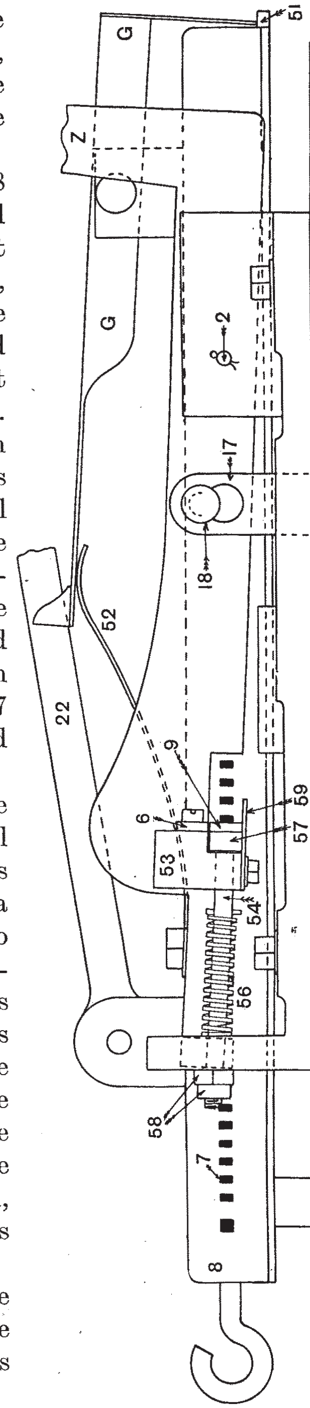



FIG. 79.

or 10-row machine, guide C would be moved to the left a distance equal to the pitch of the punches, and then bolted to the table 64 by the set-screws 65. Similarly, for a 600's or 12-row machine, the same guide C would be moved still farther to the left so as to include the extreme punch on the left. This adjustment requires to be done very accurately indeed, and to facilitate the movement for different sizes of cards it is a good plan to fix the points accurately, then drill a hole through the base-plate 60 and the table 64, so that a pin 66 may be inserted before the plates are screwed down. It will of course be understood that the holes marked 67 on the card are for the pattern. Fig. 80 is an end elevation of the parts illustrated in Fig. 79, and it will be seen that the projecting part 55, Fig. 78, in its up-and-down motions, slides against the side of guide 68, Fig. 80.

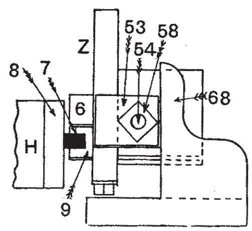
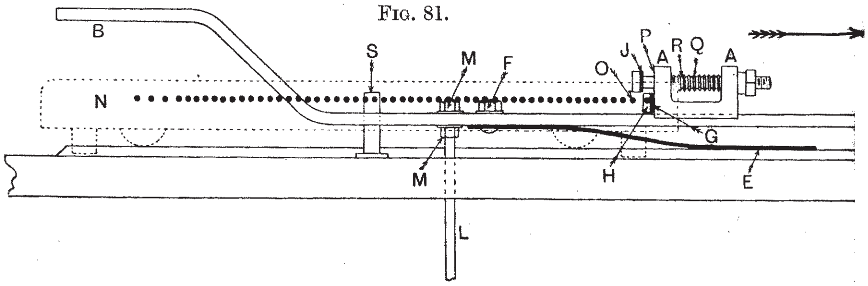



Fig. 80.

The card-cutter already described is intended for what is termed the ordinary British pitch, in which the distance between the centres of any

Fig. 81.



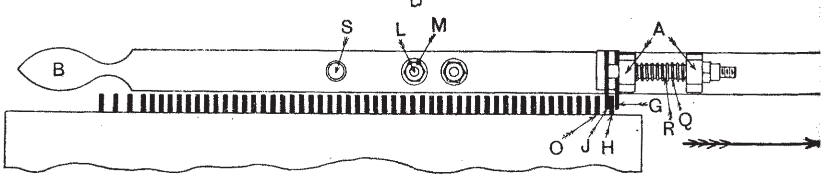




Fig. 82.

pair of holes is $\frac{7}{26}$ of an inch, or 0·2692 in. It is, of course, easy to fix a headstock of a different pitch, to introduce a new rack on the side of the carriage, and still utilise all the other parts of the machine. Except in special cases, however, the above headstock represents the usual pitch in use, and the only difference between this machine and those of other makers is in the structure or shape of the various parts for performing the same functions. Thus, in many machines the escapement is arranged as illustrated in Figs. 81 and 82, which show respectively an elevation of the pins from the opposite side of the carriage, and a plan. In the former illustration the carriage itself is supposed to be cut away, but its position with respect to the other parts is indicated by the dotted outline.

The escapement block A is, in this case, secured to the upper face of a long, flat bar B, fulcrumed at C near the extreme back part of the frame-work D, and kept normally in its present position by means of a flat spring E, one end of which is fixed to the bar B by nut F, while the other end rests upon the top of the table, and is thus capable of sliding about $\frac{1}{8}$ in. along the top when the upper part of the spring is pressed down. In many machines the bar B is itself in the form of a spring, and rigidly fixed to the framework near point C. The main advantage of the former method is that the bar is practically everlasting, since all the negative or return movement is supplied by the spring E, and this is the only part which is subject to any serious wear and tear.

The fixed catch G is shown behind the first pin H, whereas the sliding catch is clear of the pins as illustrated in Fig. 81. The headstock, which is not shown in these figures, would occupy a position on the extreme left, and the carriage N would, therefore, move from it during the operation of cutting in the direction of the arrow K. A small rod L, secured to the bar or spring B by nuts M, passes through a slot in a short stud, which projects from a lever similar to and performing the same work as lever Q, Fig. 68. Small lock-nuts are placed on the end of the rod L, Fig. 81, and the above-mentioned bracket through these nuts carries the rod L down a short distance when the left treadle of the card-cutter is depressed. The downward movement of this rod L takes down the escapement A sufficiently far to withdraw the fixed catch G from the pins of the rack, and to place the sliding catch J in the next slot—that is, into that slot which the pin is immediately above at present in Fig. 81. The weight similar to 10 in Fig. 68, attached to the end of the carriage N will then exert its force on the head of the sliding catch J, through the pin O in the rack of the carriage, and cause the latter to move until catch J is arrested by the front part P of the escapement support.

Fig. 81.

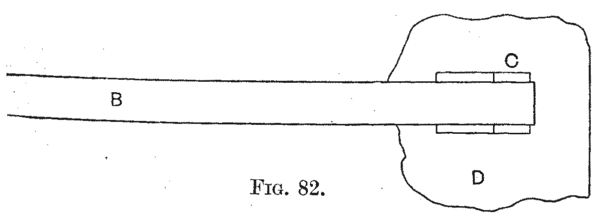




Fig. 82.

During this action the spring Q will, of course, be compressed until the right treadle is pushed down to cut the card, when the fixed catch G will return to its present horizontal plane, but will enter between the next pair of pins, and at the same time the sliding catch J will leave the same pair of pins. Immediately the catch J is clear of the pins, the compressed spring Q, through a small pin in the rod R, will force the sliding catch J and its support to the left ready to be inserted between the next pair of pins, and so on until the carriage has traversed its complete path and the card has been cut. It will thus be seen that the escapements in the two types of machine perform the same function, but from different positions. The bar or spring B is guided in its up-and-down movements by a pin S, which stands erect from the table D, and passes through a hole in the bar B. Both catches G and J are naturally withdrawn from contact with the pins of the rack when it is necessary to draw the carriage N forward to commence with a new card, or for any other purpose.

Fig. 83 is a sectional elevation of the table, introduced to show up one or two little points. In this figure, A is the carriage which runs upon the supports B. The card is gripped between the teeth of the rat-trap D and the small projecting ledge E in front of the carriage, in the usual way. The solid part C represents a 400's card, while the dotted extensions show the width of a 600's card. Two rail guides F at the same height as the ledge E support the card during all its travel, and when the last row in the card has been cut, the lever corresponding to 22 in Fig. 68 comes in contact with the underside of the overhanging rod G, which, through the action of the weight 10, Fig. 68, causes the lever 22 to be depressed slightly, and thus raises the grip D to free the card. The cutter can then remove the card from the back of the headstock, and thus obviate the necessity of drawing it forward through the slot, as previously explained. It will, of course, be understood that the rod G is supported by bracket H, which is fixed to the table as shown in Fig. 67 ; in many cases, parts G and H are in one piece.

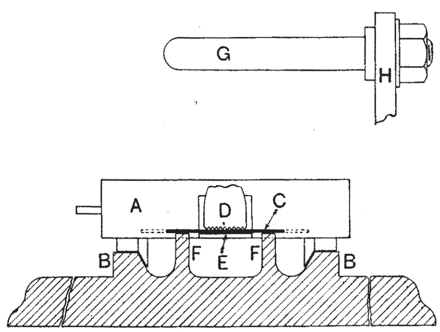


Fig. 83.

The guide rails F are also clearly illustrated in Fig. 84, which illustrates one or two minor details. The lettering in this figure corresponds with that for similar parts in Fig. 83. Part of a headstock in Fig. 84 shows holes for 14 punches in one row, but the keys are omitted. The two outside punches, with corresponding keys, are introduced into some machines to provide means for cutting the semi-circular holes K in 600's cards opposite the lace holes M. For 400's cards the third and twelfth punches would be used for the same purpose. Some firms desire these holes or snips at the edges of the cards, as they think the lacing is more satisfactory than it is without them. Such semi-circular holes are also required if the lacing is in the form of two or four cords which cross each other between the cards, and so hold the cards in position. The card shown in Fig. 84 is fully cut for five rows in order to show it up distinctly, and the front part of the card is torn away to expose the card guides N. As usual, the left guide N is a fixture when working, but the right guide is under the influence of a spring on pin O, and the latter is attached to the angle-plate P, Fig. 85. In many cases the parts N are dispensed with, and the card is then introduced on the base Q, in which case the gap R between the upper and the lower plates of the headstock is naturally in the same line. The figures show the positions of parts for a 600's card ; when it is necessary to cut 400's cards, a channel-shaped guide is introduced, and the sides of this guide fit between the vertical part of P and the edge S of the opposite side.

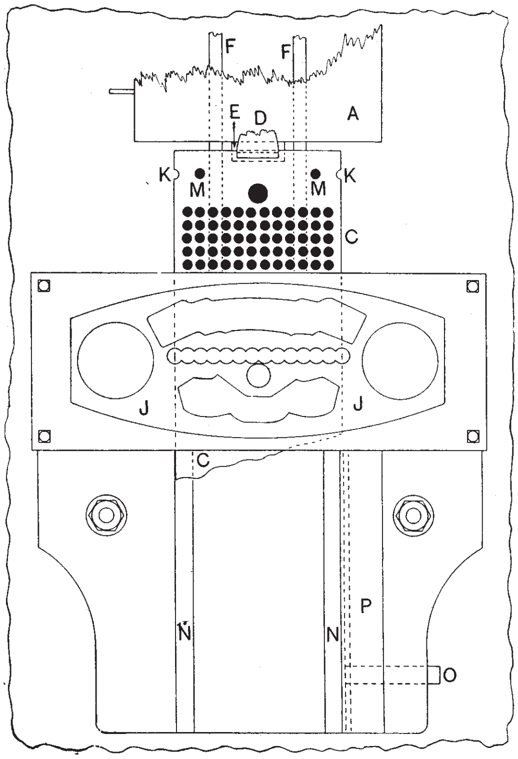



FIG. 84.

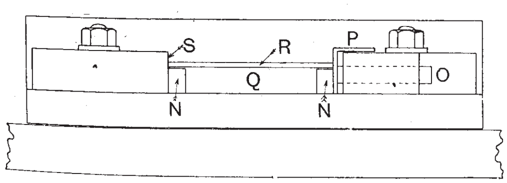



FIG. 85.

When large numbers of cards are required in the production of any type of cloth it is natural that steps should be taken to reduce the cost of the cards as much as possible. If it is essential that the pattern should be woven by what is termed a "full-harness" or "brocade-harness" jacquard, in which each needle controls only one hook, the cost of cards is minimised by the use of a finer-pitch machine, and this obviously necessitates a different card-cutting machine, or at least a different headstock and carriage to correspond with the pitch of the needles. Figs. 86 and 87 represent a front view and a sectional plan view of such a machine. There are 16 punches in a row; the middle 10 ones—*i.e.*, 4 to 13—are operated by keys A at the back of the headstock, while the remaining 3 at each end, 1 to 3, and 14 to 16, are controlled respectively by keys B, C, and D, and E, F, and G. The peg-hole punch is operated by key H. One complete row, or part of a complete row, according to the number of holes required in any row, is cut at a time, and since there are 16 keys to manipulate, the cutting is evidently a somewhat slow process as compared with the cutting for an ordinary pitch. In all other respects the machine is similar to those which are provided with headstocks for cutting the standard British pitch card.

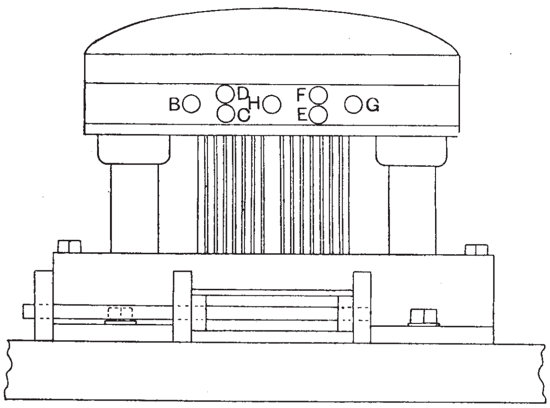



FIG. 86.

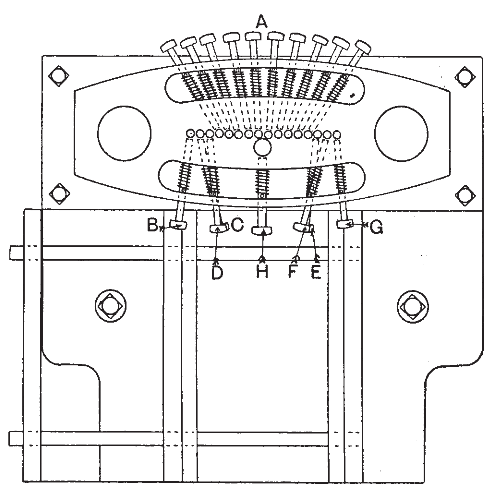



FIG. 87.

In the foregoing description and illustrations of the ordinary card-cutting or piano machines we have purposely omitted the illustration of those in which the keys, or rather in this case levers, are brought above the punches by means of cords. The only difference between these and the ordinary machines is that the above-mentioned levers, which in their normal position are held clear of the tops of the punches by springs, are pulled over those punches when and where required to prevent the punches from rising when the headstock is depressed in the usual way, whereas in the other machines the keys are pressed over the heads of the punches by the fingers and thumbs of the card-cutter. The levers thus play the same part as the keys in the modern piano machine. In the cord machines the selection of the various levers is made by drawing forward the proper cords from 8, 10, or 12 vertical cords in front of the card-cutter, and in the same plane as the punches. This machine must not be confused with the reading-in machine which was used in connection with the draw-boy, nor must it be taken to be the same as certain Continental machines, although the vertical cords provide a certain resemblance to the above. There are still many of these simple machines in use, and satisfactory work can be obtained from them, but at the same time they can scarcely be considered as modern machines.

Card-cutting by means of piano machines is probably the most suitable way when the cards have to be cut from designs in which weaves appear, and this method of cutting is also considered by many experts to be equally suitable for several kinds of design in which no weaves appear on the design paper. The very fact of both kinds of design being used in the same factory has probably something to do with the adoption of the ordinary piano machine for several types of weaveless designs, for this arrangement, besides making provision for the reproduction of all kinds of designs on to cards, minimises the variety of machines in use in any factory, and at the same time makes sure that the work will be done in an efficient manner by a cutter who is probably accustomed to one particular method of card-cutting.

# CHAPTER V

## CARD-CUTTING MACHINE FOR BRUSSELS AND WILTON CARPETS

WHENEVER a certain branch of trade assumes large proportions, special types of machines are made, if possible, to perform the work in the most economical manner, for the simple reason that such special machine or machines may be kept fully employed on one particular class or type of goods only. This departure has been followed in several cases with respect to actual weaving, and for somewhat similar reasons we may assume that the plate card-cutting machine known as the Brussels and Wilton card-cutting machine was adopted, and is still used almost exclusively, for cutting cards which are to be used on special jacquards for the weaving of these fabrics. One of these special jacquard machines for the weaving of Brussels and Wilton carpets is illustrated in Fig. 34, and three sets of cards are clearly visible in position on the triple jacquard cylinder.

In the simple hand-plate machine illustrated in Figs. 63 to 66, one punch only is used for the small holes, but in the plate machine for Brussels and Wilton jacquard cards there are as many punches used at a time as there are holes required in the card, and all these holes are cut at one stroke. We need not attempt to deal with the selection of the punches at present, but may immediately proceed to consider the mechanism of the machine.

Fig. 88 is an elevation of the driving end, Fig. 89 a section through the machine, Fig. 90 a front elevation, and Fig. 91 a plan. The machine is, of course, driven by power, and fast and loose pulleys A and B, Figs. 90 and 91, are provided if the drive is to be by means of a belt. These pulleys are placed on shaft C in the particular machine illustrated, and this shaft extends across the machine as shown, and carries a small pinion D of 13 teeth, Fig. 91. This pinion gears with wheel E of 48 teeth, and the latter is compounded with pinion F of 13 teeth on stud G. The pinion F ultimately drives wheel H of 60 teeth on the cam shaft J. This is what might be called the indirect method of driving ; the direct method, in which all the gearing is on one side, is probably more common, and is illustrated in Fig. 92, which is a reproduction from the most modern machine made by Messrs. Boucher and Co., successors to Prunells Limited, Kidderminster, the original firm of which was Messrs. Prunell, Lamb and Co. The machine was invented by Mr. Lamb more than ninety years ago as a hand-power machine; it was subsequently adapted for power by the inventor. In this case it will be seen that a small pinion on the pulley shaft drives a large wheel on the cam shaft. This shaft is identical with shaft J in Figs. 88 to 91, and all the description which follows, except that of the driving, may be considered as being applicable to this illustration as well as to the line drawings.

Two cams K, one near each side frame, rotate with the cam shaft J, and impart an up-and-down motion to each arm L; a slight oscillating motion is also imparted to the lower end of each arm L, but this is due entirely to the cams and to the fact that the upper ends of the arms L are loose on the shaft M. Shaft M supports the rising and falling block N, and from each end of block N is a pendant arm O, forked at the end as indicated at P, Figs. 88 and 89, in order that the block N may have a perfectly true vertical motion.

The general action of the mechanism having been explained, it will be well to consider the action of the moving block N upon the actual cutting apparatus. This will be understood by reference to Figs. 88 and 89, the latter of which shows the position of all parts immediately after the card has been cut. In Fig. 88 the thick part of the cam K is down, and hence the block N is in its lowest position. The hinged plates Q and R are situated between the sides S and T, the bottom plate Q resting upon and secured to the top of block N. Both plates Q and R are drilled to correspond to a fully cut card, and in Fig. 88 the upper hinged-plate R is open so that a blank card may be placed on the top of plate Q. Particulars of both plates will appear shortly. In the meantime it is sufficient to state that when the card has been placed in position, the hinged lid R is closed down as shown in Fig. 89. It will be understood that the sides, or rather ends, S and T, along with the front and back long sides, form a rectangular opening in the framework in which the block N, with plates Q and R, rises and falls under the influence of the cams K and their connections to the block N. In connection with the cutting of cards for Brussels and Wilton carpets, it occasionally happens that two cards may require to be identical so far as the order and number of the holes are concerned. In such cases both cards may be cut at one operation in the machine illustrated in Fig. 92, as provision is made in the hinging of the plates for this purpose. The punches are graduated in length so that all the cutting force is not required at the same instant, and the machine is accurate in all respects.

The plate U, Fig. 91, which contains the punches, is now placed on the hinged-plate R, Fig. 89, and the cover plate V, which is in its back position in Figs. 88 and 91, has been drawn over the heads of the punches W in Fig. 89, so that when the thick part of the cam K forces block N upwards, it is clear that the punches W will be forced through the card, or at least the card will be forced against the stationary punches W, which will thus cut the holes required. The card, as already mentioned, is between plates Q and R, and consequently at X in Fig. 89.

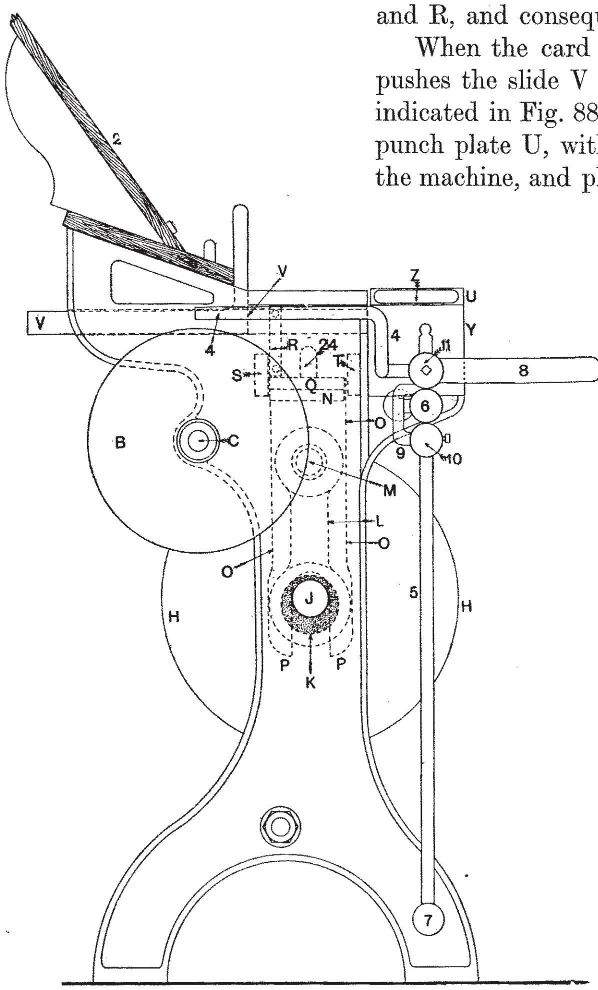



Fig. 88.

When the card is cut, the card-cutter pushes the slide V back into the position indicated in Fig. 88, and then removes the punch plate U, with its punches W, from the machine, and places it upon the stand Y ready for arranging the punches for the next card. Punch plate U is provided with handles Z or their equivalents for transferring it to and from the machine.

Before considering the other views it should be mentioned that the design-paper is placed on the reading-board 2, Figs. 88, 90, and 91, and a straight-edge is used to enable the cutter to read each line of the design correctly. The punches are kept in box 3, Fig. 89, which is conveniently situated for the requirements of the card-cutter. The belt is usually placed on the loose pulley B, Fig. 90, after each card has been cut, by the belt fork 4, supported by rod 5, which oscillates in fixed brackets 6 and 7. The handle 8 is placed near to the operative, and its movements are limited by part 9, which is secured to and moves with ball 10, and in unison with handle 8 and ball 11. The movement of part 9 is checked in both directions by bracket 12, Fig. 91, and this bracket carries the ball 6, Fig. 90.

In Fig. 91 the hinged-plate R is down, and the upper face thus exposed to view. It shows that the plate is divided into three sections as follows :

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 rows of | 8 | holes in | 1st | section | on left ; |
| 14 | ,, | 8 | ,, | 2nd | ,, | in middle ; |
| 15 | ,, | 8 | ,, | 3rd | ,, | on right ; |

or altogether 44 complete rows as a maximum. Four holes in line with the 1st, 3rd, 6th, and 8th long rows are for the lacing, and these naturally appear at four places on the plate. Finally, there are two large holes near the outer lacing holes at each end for the pegs on the card cylinder.

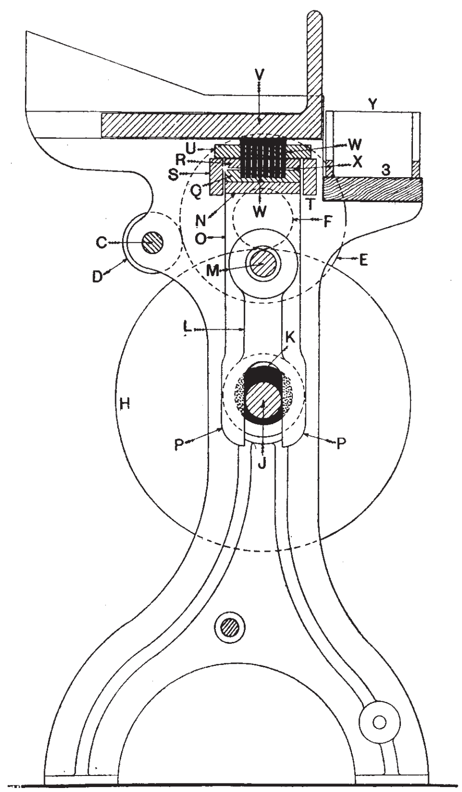



Fig. 89.

The design-paper, or rather two rows of large blocks of paper, full width, are shown at 13 and 14 on the board 2, and the first horizontal row of small squares is illustrated at 15, each small square containing a number 1, 2, 3, 4, or 5. These numbers are placed on the design-paper to indicate five different colours, which in the general and simplest acceptation means a design for what is technically termed a 5-frame Brussels or Wilton carpet. The blocks 13 and 14 are made perfectly square, as usual, but enlarged, and as illustrated are intended to represent 8 small squares each way. Other numbers in the way of the weft are used in practice, the limits usually being 6 and 10.

If we take the holes in plate R, Fig. 91, to represent the positions of 352 needles of the jacquard, the first or leading needle would be represented by the hole 16. Five hooks for the five different colours are operated by four needles in the first row—those opposite hole 16 and the next three holes—and other five hooks are operated similarly by the remaining four needles in the same row. Consequently ten coloured threads, two of each colour, are controlled by each short row of eight needles. It is unnecessary here to say more about the jacquard than to state that blanks instead of holes opposite the first four needles result in colours 1, 2, 3, and 4 respectively being lifted, but not more than one blank can appear in each group of four; whilst no blank—*i.e.* 4 holes in one group—results in the 5th colour being lifted. Not more than one colour out of five is up at a time. Each group of four acts similarly on its corresponding group of five hooks and five

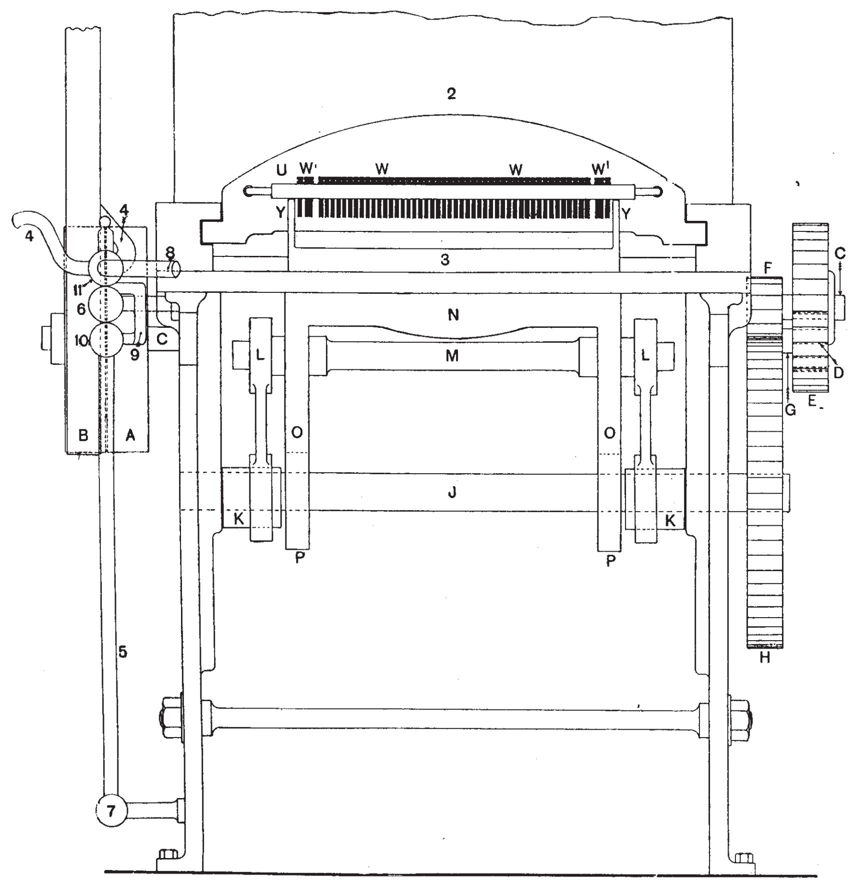



FIG. 90.

colours. It will thus be seen that although there are 352 needles in this section of the jacquard, and provision for lifting 440 threads, there is only one thread lifted at a time for every four needles, and consequently the number of small squares in one horizontal row of the design-paper will be:

$$\frac{352 \text{ needles}}{4 \text{ needles per group}} = 88\,; \quad \text{or} \quad \frac{440 \text{ coloured threads}}{5 \text{ threads per group}} = 88,$$

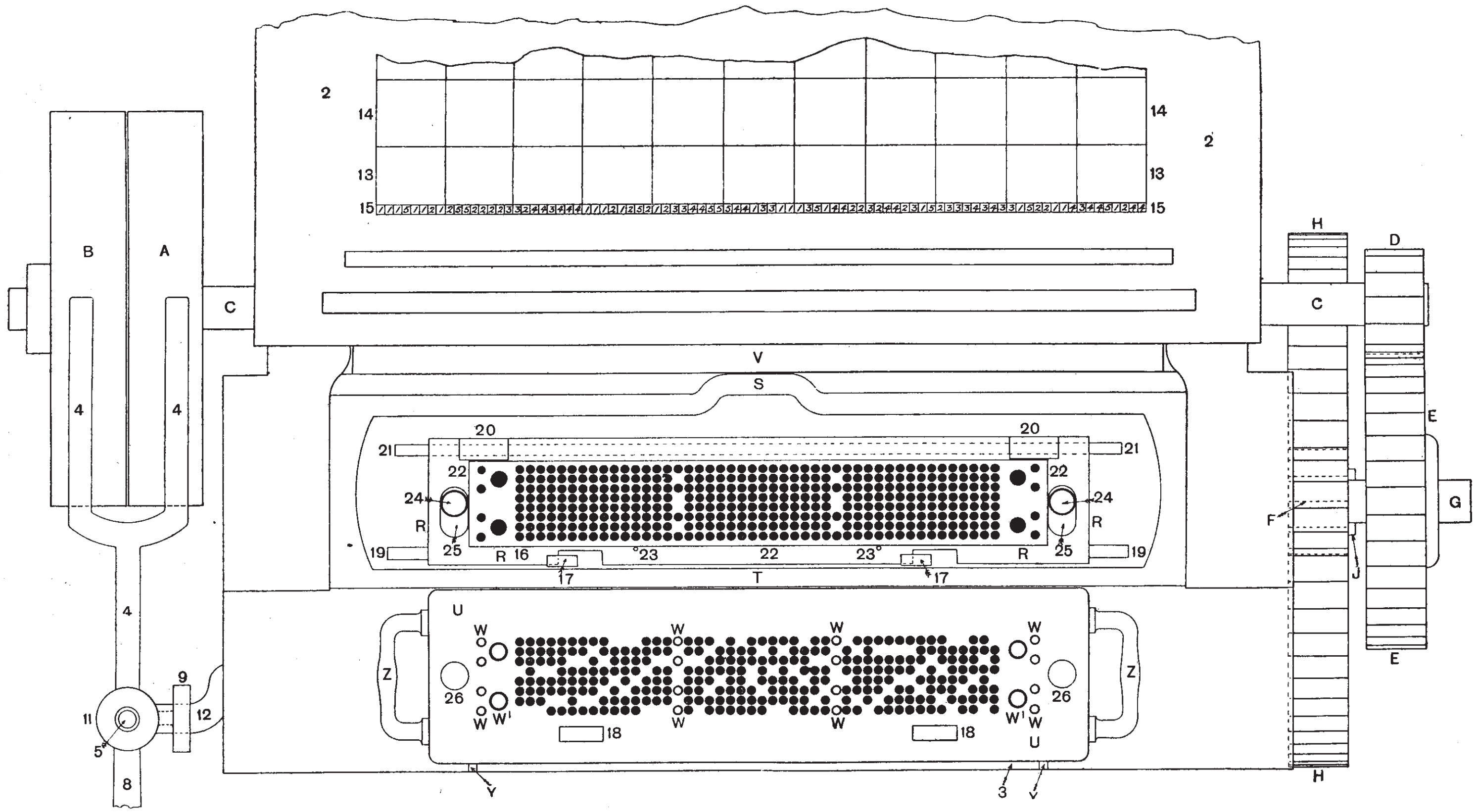


Fig. 91.

and these 88 small squares are represented on the first line of the design-paper, and marked 15.

Now let us consider the arrangement of the punches in the punch plate U, Fig. 91, to secure an effect of five colours in the cloth according to the arrangement of the five numerals on the design-paper, keeping in mind that a blank opposite 1, 2, 3, or 4 causes the corresponding colour to be lifted, and 4 holes causes the fifth colour to be lifted. Also read the short rows in the punch plate U as being composed of two sections, 1, 2, 3, 4 and 1, 2, 3, 4, instead of 1, 2, 3, 4, 5, 6, 7, 8.

In the first short row on the left on plate U there is a blank in the first position which shows that colour 1 is raised from the first group; a blank in the same short row in the fifth place—*i.e.* opposite the first place in the second group of four—also shows that another thread of colour 1 is raised alongside of its neighbour but in a separate split of the reed. In the third split of the reed another thread of colour 1 is raised because there is a blank opposite the first needle in the second row; while four holes opposite the last four needles in the second row shows that colour 5 would be raised in the fourth split. This order, 1, 1, 1, 5, is the same as that of the first four small squares on the design-paper. Similarly, throughout the row for this card—

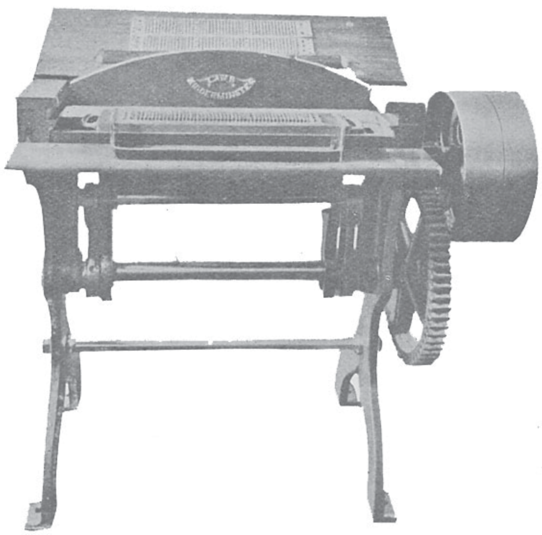


FIG. 92.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| If colour | 1 | is to be raised, | a blank | will appear | in the | 1st | place; |
| ,, | 2 | ,, | ,, | ,, | ,, | 2nd | ,, |
| ,, | 3 | ,, | ,, | ,, | ,, | 3rd | ,, |
| ,, | 4 | ,, | ,, | ,, | ,, | 4th | ,, |
| ,, | 5 | ,, | no blank will appear. | | | | |

The card-cutter thus selects the blanks according to the colour required, and naturally withdraws the punch at this place, if it had not been absent for the previous card. All the other punches for the figure, in addition to those marked W for the lace holes and those marked $W^1$ for the peg holes, remain undisturbed.

The catches 17 in Fig. 91 are controlled by two pins in a sliding bar, and are held in their present positions by means of a spiral spring attached to the frame and to the left-hand end of the sliding bar. The spring yields, and the catches move to the right when the hinged plate R is closed down, but immediately the plate R occupies its lowest position the heads of the catches protrude through the holes, and are drawn forward to the left to their present position by the spring and sliding bar. The catches thus hold the hinged plate R down securely, and as they rise, due to the upward motion of the block N, they enter the rectangular holes 18 in the punch plate U.

After the card has been cut, the card-cutter lifts the punch plate U and places it in its present position on the top of the punch box; she then draws to the right one of the catches 17, which, in virtue of the connection with the sliding bar, draws the other catch 17, and then by means of projections 19 rotates the plate R about its hinges 20 and hinge rod 21 until it assumes the position indicated in Fig. 88. It is, of course, essential that each card should be cut at the proper places with respect to the ends and sides, so that it will fit correctly on the cylinder of the jacquard and operate correctly on the needles of the jacquard. The exact size of a card for a five-frame jacquard is indicated by the rectangle 22, Fig. 91, and this shows that the back edge of the card comes against the hinges 20, the front edge against two small pins 23, and the two ends of the card against the bases of the upright pegs 24. The latter also serve as a support for the hinged plate R.

The same lettering as in the above figures has been used in Fig. 93. In this figure the hinged plates Q and R are shown opened full out, although it is unnecessary, and indeed impossible, to open them out so far in the machine. The dotted rectangle illustrates the space occupied by a five-frame card. A sectional view through the part for cutting the lace holes appears in Fig. 94; the arrows show how the plate R is rotated with respect to plate Q, the rotation being only through 90°. The end of the card is shown in solid black in this view.

When cards are required for a six-frame Brussels or Wilton, a ten-row jacquard is necessary, and hence ten rows must be provided in the punch plate U and hinged plates Q and R. It is unnecessary to illustrate more than one of these, and plate U in Fig. 95 has been prepared for this purpose. In a similar manner to that already described in the five-frame Brussels, a blank opposite any of the needles which operates the hooks or cords controlling the five colours results in the corresponding colour being lifted, while five holes opposite the needles constituting a group results in the sixth colour appearing on the surface of the cloth.

A six-frame Brussels or Wilton jacquard could be made on exactly the same principle as a five-frame machine—*i.e.* so that the first five holes in each short row should form one group for operating six colours, and the second five holes in each row to form another group. This arrangement would be quite satisfactory provided that all the carpets were of the six-

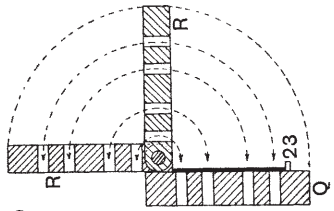



Fig. 94.

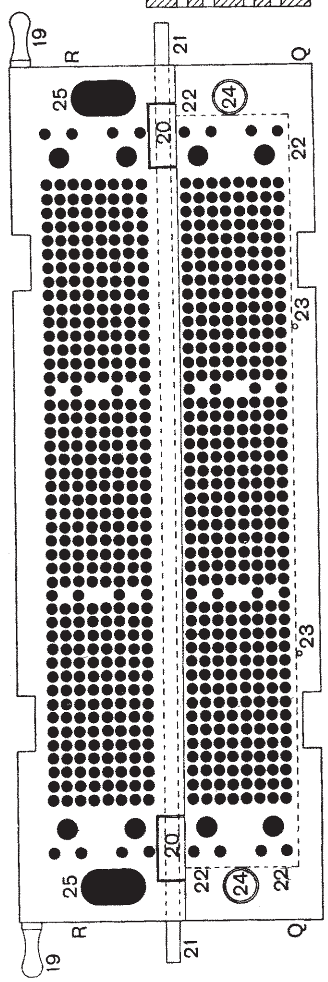



Fig. 93.

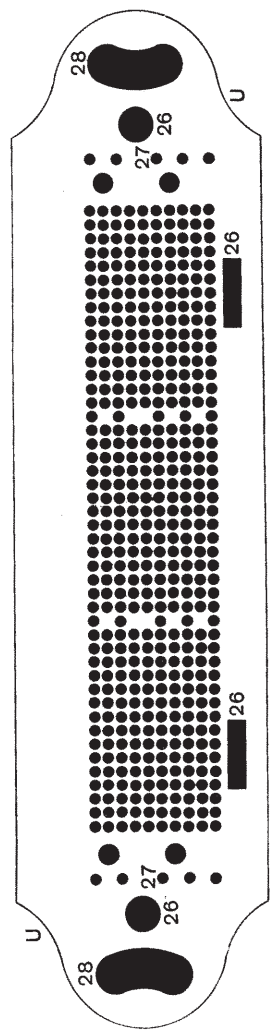



Fig. 95.

frame quality. If, however, both five-frame and six-frame qualities were required to be made in the same loom, some difficulties would arise with the above arrangement. It is for the convenience of being able to make six-frame, five-frame, or any other quality in the same loom, usually the first two, that the needles of a six-frame jacquard are arranged as follows :

| | 1st Group, operating Odd Splits in Reed. | 2nd Group, operating Even Splits in Reed. | Colour of Thread on Surface of Cloth. |
|---|---|---|---|
| Blanks opposite needles. | 1 | 2 | Controlling, say, blue threads. |
| | 3 | 7 | ,, ,, red-brown threads. |
| | 4 | 8 | ,, ,, orange threads. |
| | 5 | 9 | ,, ,, drab threads. |
| | 6 | 10 | ,, ,, sage-green threads. |
| | Five holes | Five holes | ,, ,, scarlet threads |

Each short row of the card would thus be made up of two sections or groups as above, and illustrated in Fig. 96.

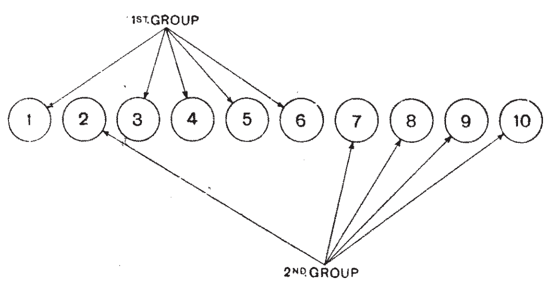


FIG. 96.

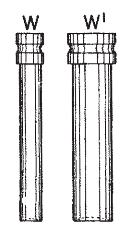


FIG. 97.

Blank opposite 1 or 2 means blue thread lifted in corresponding split.
,, ,, 3 ,, 7 ,, red-brown ,, ,, ,,
,, ,, 4 ,, 8 ,, orange ,, ,, ,,
,, ,, 5 ,, 9 ,, drab ,, ,, ,,
,, ,, 6 ,, 10 ,, sage-green ,, ,, ,,
Holes opposite 1, 3, 4, 5, 6, means scarlet thread lifted in odd split.
,, ,, 2, 7, 8, 9, 10 ,, ,, ,, even ,,

Returning again to Fig. 95, it will be observed that there are five holes in each row where the lacing holes are cut, but four only are used. The plate U, however, is made to enable cards to be cut for either a five-frame or a six-frame Brussels or Wilton. If the two bottom long rows in Fig. 95 be neglected, the holes would be identical with those in the plate, Fig. 93. When the plate is used for six-frame Brussels cards these two long rows are naturally utilised along with the other eight holes, and in two sections as explained above in connection with Fig. 96. The bottom hole in each row of lacing is also used, but the middle hole 27 is then omitted. The punches for the lace holes and for the peg holes are not disturbed unless a change is made from a five-frame to a six-frame, in which case, of course, the middle one 27 only is moved to the edge, but the peg punches remain in the same position for both sets. The ordinary punches are altered according to the design, and in all cases the sizes of the punches are the same, and are similar to those shown at W and $W^1$ in Fig. 97. These have been drawn to a larger scale. In the plate U, Fig. 95, slots 28 are cut in the plate, and these serve the same purpose as the handles Z in Fig. 91.

The jacquard loom illustrated in Fig. 34 is a five-frame machine, and two of the frames, with their bobbins, can be seen distinctly behind the loom proper.

The reader will understand that Brussels carpet designs are practically identical in colour with the loops on the surface of the cloth, although cloths of different colours made from the same design may be, and often are, woven. The sizes of the small squares or rectangles in the design-paper are also proportionate to the number of loops in the width and the number of wires in the length of the cloth, and are usually the same size or approximately so. Consequently, Fig. 98, which is really a photographical reproduction of part of a five-frame $\frac{3}{4}$ Brussels carpet, may be taken to represent the design-paper. The full capacity of a jacquard for such a carpet embraces three sections, each of which is the same size as that represented by the card in Fig. 91 for operating 352 needles and 440 harness cords, or altogether 1056 needles and 1320 harness cords. Instead, therefore, of the full design there would be only one-third of that represented in Fig. 91 on the reading board. The full capacity of the machine provides for displaying 264 loops in a $\frac{3}{4}$ carpet; that shown in Fig. 98 contains 256 loops.

It will be seen that no weave of any kind appears in Fig. 98, and therefore none will appear on the design-paper; this is because the fabric is one of those special types for which it has been found advisable to construct special machinery—the mechanical parts of which operate the threads for the actual interlacing, with the exception of the pile threads on the surface, independently of the jacquard. In other words, the actual structure of the foundation of the carpet is simple, and is obtained by the use of tappets. (For illustrations of the structure of these and other carpets see pp. 394 to 414, *Textile Design: Pure and Applied*, by T. Woodhouse and T. Milne; Macmillan & Co., Ltd., London.)

Now in all such designs it will be evident that there are several successive rows of loops in the cloth, or colours on the design-paper, which differ little from each other, and when this is the case, and there is no weave to be considered, the plate machine is very efficient. There are, of course, plenty of changes to make in every design, and particularly so where horizontal lines or mixed effects appear, and both these types of ornament are prominent in Fig. 98.

FIG. 98.

Two successive lines in an ordinary design may be exactly the same so far as the various groups of figuring threads are concerned, but since the weave almost invariably alters from one of these picks to the other, it is necessary to read the lines for both cards as if they were altogether different, and hence, except in the simplest ornament, there is no saving in time no matter how similar the figuring groups may be on successive threads. On the other hand, if two successive lines of a Brussels or Wilton carpet design are the same so far as the arrangement of the colour is concerned, there is no alteration to be made with the punches, and the two cards may therefore be cut quickly, and indeed simultaneously, as explained in connection with Fig. 92. In a similar way the various lines as a rule change more or less gradually, and when this is the case there may be very few punches to remove from the punch plate from line to line of the design. The plate machine is also made to act as a kind of duplicating or repeating machine. For this work the plates Q and R are made slightly different in order to be able to cut two cards at once.

Some years ago special gearing was added to the plate machine for the purpose of lifting off the punch plate U automatically, but several accidents resulted from the machines so fitted, and it was considered advisable to discard the special gearing. In some districts the carpet jacquards are arranged so that a hole results in a hook being lifted. The cutting is then rendered more simple, and the cards, having fewer holes, have not the same tendency to break.

# CHAPTER VI

## COMPARISON OF DIFFERENT PITCHES IN JACQUARD CARDS

With very few exceptions, the holes in jacquard cards are in perfect straight lines, although the size of the holes and the distance between each pair may vary according to whether the cards are intended to operate the needles in the so-called ordinary-pitch, medium-pitch, or fine-pitch machines. The division into the above three defined pitches is, however, not quite correct, for the change from the coarsest pitch to the finest pitch is pretty gradual; the definition, however, seems to be quite satisfactory in the various districts where two or more different pitches are in use, as it enables the operatives to distinguish between them. A few typical examples of cards of different pitches and different sizes of holes are illustrated in Figs. 99 to 105, and it will be seen that the decreasing pitch from the card in Fig. 99 to the card in Fig. 105 is more or less gradual. Table IV. supplies several particulars concerning the above seven kinds of cards, and also serves to demonstrate the diversity which obtains in this branch of weaving.

In every case in these examples the holes, which are often utilised for selvages, for simple tape weaves near the selvages of the cloth, and for other purposes which fall outside the scope of the actual figuring threads in the fabric, are omitted. When the weave for these selvage and other threads is complete on 2 or 4 picks, and the 4-sided cylinder makes a quarter turn every pick, it is a common and good practice to have the needles of the jacquard bent so that their ends may occupy a position in the needle board clear of the card, and therefore free from the control of the card. The four sides of the jacquard cylinder opposite these extra needles are drilled and the needles are operated from these rows. If tacks be driven into those holes, which in the ordinary way should be covered by blanks in the card, the heads of the tacks serve the same purpose as blanks, and hence any simple weave on 2 or 4 picks to the round can be arranged. The selvages or other simple parts are then clearly controlled independently of the jacquard cards. Instead of tacks, small wooden pegs may be used to block up the holes. If, on the other hand, the weave exceeds 4 picks to the round, or if certain needles and hooks are required for special purposes—*e.g.* lifting the retaining catch of the uptake motion for crammed horizontal stripes, or for bringing the box motion into action—then it is necessary in most cases for these functions to be performed at some particular place or places in the

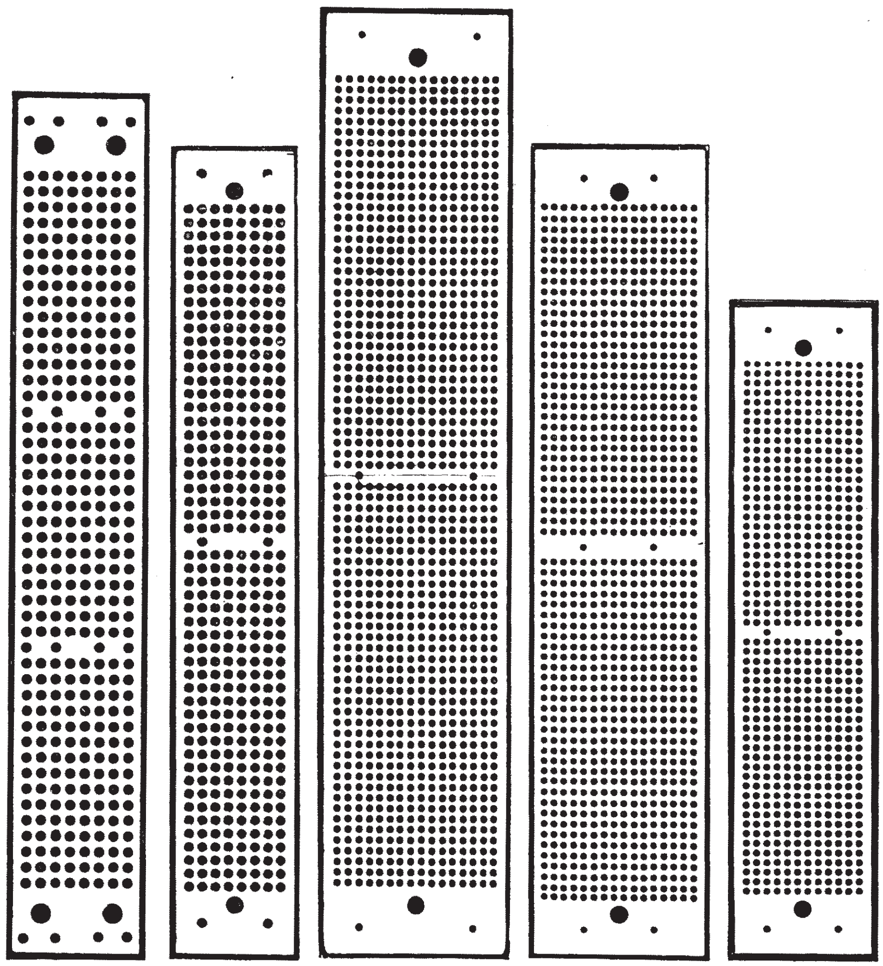


Fig. 99. Fig. 100. Fig. 101. Fig. 102. Fig. 103.

pattern, and hence the cards must be cut to operate these needles in the spare rows on the proper picks. These extra needles and hooks invariably occupy positions in the machine which are approximately in line with the same row as one or both of the peg holes in the cards in Figs. 100, 101, 102, and 103. In the card shown in Fig. 104 the same provision may be made near the two outside peg holes, and, if necessary, also near the centre peg hole. As a matter of fact, in this particular case an extra full row of needles

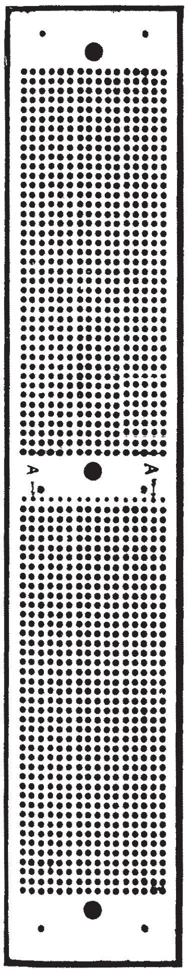



Fig. 104.

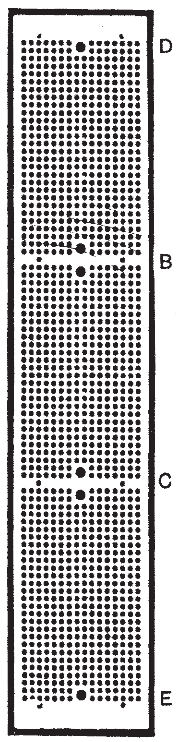



Fig. 105.

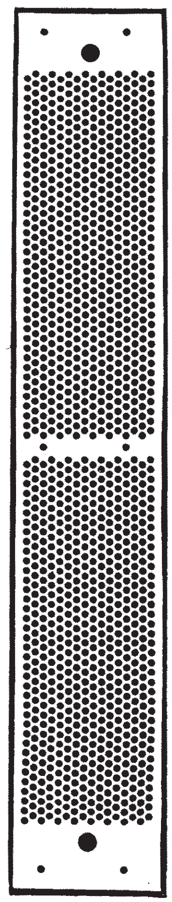


Fig. 106.

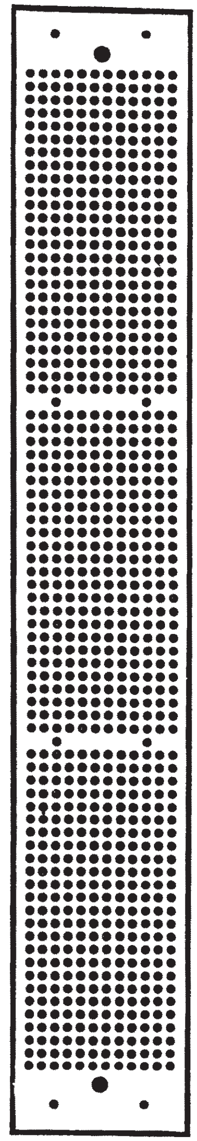


Fig. 107.

and hooks may be arranged opposite the row of small circles A mentioned in Table IV.

TABLE IV

| Number of Card. | Pitch. | Type of Card or Machine. | Over-all Dimensions in Inches. | Particulars of Short Rows. | Total Capacity. | Pitch of Holes. |
|---|---|---|---|---|---|---|
| Fig. 99 | Ordinary British. | 5-frame Brussels carpet. | $17\frac{3}{8} \times 2\frac{11}{16}$ | 15 rows × 8 = 120<br>14 ,, × 8 = 112<br>15 ,, × 8 = 120 | 352 holes operating 440 hooks. | 0·3125 in |
| ,, 100 | Ordinary British. | 400's jacquard.* | $16\frac{5}{16} \times 2\frac{7}{16}$ | 26 rows × 8 = 208<br>25 ,, × 8 = 200 | 408 | 0·2644 i |
| ,, 101 | Medium British. | 1200's jacquard. | $19\frac{1}{16} \times 3\frac{3}{16}$ | 38 rows × 16 = 608<br>37 ,, × 16 = 592 | 1200 | 0·2138 i |
| ,, 102 | Medium British. | 1040's jacquard. | $16\frac{5}{16} \times 3\frac{1}{2}$ | 33 rows × 16 = 528<br>32 ,, × 16 = 512 | 1040 | 0·2045 i |
| ,, 103 | Medium British. | 660's jacquard. | $13\frac{1}{4} \times 2\frac{7}{8}$ | 28 rows × 12 = 336<br>27 ,, × 12 = 324 | 660 | 0·1942 i |
| ,, 104 | Medium American and British. | 1312's or 1328's jacquard. | $19\frac{3}{16} \times 3\frac{7}{16}$ | 41 rows × 16 = 656<br>41 ,, × 16 = 656 | 1312, or 1328 if row indicated by letter A is introduced. | 0·1875 i |
| ,, 105 | Fine Vincenzi and British. | 1320's jacquard. | $14\frac{5}{8} \times 2\frac{3}{4}$ | 2 rows × 14 = 28<br>24 ,, × 16 = 384<br>2 ,, × 14 = 28<br>Repeated 3 times. | 440 × 3 = 1320 | 0·1555 i |

* The 600's card of the same pitch is the same length, but has 12 holes per short row instead of 8 holes, while the 900's card is the same width as the 600's but longer.

The card illustrated in Fig. 105 differs from all the others in that all the extra holes in line with the six peg holes are utilised for figuring purposes. The omission of these 12 partially filled rows would naturally decrease the capacity of the machine by 168 needles—much too large a number to dispense with. At the same time, their introduction involves difficulties in other ways. The design-paper for use in connection with 16-row machines is usually ruled in vertical rows of 8, and such ruling is evidently quite suitable for the full rows of the card in Fig. 105. In the broken rows, however, there are only 14 holes, or two groups of 7, and it is clearly undesirable and practically impossible to leave two unpainted rows of small squares in every 16, or one in every 8, on the design-paper to allow for the two needles and hooks missed in each row. In each of the two sections marked B and C there are 4 rows × 14 per row = 56 holes, and although the design-paper is ruled in 8's, and the design painted in the usual way, the 7 blocks of 8 on the design-paper which correspond with these 56 holes are re-ruled into 8 blocks of 7. Similarly, $3\frac{1}{2}$ blocks of 8 would be re-ruled into 7's for the two sections D and E, commencing with a half block, so that the last 7 would finish on a heavy line and join up perfectly with the full rows. The design-paper would contain altogether the equivalent of 165 blocks of 8 if all the needles of the machine were in use. Thus

$1320 \div 8 = 165$ full blocks ; but arranged

| | | |
|---|---|---|
| Half block | = | 4 |
| 164 full blocks | = | 1312 |
| Half block | = | 4 |
| | | 1320 needles. |

Figs. 86 and 87 illustrate the headstock of the piano machine in which the card illustrated in Fig. 102 was cut. As already mentioned in the description of the above headstock, it is a difficult matter to control 16 keys, and hence the process of cutting is slow. Thus

700 to 800 cards per day may be cut from common harness designs ;
500 ,, 600 ,, ,, full harness designs ;

but only about 200 per day can be cut on the 16-row machines from full harness or brocade designs unless the cutter has had considerable experience and the design is a simple one. In certain instances where it has been found economical to use a 16-row machine the card has been cut in two distinct operations—*i.e.* one half the card from end to end cut with 8 keys and 8 punches, and then the second half of the card cut with an adjoining set of 8 keys and 8 punches. In this case it would be necessary to read alternate blocks in the design-paper for each section—odd blocks for one section and even blocks for the other. This departure from the ordinary method of cutting a complete row, or all which are required to be cut in a complete row, had for its object the simplification of operating the keys, and for the same reason there is still a tendency on the part of several firms to adhere to the 12-row machines, and so employ a number which can be conveniently and quickly operated. The card in Fig. 103 illustrates one way of utilising this number for a 660's machine, and there are others. One machine, which works splendidly, contains 900 needles, with the usual extra needles, if desired, in line with the pegs—say 916 needles in all, and arranged as under :

| | |
|---|---|
| 38 rows × 12 per row . . . | = 456 |
| 37 ,, × 12 ,, . . | = 444 |
| 2 broken rows × 8 per row . . | = 16 |
| | 916 |

The card measures 17 in. by 3 in., and the pitch of the holes and needles is the same as the corresponding values for the card in Fig. 103.

The various kinds of cards and pitches illustrated in Figs. 99 to 105 provide a great range, and one would scarcely think that there was room for any others. Nevertheless several others have been introduced, and these include not only the straight-lined arrangement as illustrated in the above seven examples, but also the zigzag arrangement. The chief features in the latter are

1. The fact that the unique distribution of the holes minimises the danger of breaks in heavily punched cards; and
2. That space is utilised to the best advantage.

On the other hand, the arrangement necessitates slight structural alterations in the jacquard, and complicates considerably the card-cutting machine.

The general distribution of the holes in the card is illustrated in Fig. 106, and a 12-row card for a 900's ordinary British pitch jacquard is shown in Fig. 107, so that the two may be compared.

Card in Fig. 106: 38 rows × 16, or 76 rows × 8 = 608
38 ,, × 16, ,, 76 ,, × 8 = 608

1216

1216 needles for an 18 in. × 3 in. card;

$$\text{or } \frac{1216 \text{ needles}}{18 \text{ in.} \times 3 \text{ in.}} = 22{\cdot}519 \text{ needles per sq. in.}$$

Card in Fig. 107: 25 rows × 12 per row = 300
25 ,, × 12 ,, = 300
25 ,, × 12 ,, = 300

900

900 needles for a 23 in. × $3\frac{1}{2}$ in. card;

$$\text{or } \frac{900 \text{ needles}}{23 \text{ in.} \times 3\frac{1}{2} \text{ in.}} = 11{\cdot}18 \text{ needles per sq. in.}$$

# CHAPTER VII

## ZIGZAG CARD-CUTTING MACHINE FOR STIFF PAPER CARDS AND POWER CARD-CUTTING MACHINE

FIGS. 108 to 110 illustrate one type of piano-machine headstock for cutting the zigzag rows similar to the card in Fig. 106. The method of fixing the headstock to the cross-bar is exactly the same as that adopted in other piano machines — *i.e.* the cross-bar is placed on the screwed rods A, Fig. 108, between the nuts B, and the latter are then arranged to hold and to lock the cross-bar in its proper position. Figs. 109 and 110 show clearly that there are 16 punches arranged in two rows —the second set D of 8 being placed midway between those of the first set C, and, of course, in a different horizontal plane. The chief difficulty in cutting cards in such a machine is that of controlling the keys, for 8 ordinary keys E have to control the 16 punches C and D. An ordinary key F operates the punch G for the peg hole. The cap H, Fig. 108, and the upper plate J, are removed in Figs. 109 and 110 in order that all the essential parts may be exposed to view. A groove is cut in the lower

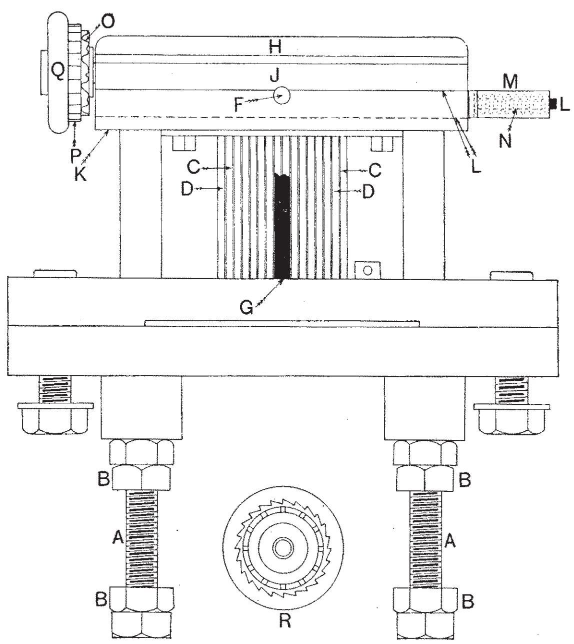


FIG. 108.

rectangular plate K to admit the sliding bar L. Eight grooves are cut in the upper part of this bar, and the ends of the keys E are entered into these grooves. The right-hand end of the rectangular plate L is turned down and passes through a hole in the bracket M fixed to the headstock. On this circular part of L is placed a spring N, which always tends to keep the plate to the left, with its extreme rounded left end pressing against the cam O. This cam is circular, and is compounded with ratchet wheel P and hand-wheel or disc Q. A view of these parts, looking towards the left in Figs. 109 and 110, is shown detached at R in Fig. 108.

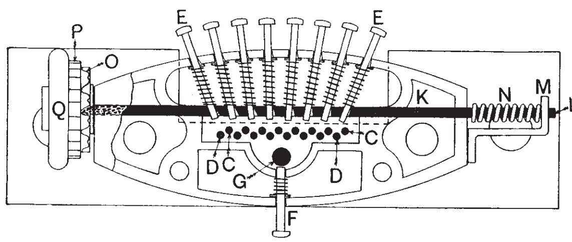



Fig. 109.

The face of the cam O consists of alternate shallow and deep recesses, and in Fig. 109 the rounded or pointed end of plate L is in one of the deep recesses, and hence the plate occupies the extreme left-hand position with the ends of keys E pointed towards the second row of punches D. On the other hand, in Fig. 110 the end of plate L is in one of the shallow recesses, and consequently the plate L is in the extreme right position, with the spring N compressed and the ends of keys E pointed towards the first row of punches C. The latter view represents the position of the keys E when the actual cutting is commenced. The card-cutter presses in those keys E which represent the painted parts in the first block of 8 on the design-paper, so as to place the ends of the keys over the respective punches C, and presses down the right treadle in the usual way. He or she then presses down the left treadle, which causes the headstock to rise, and as the latter rises, one of the teeth of the ratchet wheel P comes into contact with a fixed pawl, not shown, and thus the compounded parts O, P, and Q are rotated through $\frac{1}{24}$ of a revolution. In doing so the gradient of the cam allows the spring N to force the plate L to the left, and to carry the extreme rounded end into the lower part of one of the deeper recesses as illustrated in Fig. 109. This naturally carries the keys opposite the punches D, when a similar

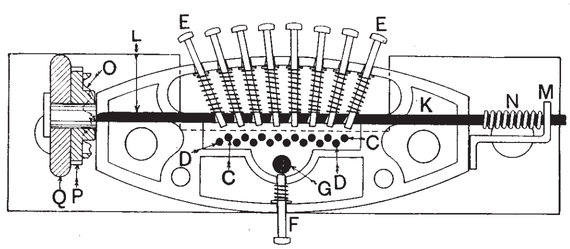



Fig. 110.

downward movement of the right treadle, with the correct keys pressed in to correspond with the painted part of the second block of 8 in the design-paper, causes the required holes in the second row D to be cut. It will thus be seen that the plate L, through the medium of the parts N, O, P, and Q and the fixed pawl, carries the keys E first to left and then to right for each pair of short rows C and D. Now, it is evident that since there are two sets of punches C and D to be operated at different times, the carriage will require to move only every second tramp of the left treadle, and not every tramp as in the ordinary machine illustrated in Fig. 68. This being so, the left treadle (see J in Fig. 68) must not be connected directly with the handle Z by rod Y, otherwise the carriage would move every tramp of the left treadle. For the zigzag pitch machine an upright catch or pulling pawl is attached to the left treadle, and this catch comes into contact with a 6-toothed or 8-toothed ratchet wheel, supported by and free to rotate on a cross-shaft, every time the left treadle is depressed, rotating the ratchet wheel one tooth at a time. Compounded with this ratchet wheel is a 6 or 8 to the round cam, the outline of which consists of alternate projections and recesses; these parts are presented successively to a special lever attached to handle Z by a rod similar to Y. One or other of the three or four projections comes into contact with, and depresses, this special lever every second tramp of the left treadle, whereas on the other tramps the recesses come opposite the lever to allow it to rise through the influence of a spiral spring and thus enable the handle Z to occupy its highest position.

Even at its best it will be evident that the smooth working of the parts, and particularly that of the cam O, Figs. 108 to 110, against the end of plate L is difficult to achieve. All the keys are on the same level, and so are the tops of the punches C and D, so that very accurate adjustment is necessary to obtain correct results.

Another method is illustrated more or less diagrammatically in Figs. 111 to 117. Fig. 111 is an inside elevation of the eight keys E, the part T being a horizontal projection from the inside face of the key; Fig. 112 is a plan of the 8 keys E together with 16 supplementary keys R and S in two planes, and the disposition of the 16 punches C and D; the large black circle is the peg-hole punch. Figs. 113 to 117 illustrate the action of the stem T of the keys E on the supplementary punches R and S. In this machine the two sets of punches C and D are operated by two distinct sets of supplementary keys R and S, each pair of which is in turn controlled by a single key E. There are thus only eight keys E for the cutter to operate. In this arrangement the keys E are provided with a projecting part T, and it is the end of this part T which operates alternately the upper and lower supplementary keys R and S. It will thus be seen that the keys E must rise and fall alternately in order that the parts T may be brought opposite to the two sets or rows of supplementary keys R and S. The mechanism for imparting this up-and-down motion to the keys E is not shown, neither are the brackets for supporting it shown. It will be understood that the keys E, as well as the supplementary keys R and S, will require springs for returning them to their normal positions whenever the former are released by the fingers.

The two positions of the keys are illustrated in Fig. 113, while Fig. 114 shows three positions :

1st. Key E pressed in, and supplementary key S forced over punch C ;
2nd. Key E pressed in, and supplementary key R forced over punch D ;
3rd. Key E and supplementary keys R and S out of action.

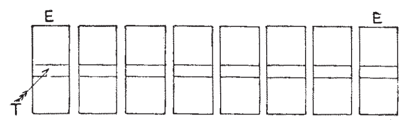



Fig. 111.

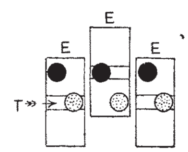



Fig. 113.

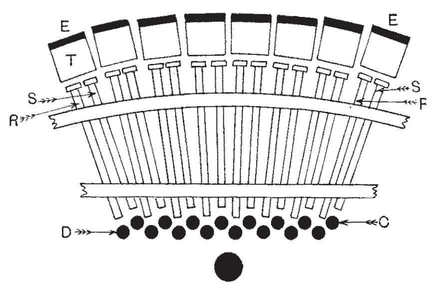



Fig. 112.

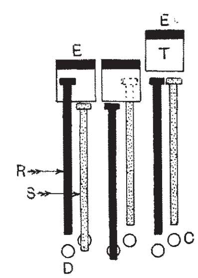



Fig. 114.

It will be understood that supplementary keys R and S cannot be pushed forward at the same time. For the first action, the supplementary keys S will be pushed over the punches C, while in the second action the supplementary keys R will be pushed over the punches D. Both actions are illustrated in Figs. 113 and 114.

Fig. 115 illustrates the part T of a key E as having pushed a supplementary key R over its punch D, while Fig. 116 shows the same key E with its part T in contact with a supplementary key S, the end of the latter being over its punch C. An end view of the parts R, S, D, and C appears in Fig. 117.

The treadles of all the foregoing piano card-cutting machines are operated by the card-cutter's feet, in short, the machines are so-called hand-power or foot-power piano machines. The one illustrated in Fig. 118

is also operated in the same way. The latter is an American type, and it

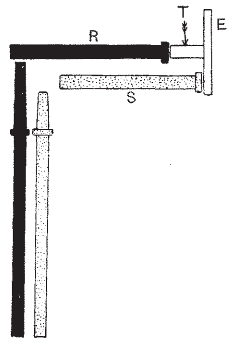



Fig. 115.

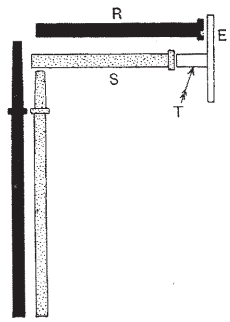



Fig. 116.

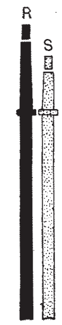



Fig. 117.

will be seen that the straight edge is moved from line to line by means of the central hand wheel, the long horizontal shaft, and the two pairs of bevel wheels in connection with the upright screws. The machine is provided with adjustable foot-pedals or treadles to make the power applied suitable for the cutting of thin or thick cardboard cards, or to enable two cards to be cut simultaneously, one below the other, for two different sets. Otherwise the machine differs only slightly from the English make illustrated in Fig. 67.

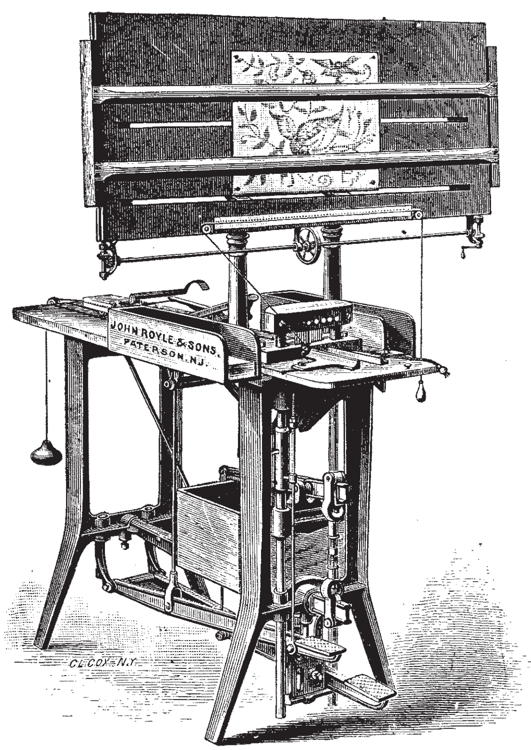



Fig. 118.

Such machines, however, are occasionally driven by power, and Fig. 119 represents a machine so driven. The framework is constructed to suit this method of driving, but the usual treadles are retained; they are used solely, however, to apply and disconnect the power. One treadle is used to connect the friction-clutch attached to the fly-wheel to start the machine, while the other treadle is employed to disconnect the friction-clutch in order to stop the machine. The treadles are easily and quickly controlled; indeed this is necessary, because the eye and the fingers determine the moments for the punches to act.

Both foot-power and power-driven machines are made to cut cards from 100's to 900's jacquards of the French index, but arrangements may be made to cut 1200's cards when desired, as well as cards for the fine-scale 1304-needle jacquards.

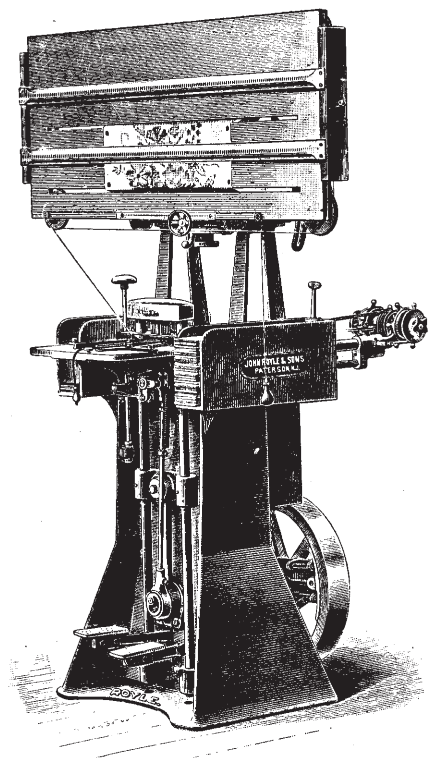



Fig. 119.

*Accessories.* — Mistakes often appear in the various sets of cards; in some cases holes are found where blanks should be, and *vice versa.* The holes which are not wanted are often blocked up with the small discs which have been punched out of the cards; the part may then be glued so that the disc will not be pushed into the cylinder by the needle of the jacquard, or perhaps a glued piece of strong tough paper may be placed over the defective place. Special patented attachments may be had for the same purpose.

On the other hand, when extra holes have to be punched at those places missed during the punching operation, these holes have to be made in the otherwise perfectly perforated cards by special types of punches provided with long jaws capable of reaching at least to the centre of the short row of the widest card in use. A handy punch for the purpose is illustrated in Fig. 120, its chief feature being the fact that the punch-holder is made of a size to facilitate the correct selection of the point at which to punch the required hole. In the illustration the under part of the jaw is below the cards, and the punch is operated, as demonstrated, by a lever.

Another type of single-hole puncher for the same purpose, and one which is largely used, is that illustrated in Fig. 121. There are also modifications of this, and in each case different punches are provided to suit the size of hole required.

Although the different pitches and methods of cutting cards made from comparatively stiff cardboard already described do not exhaust all the systems and kinds in use, the former serve to demonstrate the great diversity of pitches and the many attempts which have been made to economise in the use of paper. And this attempt at economy is quite independent of that which is so successfully accomplished with regard to special jacquards. With the present rapid changes of style and demands in almost all branches of fancy weaving, it is the exception rather than the rule for a set of cards to be completely worn out; hence the full value of the cards in such a set is not obtained, and the expenditure in cards is naturally raised. Even in those cases where a successful run on any particular design continues until the cards are pierced by the pressure of the needles, by the pegs or pivots, and otherwise damaged until they are no longer fit for service, the cost of cards is a serious item. It may perhaps be argued that an inferior quality of card should be used for those sets which are not expected to be utilised for a considerable time; but such expedients for the sole purpose of cheapness often prove to be false economy. A changeable climate such as that which obtains in this country affects the cards considerably, and if there is any shrinkage or expansion in the cards, differing, as they invariably do, from the corresponding infinitesimal alterations in the pitch of the needles, it is quite evident that the holes in the cards will no longer coincide with the points of the needles, and hence faults will appear in the cloth causing damages if they are not removed, and waste as well as decreased production if they are removed.

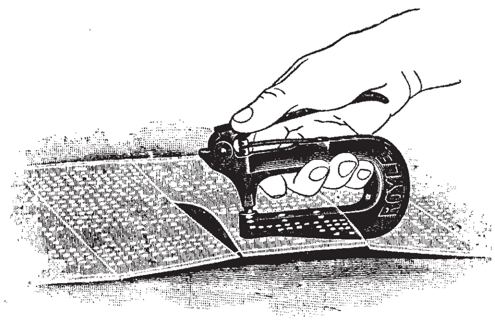


FIG. 120.

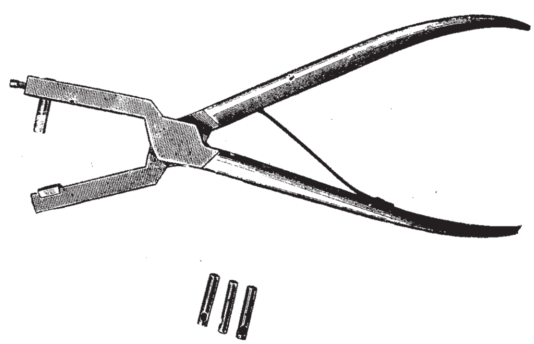


FIG. 121.

Cards made from a common quality of paper usually expand much more in damp weather than do similarly sized cards of a better make, and one of the methods employed to test the value of cards with respect to their power of resisting the action of a humid atmosphere is to soak a sample of each kind in water, and then compare their lengths with unsoaked cards of the same quality, or with the actual lengths of the cards measured before soaking. The better-class cards are, in general, affected the least, and for this reason many firms prefer to use them in preference to employing the cheaper grades. The weights of cards for the same machine will obviously vary, partly on account of their solidity and the material from which they are made, and partly according to their thickness. And it is only natural to expect that the degree of expansion will not only be influenced by the quality of the paper, but also by the thickness of the card, and to some extent by the nature of the raw material. The following table should prove of some value to those interested in this branch, as it represents observations made on six different kinds of jacquard cards for use on 600's machines :

| Number of Card. | Average Number of Cards per Lb. | Length in Dry State. | Length after 30 Minutes' Immersion. | Increase in Length. |
|---|---|---|---|---|
| | | In. | In. | In. |
| 1 | 11·55 | $16\frac{7}{32}$ | $16\frac{15}{64}$ | $\frac{1}{64}$ |
| 2 | 11·65 | $16\frac{1}{4}$ | $16\frac{5}{16}$ | $\frac{1}{16}$ |
| 3 | 12·34 | $16\frac{1}{4}$ | $16\frac{5}{16}$ | $\frac{1}{16}$ |
| 4 | 13·03 | $16\frac{9}{32}$ | $16\frac{3}{8}$ | $\frac{3}{32}$ |
| 5 | 14·13 | $16\frac{9}{32}$ | $16\frac{5}{16}$ | $\frac{1}{32}$ |
| 6 | 14·34 | $16\frac{7}{32}$ | $16\frac{9}{32}$ | $\frac{1}{16}$ |

Card No. 1 is the most expensive of the six kinds, and hence, from the point of view of resistance to change of length when under the influence of moisture, is likely to give the best satisfaction. On the other hand, it will be observed that it is the heaviest card in the lot, and would therefore prove costly, but it might, nevertheless, resist the action of the needles as well as the weather much better than any of the others, in which case it would probably be even more economical if the cards are likely to be used until they are unfit for the work. For resistance to wear and tear, it is a good plan to compare the value of cards by using a few of one kind along with others in the same set.

A few remarks concerning the approximate cost of making a design and performing all the subsequent operations required preparatory to actual weaving will show conclusively the important part which the cost of cards plays in actual manufacture with respect to the other requirements. No actual or definite price can be fixed with regard to the original sketch for any given size of cloth, nor even for a given size of sketch. Altogether apart from the size of the sketch, its price will be obviously influenced greatly by the status of the designer, and in a lesser degree by the circumstances which demand or prompt the creation of the design, by the amount of detail which appears thereon, and by the class of fabric upon which the design is intended to be displayed. On the other hand, more or less uniformity in prices obtains for all succeeding operations, although even here differences obtain according to circumstances and skill. It is therefore quite impossible to reduce the actual cost to a common level. It is equally impossible to obtain an actual standard cost of production in those cases where manufacturers employ their own designers, although each firm may clearly be able to make a near approximation to its actual expenditure with respect to the number of sketches produced in a given time. When, however, a manufacturer buys his sketches and point-paper reproductions ready for the card-cutter, there is always a definite charge which can be placed alongside the cost of cards, card-cutting, lacing, lacing twine, wires, and wiring. In certain cases a definite amount is paid for the sketch, and then the transference to point-paper is usually paid by the number of square hundreds of small blocks. Thus, a design on 300 threads and 300 picks contains: $3 \times 3 = 9$ square hundreds. Similarly, a design on $400 \times 400 = 16$ square hundreds, and a design on $600 \times 600 = 36$ square hundreds, and so on.

The same sketch, although not suitable for reproduction in all sizes, can often be used for more than one size of design, and in many cases a sketch which is intended to be reproduced on a small number of square hundreds may be much more complex than a sketch which has been made for reproduction on a very large number of square hundreds. There are thus very satisfactory reasons why the sketch, under certain circumstances, should be sold independently of the point-paper design. And in many instances somewhat similar conditions necessitate a departure from otherwise standard prices with reference to the painting of the point-paper design.

For example, a point-paper design on 600 threads and 600 picks made from a sketch intended to be reproduced in a fancy silk, cotton, or worsted fabric may require a large number of different weaves—sometimes intricate ones—in the ground and figure, whereas the point-paper design made from a somewhat similar sketch designed for a linen table damask to be woven by a twilling jacquard loom may be altogether devoid of weave structure, and even if shading or medium shades are introduced into the latter design the amount of work per square hundred on the design-paper will be much less than the corresponding work on the area for the silk design. Moreover, in the case of the design for the above-mentioned silk fabric there may be only one sheet of 600 threads and 600 picks, or 36 square hundreds, whereas the point-paper design made from the sketch for the fine linen damask may consist of anything up to nine large sheets, or even more, each sheet containing from 600 threads and 600 picks to 600 threads and 900 picks. That is, $6 \times 6 \times 9 = 324$ square hundreds in the first case, and $6 \times 9 \times 9 = 486$ square hundreds in the second case.

The conditions appertaining to the silk fabric are more or less general with respect to several other types of fabrics—*e.g.* tapestries and the like. It will thus be seen that whatever be the price paid per square hundred there is a considerable difference between the areas, and that in those cases where a large number of design sheets are required from the same sketch, it becomes a feasible plan to include the sketch in the price paid per square hundred for painting the design for a common harness, or for painting and twilling for a full harness or brocade design. Except in special circumstances, the price per square hundred to include sketch, paper, painting, and twilling for linen damasks, quilts, and similar goods where no weaves, or at the most simple weaves, are required, varied in pre-war times from 10d. to 2s.[1] Hence, if we take the comparatively low price of 1s. per square hundred, the cost for 100 picks of a 600's design will be 6s.

Let us suppose that a good class card, say at 3d. per pound, is used for such a design, and that there are approximately 11 cards per pound as in No. 1 in the above table. We should have

$$\frac{\text{100 cards}}{\text{11 per pound}} = \text{approximately 9 lb.,}$$

and 9 lb. × 3d. per pound = 2s. 3d., actually more than one-third of the total cost of designing, painting, and twilling. And if the cards are only 2d. per pound and the same weight, the cost of cards alone is one-quarter that of the designing. It is only fair to mention that many firms use much lighter cards, say about 16 to the pound. In addition to this cost of cards there is the remainder of the work tabulated as under :

| | *s.* | *d.* |
|---|---|---|
| 600's machine : 100 cards | 2 | 3 |
| Cutting for 100 cards | 0 | 8 |
| Lacing for 100 cards | 0 | 3 |
| ½ lb. lacing twine | 0 | 9 |
| | 3 | 11 |

It need hardly be mentioned that there are very good reasons for the many attempts which have been made to substitute very thin paper for the well-known stiff cards, for by the use of the former a much less weight of paper is used, and all lacing and wiring, with the necessary materials, are dispensed with.

Fig. 122 illustrates this thin paper, which is cut for use on the Verdol

Please note : since prices are not yet settled, all items below are pre-war values.

machine, such as that illustrated in Fig. 363. Two fully cut cards, or their equivalent, are illustrated in the upper figure, and two partially cut cards in the lower figure. The capacity of the machine for these cards is repre-

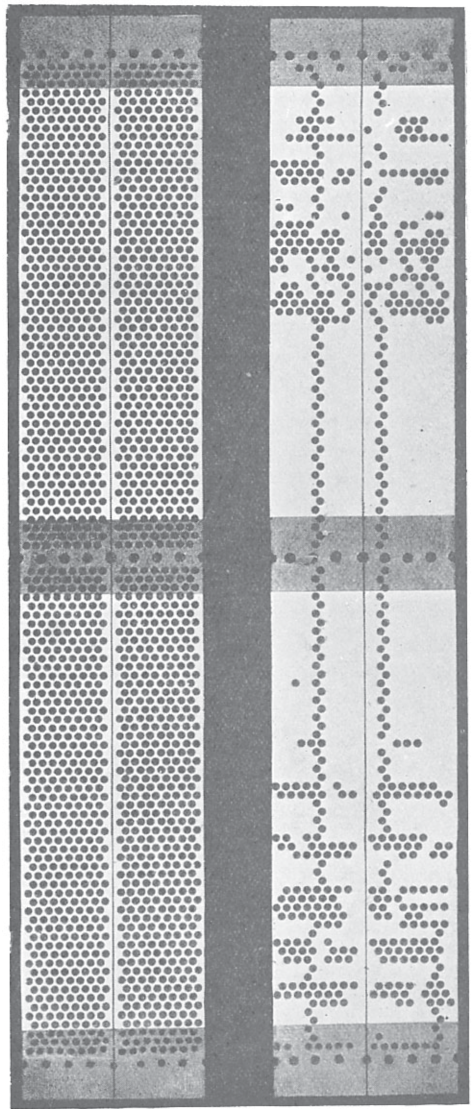


Fig. 122

sented by 896 needles and hooks, and the paper for the equivalent of one card is less than one-fifth of the area of the 900's card illustrated in Fig. 107; when the thickness of the two is taken into consideration, the actual volume of the 896's card or paper is naturally very much less than one-fifth of the volume of the 900's card. Without comparing the practical value of the two pitches and systems so far as working the machine, it will be seen that with regard to material there is a considerable saving effected when the thin paper is used, and besides this it will be clear that the space required for the storage of ordinary cards not in use will be very much greater than that required for the same number of sets of the fine pitch paper cards or paper lengths. Moreover, since the paper is in lengths, it will be obvious that no lacing or wiring is necessary, and hence a great saving is effected in these materials.

The advantages, however, are not by any means all on the side of the paper lengths. This thin paper is very easily torn; is difficult to cut; must be very accurately arranged on the cylinder because of the fineness of the pitch; and, as may be imagined, is very much more susceptible to atmospheric conditions than are the stiff paper cards which are so largely used. Provision is, however, made to effect the turning of the cylinder with a minimum amount of danger to the cards, and it is usual to take observations of the average temperature and humidity in those places where the fine pitch paper is to be used, and to prepare the paper, chemically or otherwise, so that it may be affected as little as possible.

The parts of the card or paper which are subjected to the greatest stress and wear are those where the rotating pegs of the jacquard cylinder enter the large holes for the purpose of drawing the paper round, and these parts are invariably strengthened by an extra strip of tough paper, about $\frac{7}{8}$ in. wide, and fixed to the broad band of paper. These strips are shown clearly in Fig. 122 by the three dark bands—one at each side, and one in the middle.

# CHAPTER VIII

## FINE PITCH PIANO CARD (PAPER) CUTTING MACHINE

FIGS. 123 to 126 illustrate one type of machine which is used for cutting the continuous lengths of paper to be used on the Verdol jacquard. Fig. 123 is a sectional elevation; Fig. 124 is a plan of the keys and connecting levers; Fig. 125 is an elevation of the machine; while Fig. 126 is a plan partly in section. Previous to placing the length of paper A, Fig. 123, on the peg wheels B, it is passed through a special peg-hole cutting machine, so that the holes in the three positions shown in the uncut card or paper at the bottom of Fig. 124, or the four positions in the similar but larger uncut card at the bottom of Fig. 126, may be caught by the pegs or studs of the peg wheel B and rotated when necessary. The jacquard machines are made with one, two, three, or more sections of 448 needles each, so that the cards illustrated detached in Figs. 124 and 126 represent respectively:

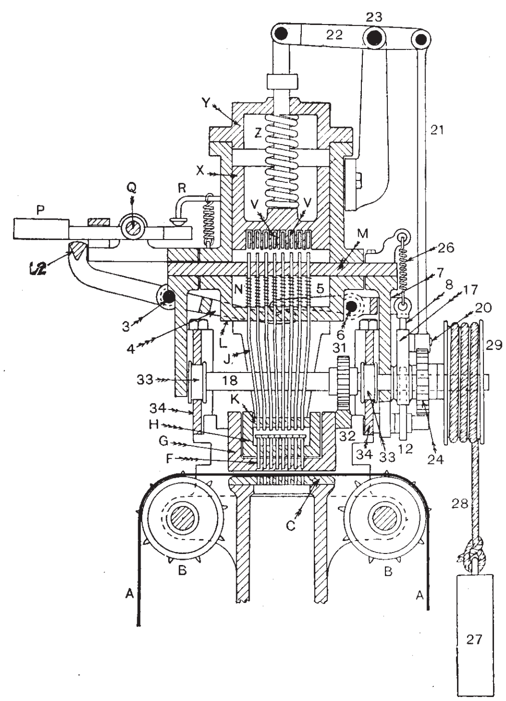
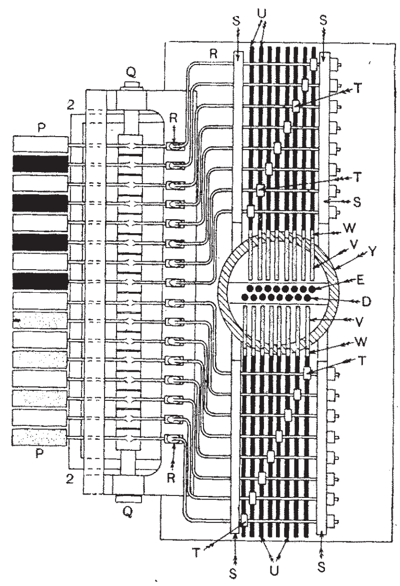



FIG. 123.

448 × 2 sections = 896 needles and hooks.
448 × 3 „ = 1344 „ „

These cards are not drawn to scale, but the actual size of the two-section card is $12\frac{3}{4}$ in. (32·4 cm.) long and $1\frac{1}{16}$ in. (2·725 cm.) broad, and the pitch in all cases is 0·1009 in. The length of the paper A, Fig. 123, would be in one sheet, and would naturally be long enough for the total number of picks in the pattern to be woven, in addition to a sufficient length at each end to facilitate the starting and finishing of the card, and to enable the two ends to be joined satisfactorily when the cutting operation is finished. Long lengths of paper may be prepared with the peg holes cut, and these lengths rolled tightly on a wooden roller and placed in a convenient position under the peg wheels B. When once placed in position on these peg wheels it remains stationary until all the holes for the pattern have been cut in one card. In this way it differs from the ordinary cards in the piano machine and in other types of fine-pitch machines, where the card moves after each short row or two short rows have been cut.



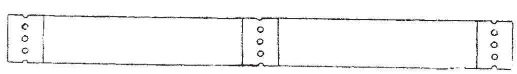



Fig. 124.

It will be a convenient plan first to examine the mechanism which performs the actual cutting, and then to consider the movements of the parts which permit of the intermittent movement of one part of the cutting mechanism with respect to the fixed position of another part of the cutting mechanism. For this purpose we will examine Figs. 123 and 124. The bottom plate C shows one row of holes, which corresponds, say, to the first row in the card; the holes are similar to, but smaller and more closely set than, the row marked D in Fig. 124. Immediately behind these eight holes in plate C, but situated a little to the right for the purpose of obtaining the zigzag pitch, are other eight holes which bear a similar resemblance to, but again smaller and more closely set than, the row marked E, Fig. 124. Rows of short punches F, Fig. 123, with suitable heads pass through the two channels G and H, and their cutting ends rest upon the paper card A just before the actual cutting takes place. In the drawing these punches are shown lifted clear of the paper in order to show all parts more distinctly.

After the selection of needles or punches has been made, one, two, or more of the short punches F are forced through the paper A by means of the downward movement of the long punches J, which are guided in their up-and-down movements by holes drilled in the plates K, L, and M, and are returned, after having operated the desired punches F, by means of the springs N. At this time it will be clear that some of the punches F will have their ends through the paper, but this does not affect the continuation of the process. As a matter of fact, it is an advantage for these punches to remain in the holes until every row in the card has been cut. There are just as many short punches F in the plate or inner channel H as there are needles in the machine for which the card is intended, and the punches help to keep the paper in its correct position. A second row of eight punches is required for the alternate rows E, Fig. 124, and one of these is shown at O, Fig. 125. Two rows, one of D and one of E, are cut at the same operation.

We will now consider the mechanism by means of which the long punches or needles J in Fig. 123 and O in Fig. 125 are selected according to the design. There are 16 short punches F and 16 long punches J and O required for the two rows of holes D and E, and each punch J and O has its own particular key by means of which the card-cutter selects the proper ones. These 16 keys are shown at P in Fig. 124, and one of them in Fig. 123; for the convenience of the reader the keys in Fig. 124 are represented by different colours, and the same or similar arrangement might be adopted for the convenience of the card-cutter. In our illustration we show

| | | | | |
|---|---|---|---|---|
| 1 white key<br>1 black key | for 8 keys to operate rows E. | | | |
| 1 white key<br>1 stippled key | ,, 8 | ,, | ,, | D. |

With some such arrangement the selection may be made with the maximum of ease, and with few mistakes. The selection at the best is, of course, a slow process, as is usual with all cases where several from 16 keys have to be chosen at once, but two successive keys may be operated by one finger when it is necessary to have more than one-half out of each group depressed. Each key P, Figs. 123 and 124, is fulcrumed at Q, and upon its inner arm rests a lever R, bent as shown, and supported by the two frames S. Fixed to each of these rocking levers R, and between the plates S, is a pendent lever T, the curved lower end of which fits into a suitably shaped recess in the sliding rod U. A second series of sliding bars, which we may call supplementary bars, is shown at V in Figs. 123, 124, and 125. To the inner ends of sliding bars U are fixed small angle-irons W, Fig. 125, and from the horizontal part of each angle-iron depends a pin which passes through a corresponding hole in the end of the supplementary sliding bar V. It will thus be seen that the supplementary sliding bars may move vertically up and down when desired in virtue of the pin connection, and since the two bars U and V are coupled together by means of W and the pin, it follows that they move in unison in the horizontal direction.

The downward action of any of the piano keys P will consequently raise

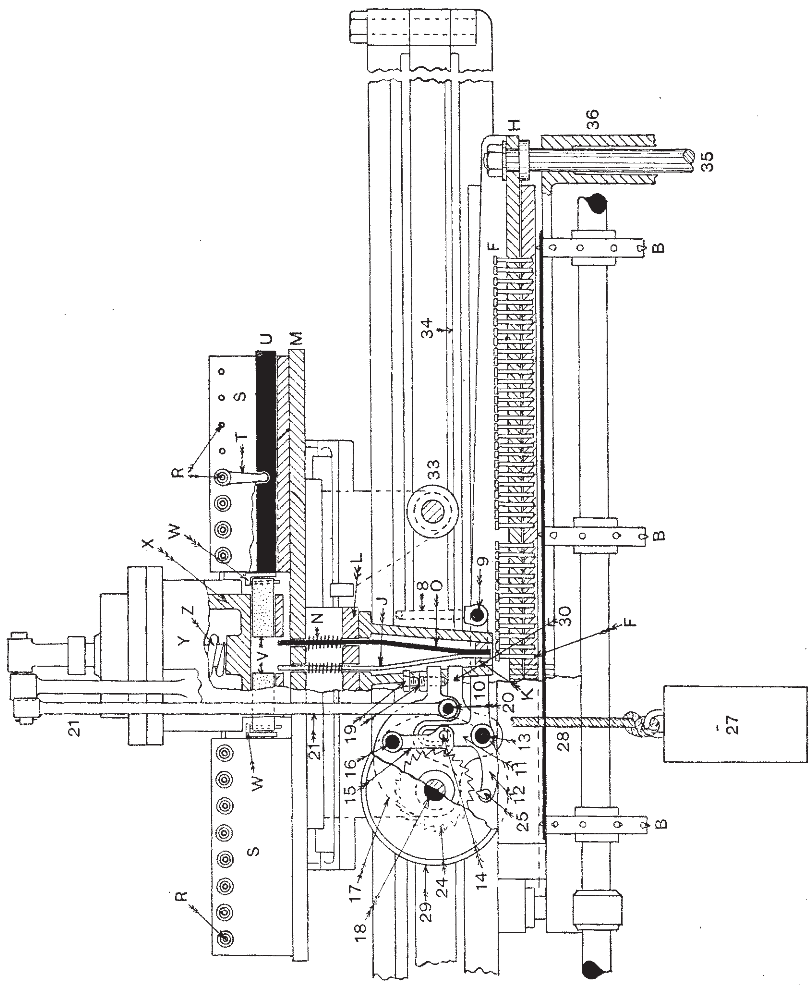



Fig. 125.

the inner end of the key, and also the end of lever R, Fig. 123 ; the straight part of R between the plates S will therefore revolve slightly and sufficiently to enable the lower end of the lever T, Fig. 125, to push forward slides U and V, and hence to place the end of supplementary slide V over its corresponding long vertical needle or punch J or O. The supplementary slides V are situated in slots at the base of the plunger or piston X, enclosed in cylinder Y, and depressed, when facilities are offered, by means of the pressure of spiral spring Z between the lid of the cylinder and the central part of the plunger. The normal position of the piston X is up, but when the required number of supplementary slides V have been pushed into the active position—*i.e.* over one or more of the long punches J and O—the piston X is liberated and is forced downwards by the spring Z; the lower face of the piston in turn forces the long punches J and O down against the heads of the short punches F, and the cutting ends of the latter are consequently forced through the card or paper A at those points which represent the corresponding painted squares of the design-paper.

We may now examine the remaining parts of the mechanism which are also under the influence of the piano keys P. In Fig. 126 these keys are omitted entirely in order to expose more clearly the mechanism which is situated underneath and operated directly by the downward motion of any of the keys. A rectangular framework 2 is fulcrumed at 3, Figs. 123 and 126, and from the back part of the frame projects an arm 4; at the extreme rear end of arm 4 rests a similar arm 5, fulcrumed at 6, and prolonged at 7 in order to be attached to the end of a vertical rod 8. The lower end of rod 8, Fig. 125, is attached at 9 to a three-armed lever 10, 11, and 12, fulcrumed at 13. The vertical arm 11 contains a slot into which is passed a pin 14 projecting from the side of the hanging catch 15, fulcrumed at 16, near the edge of an arm 17. The arm 17 rotates on the shaft 18, which passes through the machine. The free end of arm 17 is provided with a set-screw and lock-nuts 19, while to a pin 20, which projects from the side of the arm 17, near its end, is placed a rod 21. The upper end of rod 21 is attached similarly to the short arm of 22, Fig. 123, fulcrumed at 23.

When any of the keys are depressed, the rectangular frame 2 rotates slightly about its fulcrum 3, its arm 4 is elevated, and so is arm 5, fulcrumed at 6. Consequently the short arm 8 descends slightly, and this action causes the three-armed lever 10, 11, and 12, Fig. 125, to rotate slightly clockwise about its fulcrum 13. When this happens, the pin 14, which is under the influence of the slot in the upper part of arm 11, is drawn to the right, and this naturally causes the pawl of hanging catch 15 to turn about its fulcrum 16, and to withdraw the pawl from contact with the teeth of the ratchet wheel 24, on shaft 18. At the same time it will be seen that the small pawl 25, on the end of the arm 12, will enter the teeth of the ratchet wheel 24, and thus prevent any movement of the latter for the moment, which happens to be the time when part of the card is being punched.

In the positions shown in Fig. 125 it will be seen that since the hanging catch 15 has its fulcrum on the side of lever 17, and its pawl in contact with one of the teeth of the ratchet wheel 24, the rod 21 is held securely for the time being in its lowest position, and hence the spring Z, Fig. 123, cannot move the block X downwards. The withdrawal of the hanging catch pawl 15 by means of pin 14, due to the partial rotation of the three-armed lever 10, 11, and 12, however, releases the lever 17, and consequently enables the spring Z to force down the block X, and so force the short punches F through

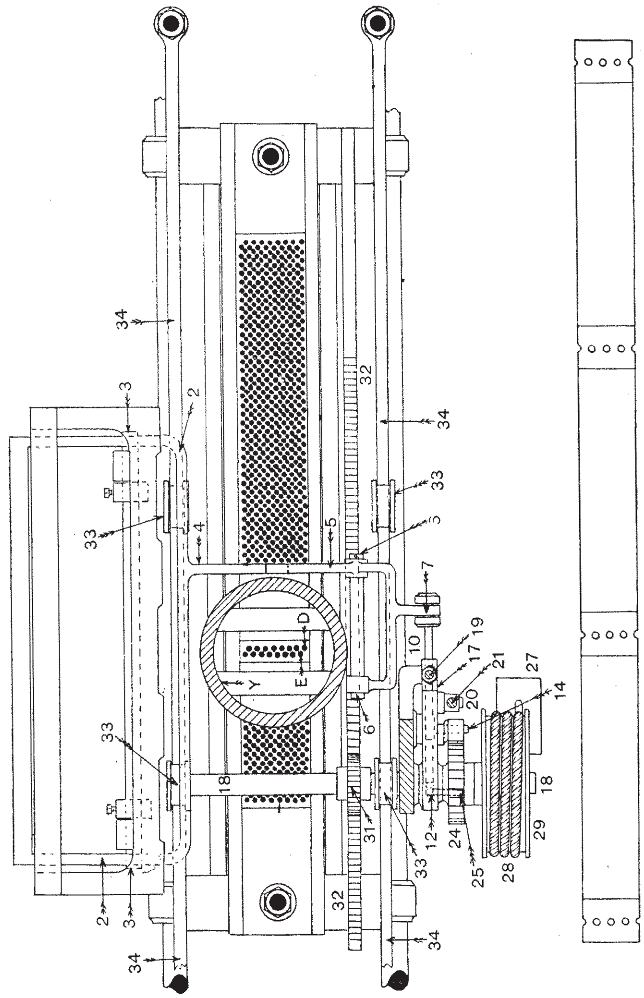


Fig 126.

the paper A. At the same time it will be evident that the pawl and hanging catch 15 will move upwards with the lever 17, and so place the point of the pawl opposite the next higher tooth in wheel 24, under which tooth it will pass when the operator withdraws the pressure from the key P; for immediately the fingers are removed from the keys, the spiral spring 26, Fig. 123, raises arm 7 and rod 8, and thus rotates the three-armed lever counter-clockwise. The slot in the arm of 11 thus carries the pin 14 and the pawl of the hanging catch 15 to the left, and places the pawl in the next higher tooth to that with which it is at present engaged. The upward movement of arm 7 by spring 26 depresses the arm 5 and arm 4, and hence raises the arm 2 and all the keys P to their normal position.

Simultaneously with the insertion of pawl 15, Fig. 125, is the withdrawal of pawl 25 due to the slight rotation of the three-armed lever 10, 11, and 12, and since at this moment the pin 14 is near the upper end of the slot in the arm 11, in consequence of the raised position of lever 17, the latter and all its connections are pulled down by means of the heavy weight 27 and rope 28 acting on the rope pulley 29 on shaft 18. This slight rotation moves ratchet wheel 24 until the set-screw 19 in the end of lever 17 reaches the stop block 30. This action results in a downward movement of rod 21, and at the same time lifts the block X into its highest position ready for a similar action. The distance moved by the lever 17 can be regulated by the set-screw 19 and the lock-nuts near its end.

When the ratchet wheel 24 is thus turned one tooth, the main shaft 18 is partially rotated, and naturally through the same angle. Hence, wheel 31, Figs. 123 and 125, which is fixed to the shaft 18, also moves through the same angle. The teeth of wheel 31 work in a long rack 32, while grooved pulleys 33 run on rails 34; the wheel, rack, and pulleys thus enable the whole of the headstock to move a distance equal to two short rows, or 16 holes, every time the keys P are liberated by the fingers of the card-cutter.

The whole of the upper part of the cutting mechanism moves from left to right, and the cutting is repeated as described until the indicator—not shown in this machine—points to the position on the card where the central peg holes are situated in Fig. 125. At this place there is a blank tread, one short row in each set, or two short rows of punches F in all, being omitted in the plate H. When the headstock has passed over all the punches F, and the card is cut, it will be clear that there will be a considerable number of short punches F with their cutting points through the paper. These punches F must be withdrawn after the last pair of short rows has been cut. Two upright bars or rods, one only shown at 35 in Fig. 125, pass through suitable holes in the framework 36, and the upper ends of these rods are attached as shown to the two ends of the lifting channel H. By the aid of a foot lever the two rods 35 are raised, and hence the channel H lifts all short punches F clear of the card A. The card or paper is now rotated to expose a new position, the headstock brought back to the starting-point, and similar operations performed for the new card and all succeeding cards.

Figs. 127 and 128 are two views of one section of a card-cutting, lacing, and preparing department. In Fig. 127 there are two card-cutters working at two piano card-cutting machines, on the reading boards of which are two designs; the design on the reading board of the far machine is a bordered design, while the other is probably a design for the field or repeating part of the filling. Two card-lacers are also at work—one lacing perforated cards which have probably been cut on one of the piano card-cutting machines on the left, while the other is lacing uncut or blank cards by means of a machine; both will be referred to later.

Three machines are shown on the right of Fig. 128; two of these, the outside ones, are of the fine-pitch type, but of a different make and on a

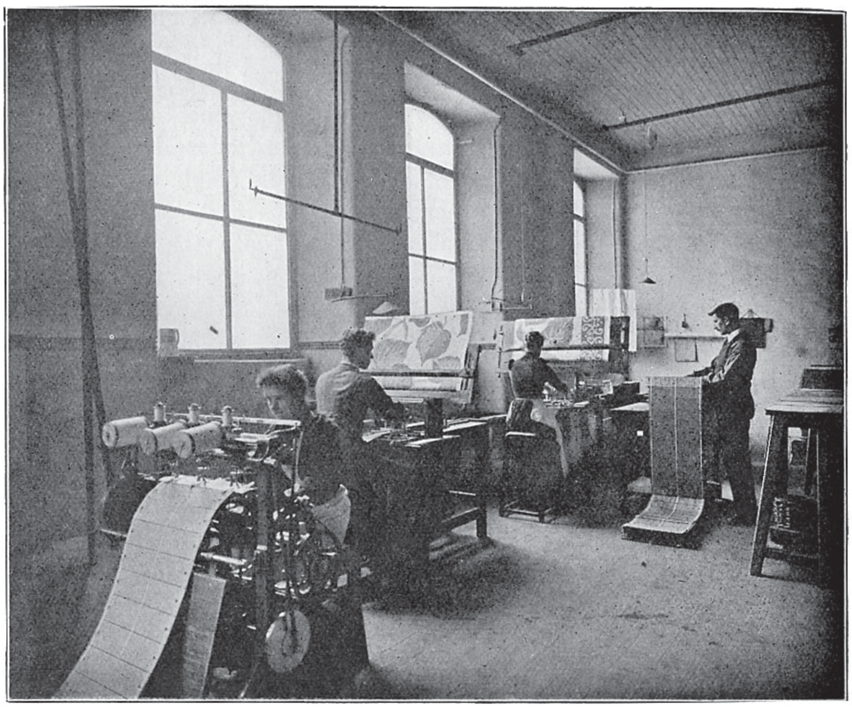


FIG. 127.

different principle from that shown in Figs. 123 to 126. The central machine in Fig. 128 is of the ordinary pitch type. Three designs have been placed on the reading boards merely to give the machines a workable appearance. The two largest designs are for full harness work, and are clearly intended for the fine-pitch machines, whereas the smaller design is for the ordinary jacquard, and is a common harness design. A roll or part of a roll of fine-pitch paper has been introduced into each of the fine-pitch machines illustrated in Fig. 128, while near the footstool of the far machine is a complete roll.