JACQUARD

WEAVING AND DESIGNING

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BY

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PREFACE

THE contents of the following pages have been derived from a long course of art and technical training, together with a lengthened practical experience in textile manufacturing and designing; during which time I received much valuable assistance from many kind friends—especially Mr. B. Ashenhurst, when master of the Belfast Technical School, and his brother, of Bradford; also Mr. John Mitchell, of Belfast and Glasgow—which I thankfully acknowledge.

To supply a treatise that would be alike suitable to the manufacturer, the workman, and the student would be a difficult matter. To explain each point so fully that it would be clear to every person would make it wearisome to those having a knowledge of the subject. I have therefore endeavoured to keep the descriptions as concise as is compatible with a fairly clear explanation, which I hope will be considered the wisest plan to adopt; and, while quite aware of the many shortcomings of the work, I venture to hope that it will prove a valuable assistance to those wishing to improve their knowledge of jacquard weaving and designing.

T. F. BELL.

BELFAST, 1894.

It affords me much satisfaction to add a few words of introduction to this work of my friend Mr. Bell. I cannot pretend to criticise his explanation of technical processes, but, from an examination of the proof-sheets, I am convinced that the book will be found an invaluable aid to students of both art and technical schools. We already possess numerous text-books on designing as an art, as also on the technical processes of weaving, &c., and on the materials of manufacture. Mr. Bell has aimed at bringing the technical and artistic sides of the subject together in a practical form, and has thus provided us with a valuable handbook.

Though we have a Government Department of Science and Art, a knowledge of both branches is seldom united in the same individual. The artist is too often deficient in the science of his craft; while the man of science not unfrequently shows contempt for art. The author of this volume is peculiarly qualified for the task he has set himself, being a practical manufacturer as well as a designer of long experience, and thoroughly learned in the science of his subject. His book will supply a long-felt need.

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CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	JACQUARD MACHINES	27
III.	FULL-HARNESS MOUNTINGS	69
IV.	DESIGNING AND DRAUGHTING	110
V.	CARD-CUTTING AND LACING	139
VI.	SPECIAL JACQUARDS AND HARNESSES	155
VII.	GAUZE	196
VIII.	DOUBLE CLOTH	233
IX.	TAPESTRY AND PILE WORK	255
X.	CARPETS	264
XI.	LAPPETS AND SWIVELS	294
	INDEX	301

JACQUARD WEAVING AND DESIGNING

CHAPTER I

INTRODUCTION

THOUGH the term 'jacquard weaving' is properly applied to work done by the jacquard machine, it will here be taken to apply to all harness weaving, or work that extends beyond the range of shafts, or leaves of heddles.

The question arises, When is the limit to the number of shafts that ought to be used reached? It apparently used to be when no more could be got into the loom, as up to ninety-six shafts were used; and this seems to be quite enough for any weaver to get the yarn through, or for any loom to hold, but it must be remembered that at present the appliances are much more suited to the work than they formerly were; and now, except in woollen or worsted goods, where it is desirable to use shafts on account of their firmness in comparison with that of a harness, from twelve to sixteen shafts are as many as it is generally thought desirable to have in a power loom. I have seen thirty-five shafts, all in one tier or set, working diaper very conveniently in a hand loom, and more than double that number of leaves working worsted in a power loom; but whether the latter was desirable, or not, I must leave to the judgment of the manufacturer who possessed it.

Many ingenious inventions have been made for the purpose of simplifying the working of a large number of shafts, but as a description of them would be out of place here, we may pass on to the draw loom, which appears to be the first form of harness of which we have an accurate description. How the cloths of Babylon were woven, in which

> Men's figured counterfeits so like have been
> That if the party's self had been in place,
> Yet Art would vie with Nature for the grace—

is not known, though in Gilroy's report of Arphaxad's description of his loom to Deioces, king of the Medes, it is stated to have been accomplished by means of carved blocks of wood acting on needles, which wrought the harness or heddles and thus formed the pattern; but as Gilroy has admitted that the introduction to his work on weaving is a pure invention of his own, for the purpose of making it appear that the Ancients were acquainted with motions similar to those on our modern looms, or as a 'take-off on those who angle hourly to surprise, and bait their hooks with prejudice and lies,' we need not dwell further on the subject. In any case, figured cloths must have attained considerable excellence in very early ages. The curtains of the Tabernacle were embroidered with figures, and the veil of the Temple was, according to Josephus, embroidered with all sorts of flowers, and interwoven with various ornamental figures, the door curtain being embroidered with blue and purple and scarlet. The ephod of the High Priest was similarly embroidered.

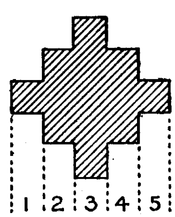

Fig. 1

The Egyptians worked coloured patterns in the loom so rich that they vied with the Babylonian cloths, which were embroidered with the needle. The method of working is unknown, but cloths taken from the tombs in Egypt, which may be seen in South Kensington Museum and in the Gobelins tapestry manufactory, Paris, appear to be made on a principle similar to that of the Gobelins tapestry; the warp is of flax and the weft of coloured wool: and the looms depicted on the catacombs in Egypt are very similar in appearance to tapestry looms.

Embroidering was practised in Egypt prior to the Exodus of the Israelites; and gold and silver threads or wires were used both for embroidering and weaving, being known nearly 4,000 years.

The Babylonish garment taken by Achan, whose sin brought much woe upon the Israelites, is said, by Josephus, to have been a Royal garment woven entirely of gold; but it might only have been embroidered with gold, and was probably wrought in the plain of Shinar, as it was not till long after that Babylon was celebrated for its manufactures.

Pliny says that weaving cloth with gold thread was invented by Attalus, an Asiatic king, and that the Babylonians were most noted for their skill in weaving coloured cloths. This was in Homer's time, about 900 B.C., when weaving and embroidering appear to have attained great excellence, and to have been very gorgeous. At that time the labour of the loom was considered an accomplishment, which ladies and even princesses tried to excel in.

As before stated, the draw loom is the first form of machine for figured weaving of which we have any record. It is not known where it was invented, but it probably passed from China to Western Asia with the silk manufacture. The ancient Egyptians, Greeks, and Romans do not appear to have known it. The Chinese have still in use a draw loom in which the drawboy stands on the top and draws up the parcels of twines which have been previously arranged for him. After being established in Damascus (hence the name damask), the draw loom passed on to Europe, where the Chinese method of working was used till 1604, when M. Simblot, in France, connected to the neck a separate series of cords, called the 'Simple' (perhaps a corruption of his name), so that the drawboy could work when standing at the side of the loom. It is said to have been introduced into England in 1567. The next improvement was to dispense with the drawboy's services, and for this purpose a patent was taken out in 1687, by Joseph Mason, for 'a draw boy engine by which a weaver may performe the whole worke of weaving such stuffe as the greatest weaving trade in Norwich doth now depend upon without the help of a draught boy.' In 1779 William Cheape patented a plan to dispense with the drawboy by having the 'simple' above his head, and drawing it down with knots which were held in notches, as described in Fig. 2.

Before beginning to describe the draw loom it may be better first to describe what it is required to do.

Its principal use appears to have been for the weaving of damask which is one of the simplest forms of figured weaving. Reduce a damask texture to its elementary form, and it consists of twilling, or, more correctly, turned or reversed twilling. If we take a common dice pattern woven with shafts, it will easily be seen that one dice is formed by a warp twill, and the next one by a weft twill, or that the dices are formed by warp and weft twills alternately.

Now, what forms the pattern ? The yarn may be all of one colour, the threads may be so closely set together as to make them individually invisible, or to appear as a plain surface, and yet the dices come out distinctly in two shades of colour. The play of light on the longi-

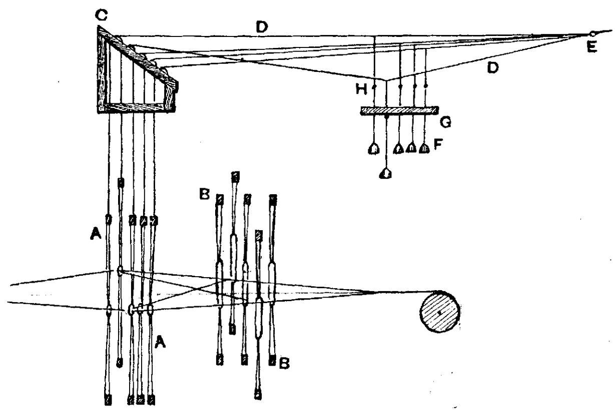

Fig. 2

tudinal and latitudinal threads produces this effect. The dices formed by the latitudinal or horizontal threads will always appear darker than the yarn in the cloth when the latter is placed between the observer and the light, whether these threads be warp or weft, as there is a certain amount of shade on each of them, and of shadow cast by them, whereas the longitudinal or vertical threads are illuminated, without any shade or shadow, and appear lighter than the yarn did before being woven ; and this is the reason why a good side light is the best for showing up the pattern on damask, it developing the above to the utmost. In a good material the difference of shade between the ground and figure is very considerable, but in some thin, coarse goods it is hardly visible, requiring them to be held in a favourable light to show the distinction: the pattern will appear light on a darker ground, or the reverse of this, according as the surface threads forming it run across the light or in the direction of it.

This is the reason of the pattern appearing on the cloth; then it is the business of the designer to regulate what form it is to partake of, by preparing a suitable design; and according to instructions furnished to him by the design, it is the duty of the drawboy to raise the warp by regulating the cording of his harness, and drawing it so as to reverse the twill from a weft one to a warp one wherever the figure is to be formed on the cloth, and to do so in such order as to produce the pattern required.

The draw-loom mounting consists of two parts—the drawboy mounting, or the harness with its tail and simples, to be wrought by the drawboy; and the shaft mounting, which is required to form the texture of the cloth, or to interlace the warp and weft through both ground and figures; the harness only interlaces them at the edges of the pattern, or causes either warp or weft to be above, to form the figure *en bloc*, but without interlacing them together.

It is therefore a 'compound mounting,' and is known as a 'presser' or 'pressure' harness. For simplicity's sake let us suppose the principle of the drawboy to be applied to shafts or healds, and take a simple figure, as Fig. 1.

For it there are 5 parts, or it could be wrought with 5 leaves of heddles with a straight draught. Fig. 2 shows the mounting; A A is the back mounting, which in this case is a shaft mounting, but would be a harness for a more extensive pattern. B, B are the pressure heddles or front mounting. These are 5 in number, as the ground or texture is taken as a 5-end satin or twill. C is the pulley box with the tail cords, D, D, passing over the pulleys, and tied to the wall or to the loom framing as at E. The knobs F hang over the weaver's head, and are attached by cords H, passing through a hole board G, to the tail cords, D, D. There are beads on the cords H, and the holes in the hole board are made thus ; so that when the weaver pulls down a knob the bead can pass through the round hole, and the shaft or shafts of the back mounting attached to it will be raised, and can be kept in this position by drawing the cord into the notch or narrow part of the hole, which the bead will not pass through. Any number of shafts can be raised that are required to form the pattern, either by pulling down the knob for each shaft, or by having the knots corded to the shafts, so that each one will raise the proper number of shafts. Thus, in the figure, each knob is only tied to one of the tail cords; therefore a knob must be pulled down for each leaf of heddles to be raised, but each knob might be attached to any number of the tail cords according to the number of leaves of heddles it is required to raise, so that pulling down each knob in succession will complete the pattern. It might require too many knobs to do this, and then the former method would have to be adopted. When the weaver begins to work he draws the first figure shed with the back mounting by pulling down one or more of the knobs as is required; he then works over the ground treadles, B, B, till a change of pattern is required. Next he releases the drawn shed by pulling the cord out of the notch in the hole board; draws another shed, and works over the ground treadles as before. This gives the principle of how the draw loom works, but the principle of forming the texture with the back and front mountings combined will be fully explained under 'Pressure Harness.'

Fig. 3 gives the draw-loom harness; A, A is the carriage, or the rails that support the harness, which rests on the capes or side rails of the loom. Supported by the carriage is the pulley box P, which is a frame fitted with small pulleys, and must be sloped at such an angle as will allow the tail cords to sink when opening the sheds without obstructing the pulleys underneath them. The neck twines extend from the figures 1 to 8 to the knots above the hole board D D. The cords which connect the neck twines to the mails E, E are called sleepers, and those which connect the mails with the leads F, F are called hangers. The hole board is made of hard wood perforated with holes, which run from front to back in diagonal rows from right to left; it should be a little finer than the set of the reed, to allow for empty holes that are sometimes caused by the tie of the harness ending with broken rows of hooks in some or all of the repeats. In Scotland,

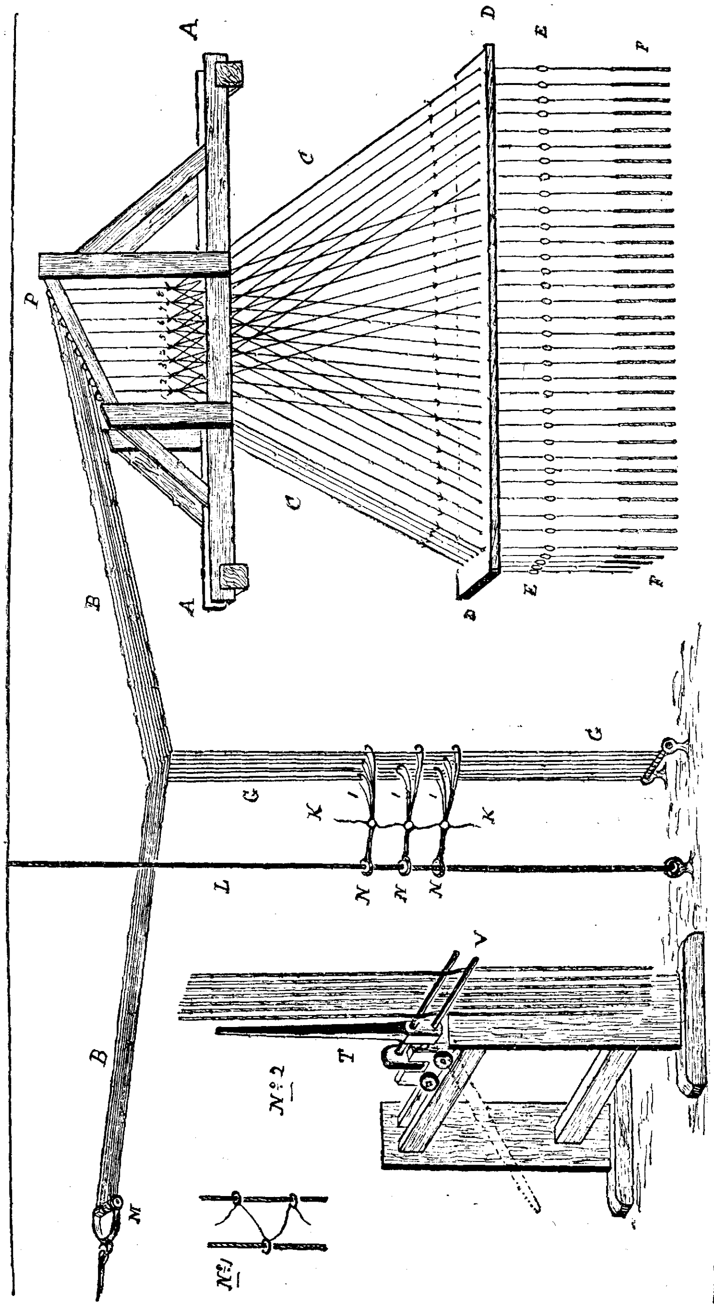

Fig. 3

for this reason, when the reed is set on 37 in., the cumber board, or hole board, is set on 36 in.

B, B are the tail cords, attached to the neck of the harness at one end, and at the other end all of them are fastened to the tail stick M, by means of which they are secured to the roof of the house. There must be a tail cord for each part of the harness; here only eight are shown for the front row of the harness, and if there were eights rows of harness in the hole board, 64 tail cords would be required, and the complete harness would be made up of several repetitions of the 64 neck twines; four of these repetitions are here given for the first row of the hole board. Of course there might be 400 to 600 tail cords in a full mounting.

From each tail cord descends a vertical cord to the ground, as shown at G, G. These are the simple cords, which, taken collectively, are termed the 'Simple.' It is on these cords that the pattern is read, or, rather, tied up. The simple cords are gathered together, according to the pattern, by passing twines round them and forming the twines into lashes or leashes, as shown at I, I. Heads of stronger cord, to which the lashes are attached, are shown at N, N. The leashes or lashes are made of cotton yarn No. 48, from six to eighteen plies of which are moderately twisted together so that the twine will not curl; the heavy twine is used for coarse work, where only a small number of lashes is necessary. The length of the lashes is from 8 to 12 in., according to the breadth of the simple. The heads are about $4\frac{1}{2}$ in. long, of good cord, as foot twine, which is used finer or coarser according as more or less heads are required. The heads are made with a noose on them that will run up or down on the gut cord L, which is a strong cord, generally extending from the ground to the roof of the house. K, K are the bridles connected with the lashes, and used to draw them down in succession as they are wanted by the drawboy. When there are a great number of lashes, two gut cords are used, as shown at No. 1 (Fig. 3), and the lashes are looped alternately on each and bridled accordingly. In coloured work, where three or four draws are required for each weft line of the pattern—that is, one draw for each colour—it is usual to have two gut cords with cross bridles from the one to the other which will slide up and down on them. On these cross bridles the heads of the lashes are fastened, about 1 in. apart, so that the drawboy can take them in succession and draw the shed for each colour.

The method of preparing and mounting the draw-loom harness is much the same as that now in use for jacquard harnesses, and, as it is entirely out of use, it is unnecessary to describe it.

In order to make the neck twines draw evenly, rollers are placed between each set of cords at the points 1, 2, 3, &c.; these rollers keep the cords straight and make them all rise the same height at the mails, which they would not do unless they all sloped to the hole board at the same angle.

READING OR LASHING THE PATTERN

The pattern, painted on design paper, same as for pressure-harness damask, is fixed upon a lashing frame, as shown in Fig. 4, and the lower ends of the simples are passed over it and fastened to the cross-bar B. The simple cords are held in position over the design by the comb C, C, which must be of such a fineness as to make each simple cord stand directly opposite that space of the pattern to which it corresponds, one simple cord being placed between each pair of teeth of the comb. It will thus be seen that there must be a simple cord for each vertical line on the pattern, or rather for each vertical space between the black lines. In the same way, there must be a head of lashes for each horizontal space, or line, as it is usually called, and which would answer to a card for the jacquard or dobby. The straight-edge E E is made so that it will slide up and down in the frame, to mark the line on the design paper that is to be next read by the lasher. Now refer to the line of the pattern above the straight-edge, and it will be seen that the first square or check to the left is blank, and it is accordingly passed over by the lasher; the second and third checks are painted, and as the simple cords corresponding to them have to be drawn to form the pattern, the lasher twists one end of his lash over the pin G, and takes a turn of it round the second and third simples, again passing it round the pin G. The fourth check, being blank, is passed over, and a turn or tack of the lash twine is taken round the fifth, sixth, and seventh simples, as the checks on the design paper opposite these are painted. The reading and lashing proceeds in this way till the line is finished, as shown in the figure; then the two ends of the lash twine are tied together round the pin G, which is then taken

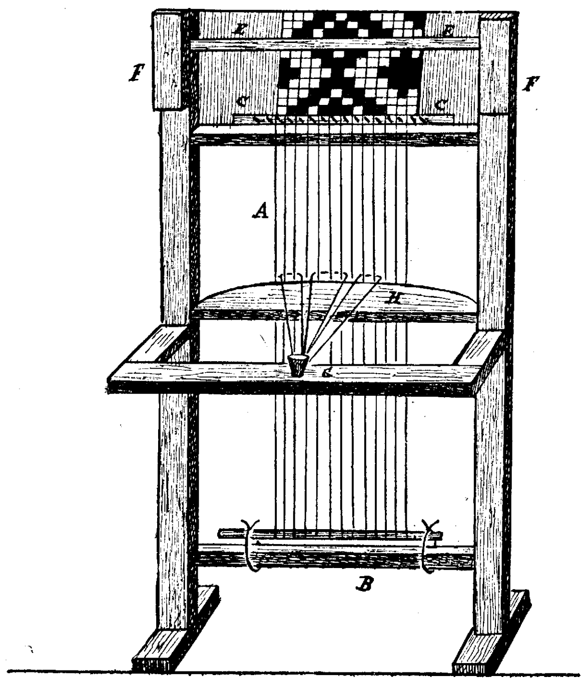

FIG. 4

out, and the loop made round it by the lash twine is twisted round and formed into a snitch for the purpose of fastening it to the head. The lash is now pushed down behind the board H, to make room for another; the straight-edge is then shifted to the next line, and the lashing proceeded with as before. If too many painted squares of the design paper come together, all the simple cords corresponding to them must not be looped or lashed together, but can be taken in two or more loops or tacks, never taking more than six or seven simple cords into one tack of the lash twine.

It will be observed that the board H is rounded at the back; this is for the purpose of having all the simples at an equal distance from the pin G when they are tacked up by the lash twine, and consequently a more regular shed will be produced when they are drawn in the process of weaving.

The method of fastening the head to the lash is to loop the cord for the head, which should be double, round the gut cord, then knot the two ends of it together, and take this knot through the snitch formed on the end of the lash, and when the snitch is drawn tight the knot prevents the head from slipping out.

In weaving with the draw loom two persons are required—the weaver, who works over the ground treadles, throws the shuttle, beats up the weft, &c.; and the drawboy, who takes the lashes in succession as he draws them down by the bridle, and by pulling out the simples raises the harness and holds it in this position till the weaver has worked as many shots as are required to be given to each draught.

When some thousands of twines were required for the harness, and with a simple of three or four hundred cords, the weight and friction made it very severe work for the drawboy. To assist him a fork, as shown at V, No. 2, Fig. 3, was used. It was made to run to and fro on a carriage, so that when the simples were drawn forward by the lashes, one spike of the fork could be run in behind those drawn forward, while the other spike was in front of them. When the fork was depressed, till the handle T came to the position shown by the dotted lines, it drew down the simple cords, and they could easily be held in that position till a change of draught was required.

When the mounting of the draw loom was very extensive, it was necessary to employ from two to ten pulley-boxes and as many drawboys, so that it is not surprising that many endeavours were made to work without the aid of a drawboy. One of these machines, known as the 'Parrot' or 'Pecker,' is shown in Fig. 5. It is wrought by the treadles T, which are attached to the marches M, and these are connected by the pulley P, on the rocking shaft R, by a cord which passes over and is fastened to it. When one of the treadles is pressed down the pulley rocks and turns the shaft to one side, and when the other treadle is pressed down the shaft will rock to the other side. The parrot or pecker K is movable on the rocking shaft—that is, it can

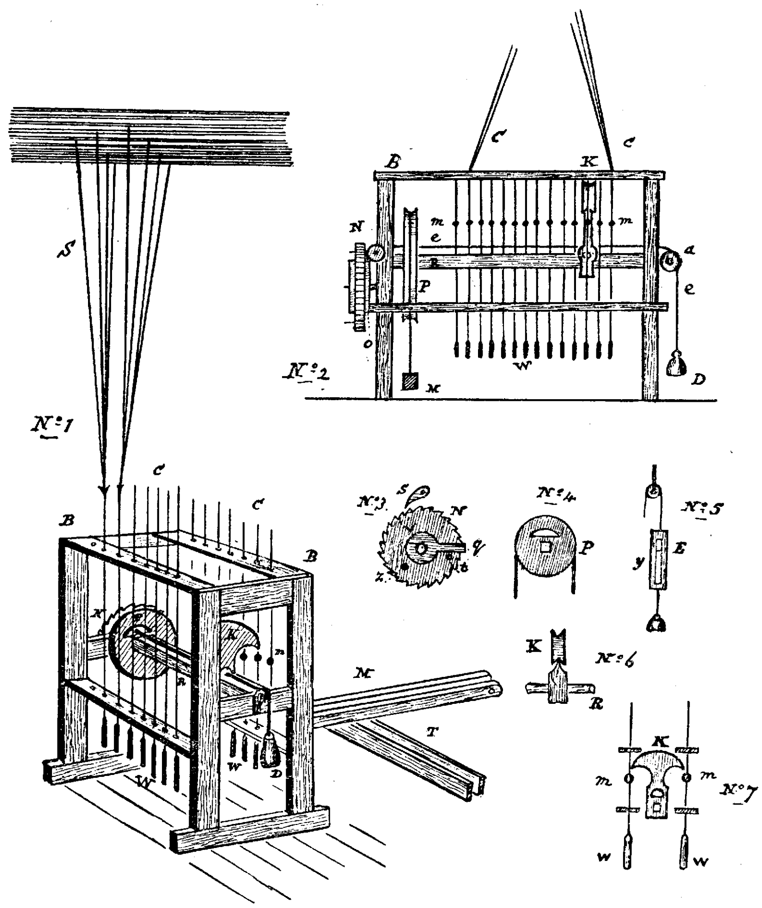

FIG. 5

slide along it—but it must rock from one side to the other with the shaft. The cords C, C are passed through holes in the boards B, B, for the purpose of keeping them in position, and they have knots or beads on them at *m*, *m*, and weights, W, W, at their ends to keep them in tension. Fastened to the cords C, C is another set of cords, S, connected with the tail cords of the draw-loom harness, and so corded or arranged as to draw those tail cords required to be sunk to raise the harness to form the pattern. As the shaft R is rocked from side to side by depressing the treadles in succession, it carries with it the pecker K, and the groove or notch at the point of the pecker, shown clearly in Nos. 2 and 6, coming into contact with the knots or beads on the cords, draws them down alternately, first at one side of the machine and then at the other, until the pecker, as it slides along the rocking shaft, has passed over all the cords; it is then released and drawn back to its original position by means of the weight D, attached to it by the cord *e*. At the end of the rocking shaft is a ratchet wheel, N. The cord *e* passes from the pecker through the segmental hole in the pulley P, as shown in No. 4, and is fastened to a boss, O, on the inner side of the ratchet wheel. This wheel receives its motion from a catch, as shown at E, No. 5, which is simply a pin fixed in a slotted piece of wood. The pin *y* forms the catch, and the slot acts as a guide, which passes over the edge of the ratchet wheel, and keeps the catch in position. The catch is attached to the marches and works vertically. It is raised by the treadles, and when released is drawn down by the weight attached to it, the wire *y* catching one of the teeth of the ratchet and moving it round. There are two pins, *z* and *t*, in the ratchet, as shown in No. 3, and it is according to their distance apart that the length of traverse of the pecker is determined. The bar *q*, shown in No. 3 attached to the pulley V, which is loose on the axle, is raised by the stud *t*, as the ratchet wheel is advanced tooth by tooth, till it comes into contact with the catch S, and raises it; this allows the ratchet wheel to be reversed by the weight D on the end of the cord *e* till the stud *z* comes round and draws away the bar, which allows the catch to fall into position again and stops the pecker where the pattern is to begin. Thus, the distance between the studs *z* and *t* must be arranged to suit the number of cords the pecker has to pass, or to give the number of threads in the pattern. The teeth of the ratchet wheel and traverse of the catch must be of such a pitch that as each tooth is moved round the pulley will be turned the exact distance required to move the pecker from one cord to the next one. No. 2, Fig. 5, is an elevation of a 'parrot' arranged for a single row of cords, as these machines were first made. There was only one treadle, as shown in section at M, No. 2, and the pecker only rocked to one side. Either this or the double machine could be used for a shaft mounting where a large number of treads are necessary. The cords C pass over pulleys, and are fastened to long coupers or levers with their fulcrum at the side of the loom, and to these the shafts are hung from jacks or otherwise. These machines were made to work very exactly. In the double machine the pecker would travel over three or four hundred cords in consecutive order.

To avoid confusion the beads are not shown on the front cords in No. 1.

CROSS'S COUNTERPOISE HARNESS

About the year 1816 Mr. James Cross, of Paisley, invented a machine to do away with the drawboys.

This machine is fully described by Murphy and Gilroy in their works on weaving. Only the general principle of it will be given here, as an introduction to the jacquard. The detail of drawing the lashes and treading, though ingenious, is not of any practical importance now, and it requires rather a lengthy description to explain it. The harness F is the same as in the common draw loom till it reaches the tail cords, where the counterpoise apparatus commences. The framing B B (Fig. 6) of this machine is supported by the carriage A A, which rests on the capes or top rails of the loom. In this frame are two boards, C and D, perforated with holes corresponding in number with the tie of the harness or cords in the simple. The top board is called the suspension board, and is mortised into the bar E. From this board the harness hangs, the neck being taken up through the holes in it, and fastened above them. The lower board, D, which is mortised into the bar G, is called the neck board, or directing board, as it keeps the harness in its proper place. H and K are two other boards, perforated as shown in Fig. 7, mortised into the sliding bars I and L respectively; these are called the trap boards. M, M and N, M are four bars, called pushers, which are fastened to the sliding bars I and L as well as to the pulleys P, P, and when the pulleys are oscillated by means of a treadle the sliding bars will be moved up and down. The knot cords or tail cords O, O are fastened to the suspension board C,

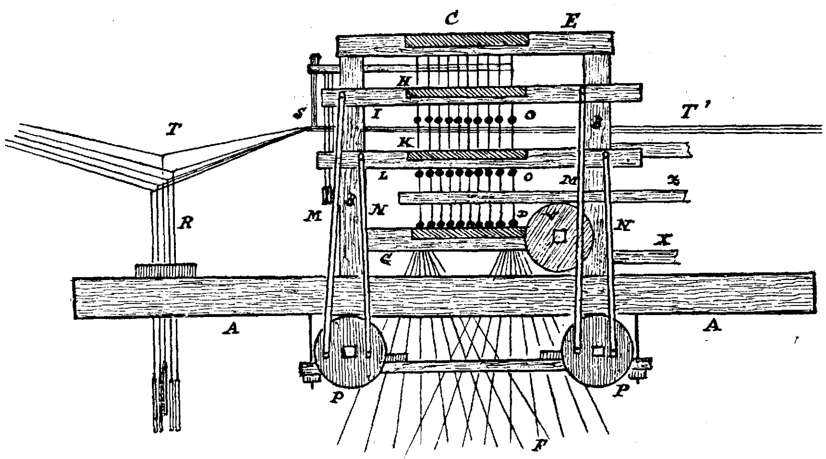

FIG. 6

and pass through the two trap boards, then through the neck board, and are tied to the harness. Only two of these cords are shown tied to the harness, to avoid confusion. These knot cords have knots or beads on them as shown, and the round holes in the trap boards H and K, as shown in Fig. 7, must be sufficiently large (about $\frac{1}{4}$ in. in diameter) to allow the knots or beads to pass freely through. There are notches or saw-cuts at the sides of the holes to admit the cords, but support the knots. T, T^1 is the simple, extending horizontally through the knot cords. It is fastened to the ceiling beyond T, and to the frame of the machine beyond T^1. S is a half-leaf of heddles for the purpose of supporting the simple cords. Each simple cord is tied to a knot cord, and beyond T^1 the simple is lashed according to the pattern. In working the machine the lashes are drawn by means of hooked

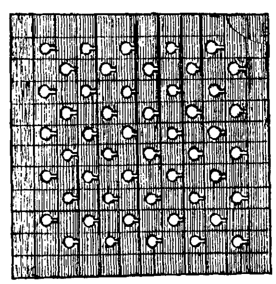

FIG. 7

levers, wrought by a treadle connected with the pulley V, and those simple cords that are drawn down pull the knot cords into the notches or saw-cuts in the trap boards, so that when the trap board is raised the harness fastened to those knot cords that are drawn into the saw-cuts will also be raised. R is a set of cords with weights on their ends for the purpose of drawing the knot cords out of the saw-cuts as soon as the simple is released by the lashes. The two trap boards rise and fall alternately, and this is why the machine is called a counterpoise.

Some time after an improvement was made upon this machine which was known as

THE COMB DRAW LOOM

This machine appears to have been invented in both Scotland and Ireland, as Gilroy describes it as an invention of Dr. McLaughlin, of

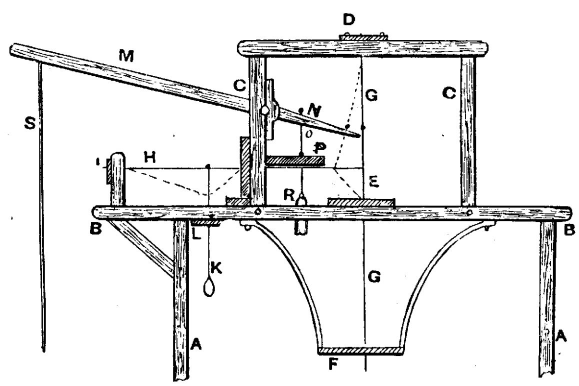

FIG. 8

Ballyshannon, County Donegal; and Murphy describes a similar machine invented by Mr. Bonnar, of Dunfermline. The machine is shown in Fig. 8. A, A are the posts of the loom, and B B the top rail; C C is the framing of the machine. The harness G, G is suspended from the suspension board D, and passes through the guide board E and the cumber board F. The upper portion of the harness is composed of tail or knot cords, as in Cross's machine. From each of the tail cords a simple cord, H, extends horizontally over the weaver's head, and is fastened to the board I. The lashes K hang from the simples over the weaver's head, and have a knob on the end of each, so that the weaver can catch them and draw his own draught.

The lash cords have a knot or bead on them, so that when drawn they can be held in the cuts of the board L, also shown in plan at L (Fig. 9). M, N (Fig. 8) is a side view of the comb and handle, or lever, shown in plan at M, N (Fig. 9). S is a cord or chain attached to the end of the lever M, and passing down to a treadle. When the weaver draws one of the knobs, the tail cords connected with the simples in this lash are drawn between the teeth of the comb, as shown by the dotted lines in Fig. 8. He then depresses the treadle, which raises the comb, and the harness along with it; he holds the treadle down with his left foot, and works over the ground treadles with his right one. The comb is recovered or counterbalanced by the cord O, which passes from the comb through the board P, and has a weight, R, suspended on it. D (Fig. 9) is a plan of the boards D, E, F and I (Fig. 8).

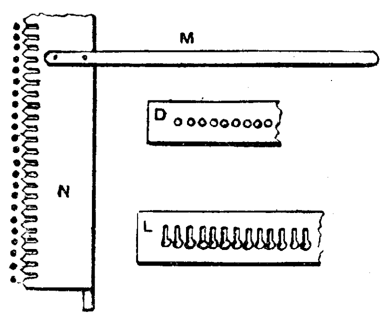

Fig. 9

THE BARREL OR CYLINDER LOOM

This machine was introduced by Mr. Thomas Morton, of Kilmarnock. The harness and tail or knot cords are arranged similarly to those in the comb draw loom; but instead of the simple cords for drawing out the tail cords, each tail cord in the barrel loom passes through a slide, or horizontal wire. The points of these slides are acted upon by the pattern cylinder or barrel, and those held back press out their tail cords from the others, and the knots on these tail cords are caught by the teeth on the comb or roller, and the harness raised.

The pattern is arranged upon the barrel much in the same way as a tune is arranged on the cylinder of a barrel organ or musical box.

A section of the barrel is shown at A (Fig. 10), with wire staples driven into it to form the pattern.

Each of these staples represents so many lines of the design paper, or so many lashes or draughts. The pattern is ruled out and painted on the barrel, and staples are driven into it so as to cover the painted squares of the pattern. The barrel is so arranged on the loom that exactly the space of one line of the design paper is turned round for each draught, and the slides are drawn back by cords attached from their ends to a roller when the shift of the barrel is being made. B is a section of the comb; it is a cylinder with teeth, C, like a parrot's beak fixed to it. The teeth are made of this shape to hold the knot cords when they are caught by them, and they rise or fall as the roller is rocked upwards or downwards by a treadle.

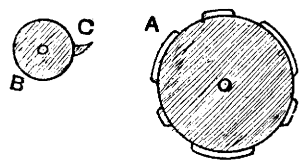

Fig. 10

Whilst these improvements on the draw loom were being made in this country for the purpose of producing a convenient method of harness weaving, the French were endeavouring to obtain the same result, but on a different principle, and their method has proved successful.

In 1725 M. Bouchon employed a band of pierced paper, pressed by hand against a row of horizontal needles, so as to push back those which were opposite the blank spaces, and thus bring loops on the extremities of vertical wires into connection with a comb-like rack below, which, being depressed, drew down the wires, pushed on the pins in it, and raised the harness.

Fig. 11 is a sketch of a model of this loom in the Conservatoire des Arts, Paris. A is the pulley-box with two rows of pulleys in it; B the tail cords; C the simples, tied to rings on their upper ends, which run on the tail cords at B; the other ends of the simples pass over a small roller at D to prevent them rubbing against the side of the loom, then down through the hole board F, under which they are tied to wire hooks or loops, as shown under A (Fig. 11A). Next these wires pass through the needle box G, also shown at B, Fig. 11A, and down to the comb H (Fig. 11), and C (Fig. 11A). The perforated paper is rolled on the roller E, and passing downwards, is pressed against the needles with a hand bar, as shown at L, Fig. 11B. The roller K is for rolling up the paper as it passes down from the upper roller.

Fig. 11B is a back view of the mounting. A shows where the simples are connected with the tail cords P; B shows the connection

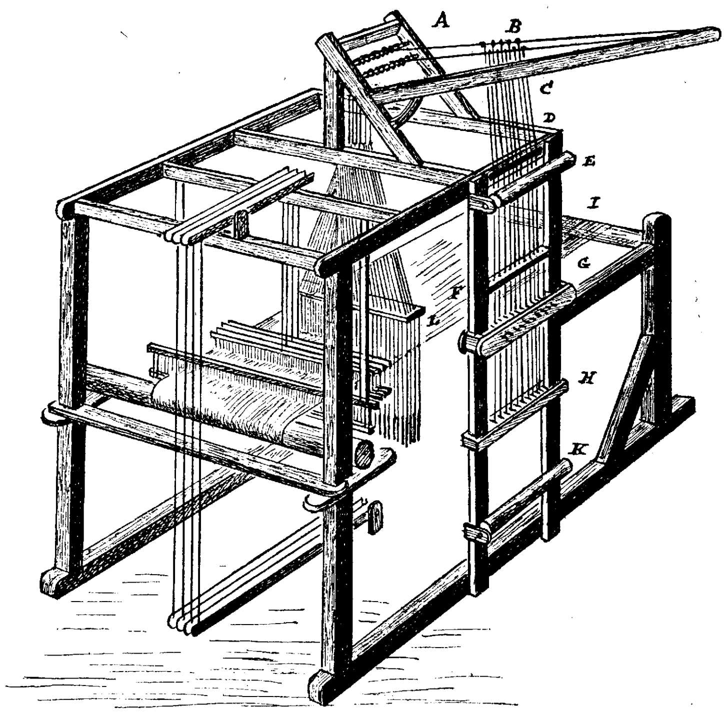

FIG. 11

of the tail cords with the harness; C is the cumber board; D the mails and E the leads. F and K are the two rollers for the paper, H the needle box, and I the comb. This was the first attempt at forming the pattern by means of perforated paper acting upon needles and wires.

In 1728 M. Falcon adopted a chain of perforated cards in lieu of the perforated paper, and placed his horizontal wires or needles in several rows or ranks, thereby admitting the use of a greater number of them in a moderate space. He also used a square prism or cylinder, as it is called, for the cards to pass over.

Fig. 12 is a sketch from a model of his loom, also in the Conservatoire des Arts. The principle of it is much the same as the preceding. A is the pulley box for four rows of pulleys, B the connection of the simple with the tail cords, C the hole board for the simple to pass through and also the support for the cylinder H, D is the needle box, E the comb or griffe, F the levers for drawing down the griffe, and G the treadle. The cards are laced in a chain and pass over the cylinders

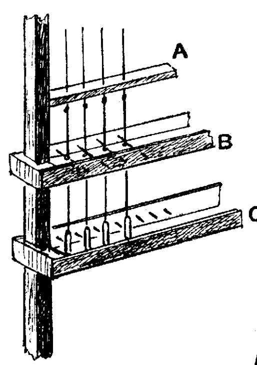

FIG. 11A

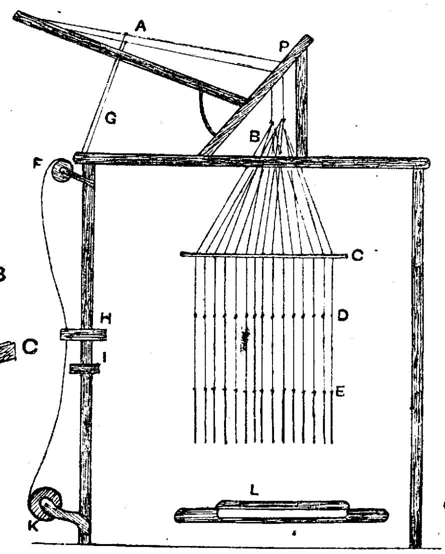

FIG. 11B

I and H, but they are pressed against the needles by a hand bar, similar to that used by Bouchon. There are two racks or receptacles for holding the cards, as shown. The cylinders H and I are simply used as rollers to support the cards, and not for pressing them against the needles, as in the jacquard.

Figs. 12A and 12B give detailed views of the hooks, etc., for drawing the harness: the letters in both refer to the same parts as are marked with similar letters in Fig. 12. The simples B are tied to loops on the hooks under the hole board C. In Fig. 12B it will be clearly seen how the needles in four rows act upon the hooks. The griffe consists of four round iron rods or wires set in the frame E, Fig. 12A, which can be drawn down by the treadle G, connected with the levers F by the cords 3 and 4. One of the levers has its fulcrum at one side and the other has it at the opposite side, and the points of the levers are tied to the griffe frame by the cords 1 and 2. The griffe, when sunk, is brought back to its place again by weights hanging on cords running over pulleys. It may be seen that the hooks hang in front of the rods

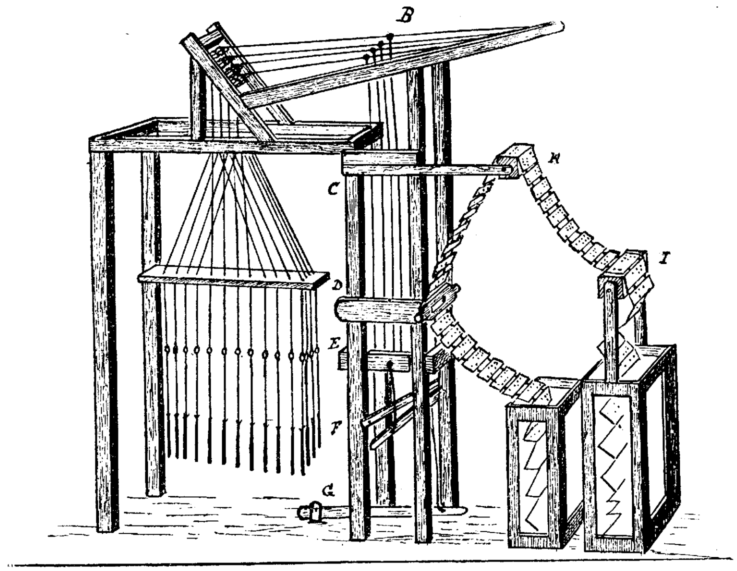

Fig. 12

or bars of the griffe; therefore, those hooks will be pushed on the griffe whose needles come against the solid portions of the cards, thus acting similarly to Bouchon's machine. The hand bar for pressing the cards against the needles is shown at F. The needles can pass through the slot in it, and, when a card is pressed against the needles, the bar can be fastened with hooks for the purpose, so that the operator is free to depress the treadle. There are no springs on the needles, but a clap board comes behind them, which is pressed in by means of a cord passing over each end of it and fastened to a spiral spring. There are ten leaves of heddles in front of the harness. They are plain clasped heddles, and apparently act as five, the front five being raised by the top levers connected with the treadles, as shown in Fig. 11, and the back five are held up by a set of levers at each side, with weights on the ends of them, similarly to those now used for hand-loom damasks, and tied to the treadles below, so that sinking a treadle would cause one of the back leaves to sink and one of the front ones to rise. Only

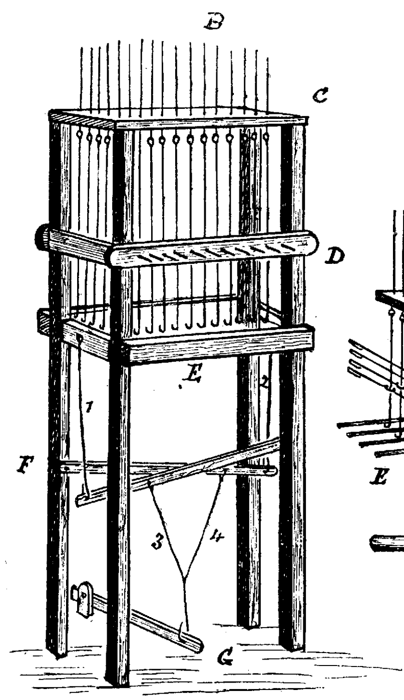

Fig. 12A

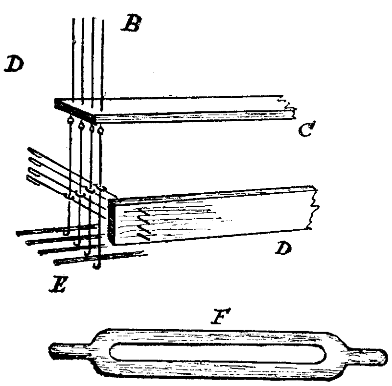

Fig. 12B

the harness mechanism of Falcon's loom is given in Fig. 12, the front portion being similar to that of Bouchon, or to any hand loom.

In 1746 the accomplished mechanician, Vaucanson, altogether dispensed with the cumbrous tail cords and simple of the draw loom, and made the draw-boy machine completely self-acting by placing the hooks upright on the top of the loom, and hanging the harness from them. This loom may be seen in the Conservatoire des Arts, as well as a model of it on the same scale as those already mentioned—viz., one-third the size. The machine for drawing the harness is exactly like a small jacquard, with two rows of hooks and two rows of needles, as shown in Fig. 13. Instead of a square cylinder and cards, the pattern is punched on a band of paper, which passes over a round or true cylinder. This cylinder is fitted with a rack wheel, so that a tooth can be passed for each change of pattern, the cylinder moving out and turning one tooth, then pressing in against the cards again. The diameter of the cylinder is about twelve inches. The hooks are raised with a griffe, similar to that in a jacquard, which is fastened to a lever connected to a treadle below. This treadle, and four others for working the heddles, is wrought by tappets, made of wood, on a shaft running along the side of the loom and turned by a wince handle in front. Altogether, the loom is a nice mechanical contrivance, and a great step in advance of its predecessors.

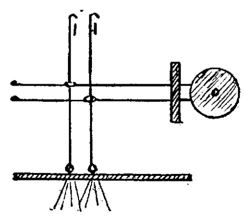

FIG. 13

Joseph Marie Jacquard, a working mechanic of Lyons, having invented a fishing net loom, turned his attention to improving the means of drawing the harness in looms for figured weaving, about 1790. A model of a machine by him, dated 1790, to dispense with the drawing of the harness, is in the Conservatoire des Arts. It is made with cords and rollers, and has no resemblance to the machine bearing his name. He was brought to Paris to repair Vaucanson's loom about 1804, and it appears to be then that he combined the best qualities of the machines of his predecessors, and produced the jacquard, a model of which, dated 1804, is in the Conservatoire des Arts. This is very much like our present jacquard, but with four rows of hooks and needles made similar to those of Vaucanson, Fig. 13. He dispensed with Vaucanson's cylinder and band of paper, and used instead a square prism with a chain of cards passing over it. The cylinder (or prism) he set in a frame or carriage, made to run on four wheels or pulleys on the top of the frame of the loom. The carriage is drawn out by depressing a treadle, and brought back again to press the cylinder against the needles, by means of weights tied to cords running over pulleys. The griffe is raised by means of two levers, one at each side; one end of each is connected with the griffe, and the others to a crossbar at the bottom of the loom, and this crossbar is fastened from its centre to a treadle. In all these looms the cards or paper hang at the side of the loom, the mounting being on the principle known as the London tie. Jacquard was born in 1752, and died in 1834. Vaucanson died in 1782.

FRENCH DRAW LOOM

Shortly after the introduction of Cross's counterpoise harness, a machine was imported from France, which is shown in Fig. 14, and described in Murphy's 'Art of Weaving' as a French draw loom. This machine far surpassed any attempts at the improvements at the draw loom that had hitherto appeared, in simplicity of construction and operation. From the neck upwards the harness is similar in construction to Cross's counterpoise, having the knot cords arranged in the same manner, but with only one trap board. Instead of the cumbrous tail, the knot cords are acted upon by wires or needles, on each of which is a loop, through which one of the knot cords passes. D is the cylinder or barrel, perforated with holes, as in the common jacquard cylinder, and C, C shows the chain of cards for forming the pattern; E is the lever for raising the trap board, to which it is connected by means of pieces of iron at each side, with a bar across between them, to the centre of which the lever is connected with a piece of wire. O O are crossbars of wood, with holes in their centres, through which run pieces of strong iron wire, which are fixed into the trap board at each end to keep it steady while in operation. There is no spring box for the needles as is now used in the jacquard, but into the crossbar or frame F is inserted a flat piece of wood moving on springs, which yields to the pressure of the needles that are forced back by the barrel, and recovers them again when the barrel is withdrawn. The lever E is drawn down by the cord H, attached to a treadle, when the trap board is to be raised, and the barrel is drawn back by the cord G, which is attached to another treadle. The barrel is pressed against the needles by springs, and when it is relieved by the treadle and is moving inwards, it is turned by one of the catches shown in Fig. 14A. Either of these catches can be brought into action, so as to turn the barrel either way, by raising or lowering them with a cord. When at rest the knot cords stand in the notches or saw cuts of the trap board, but when the cards are pressed against the needles, except where there are holes in the cards, the needles are pressed back and the cords are pushed out of the notches so that the knots stand above the holes in the trap board, and pass through them when the board is raised by depressing the treadle connected with the lever E. The trap board is shown in Fig. 7.

Fig. 14

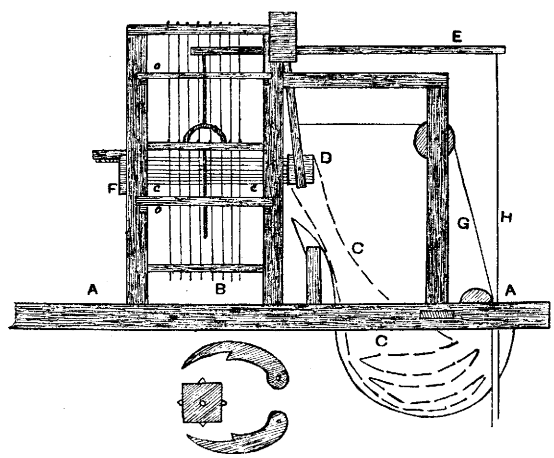

Fig. 14A

Whether this machine was Jacquard's invention or not, I have not been able to ascertain; but Gilroy states that Jacquard's first machines were made with cords and trap boards, like Cross's counterpoise machine. It is also recorded that William Jennings, of Bethnal Green, invented a machine, similar to the above, about 1830, as an improvement on the jacquard, on account of its simplicity, as the latter appears to have given the weavers some trouble, and notice was taken of his machine by the Society of Arts.

Machines similar to the above are still in use for hand-loom work, and answer very well. They have also been used for power looms, but the cords do not stand the friction long. As at present made about Glasgow, the cylinders of these machines work on slide rods, and receive their motion from the rising of the trap board, same as the cylinders in jacquards are sometimes wrought by the rising of the griffe with what is known as the 'swan neck' motion. The spring board at the ends of the needles is held back by a spring and drawn in by the cylinder frame as it moves outwards, which brings all the needles forward, and the cords into the saw cuts in the trap board, or comb as it is frequently called. The knots on the cords for these machines are made as at B, Fig. 15, which, when drawn tight, are as shown at A. The cord is a good twisted cord, such as whipcord, and the holes in the trapboard are about $\frac{3}{16}$ in. in diameter, which the knots on the cords must pass freely through. The upper ends of the cords pass through a perforated board on the top of the machine, and another cord is drawn through loops on their ends, which prevents them from being drawn through the holes.

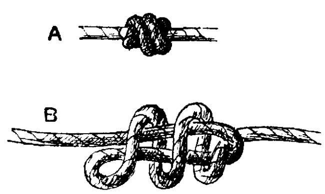

FIG. 15

CHAPTER II

JACQUARD MACHINES

THE jacquard machine was introduced into England about 1818 and came into general use from 1824 to 1832. It was introduced into Scotland about 1824. Fig. 16 is a representation of the early form of jacquard, and of course intended for hand-loom work. Although the present machines for power-loom work are very different in make, nearly all the working parts as here used are to be found in different machines at present working, or still being made, though the best machine makers have adopted newer and better principles for fast working and withstanding wear and tear. Fig. 16A is a view of the interior of the machine. The working of the machine will be explained further on; only those parts that will not be given in the new machines will now be noticed. The griffe or frame for raising the hooks is lifted by the straps A, A, Fig. 16, which are attached to the pulleys B, B, and a cord C over a pulley on the same shaft as B, B, is attached to a treadle beneath the loom. As the weaver presses down this treadle the griffe is raised, and when the treadle is released the griffe falls of its own weight. The cylinder is moved out and in by the pulley E, fastened on the bent iron bar, attached to the frame which carries the cylinder, when the griffe rises and falls. D, D is a frame which lies in the turned-up portion of the hooks; only a few hooks are shown, and the outer bars of the frame. There should be a bar in the frame for each row of hooks. This frame rises up and down with the hooks, the turn on the ends of which must be of such length that when the frame is raised by the hooks lifted by the griffe, it will not be raised out of the turns on those that are left down. This frame is for the purpose of preventing the hooks from turning round, so that the turns on the upper end of them, as shown at A, A, Fig. 16A, cannot get out of position to be caught by the blades or crossbars of the griffe. The lower ends of the hooks rest on a perforated board as shown in Fig. 16A, and tail cords are looped on them and pass through the perforated board as shown. To these cords is fastened the neck of the harness. Machines with these perforated boards and frames to keep the hooks in position are still (1890) being made in Yorkshire. In Fig. 16A is shown a section through the spring box B. This box con-

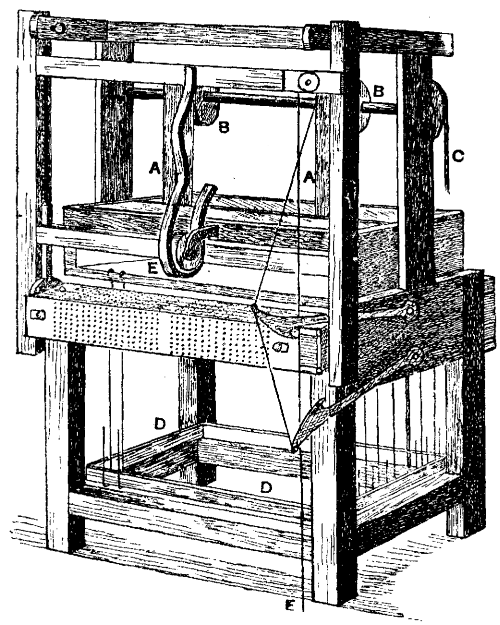

FIG. 16

tains a spiral spring for each of the horizontal needles, the ends of which press against the springs, which allow them to yield or move back as the cards press on their points; but recover them again when the card is moved away by the cylinder. Similar spring-boxes are now used.

It might be interesting to describe the various changes and attempted improvements that have been made on the original jacquard, but it would take up too much space, and many of them are of more historical than practical importance; some of them will be mentioned that may be interesting from a mechanical point of view, in connection with the descriptions of the machines, even though they have only been partially successful. Though a very different machine from what it originally was, the principle of the jacquard remains the same, and is not likely to be altered or superseded till a revolution takes place in the process of weaving.

A jacquard machine is simply a shedding motion by which a great variety of sheds can be formed; the larger the machine, or the greater

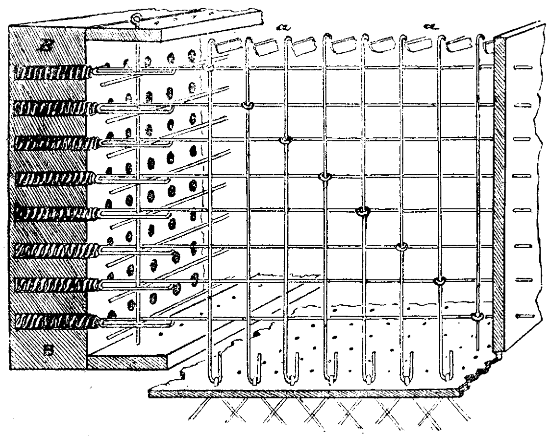

FIG. 16A

the number of hooks it contains, the greater is the variety of shedding that can be produced by it.

If a jacquard is made small, with, say, from 16 to 48 hooks, it is called a dobby or shedding motion, and is used for working shaft mountings; but the ordinary jacquard machines have from 200 to 600 hooks, which have long cords, called the harness, connected to them, no shafts being required, as each hook has only a few cords tied to it, which can be raised independently of the others. The fewer the cords that are tied to each hook, the greater is the variety of shedding that can be made on the same number of warp threads, till, when there is but one cord to the hook, any thread or any number of threads can be raised independently of any of the others.

Jacquards may be divided into four classes—viz. single-acting, double-acting lift, double acting with double cylinders, and twilling jacquards ; and besides these there are several other varieties made for special purposes. The single-acting is the real jacquard, and much the simplest machine. It has the disadvantage which all single-acting shedding motions have—viz. that one shed must be closed before the following one begins to open. This is on account of the same lifter having to open each shed ; it must bring down the set of hooks that are raised, and then raise the next set.

This constitutes the true jacquard lift ; and while it makes a clear shed, and is desirable for some purposes, it is generally considered the most imperfect form of shedding—that is, so far as the making of a good cloth is concerned. It is not suitable for making a heavy, well-covered cloth, nor for working at a high speed, 120 to 140 picks per minute being a very good speed to drive it.

A single-acting jacquard is a very simple machine, and when properly made should give very little trouble in working, particularly if the motions are properly set in relation to each other, and if such methods of working are adopted as will cause the least wear and tear on it.

In whatever way jacquards are made, the principle of working is much the same. There are a number of upright hooks set in a frame ; attached to each hook is a horizontal wire or needle, one end of which is pressed upon by a spring, which keeps both it and the hook steady and in position, while the other end, or point, passes through a perforated plate, beyond which it projects about half an inch (see Fig. 16A). To lift the hooks there is a set of bars or knives arranged in a frame, just below the heads of the hooks ; this frame is called the 'griffe' or 'brander,' and if raised would draw all the hooks up with it. What hooks will be lifted for each shed is regulated by perforated cards being pressed against the points of the needles. A perforation in the card allows the point of a needle to pass through and the hook to be raised ; but where there is no perforation the card comes against the point of the needle, pressing it back, and holding the head of the hook clear of the blade of the griffe, so that the griffe will pass without raising the hook. It will thus be seen that any variety of shedding can be made by punching the cards to suit it. Fig. 17 shows one of the best makes of single-acting jacquards. One of the best methods of driving is shown in this and the following figure. The griffe is raised by means of the lever G, which is sometimes supported on a beam fastened to the roof or pillars of the shed, or it may be supported by an upright fastened on the frame of the loom. A portion of this upright is shown in Fig.

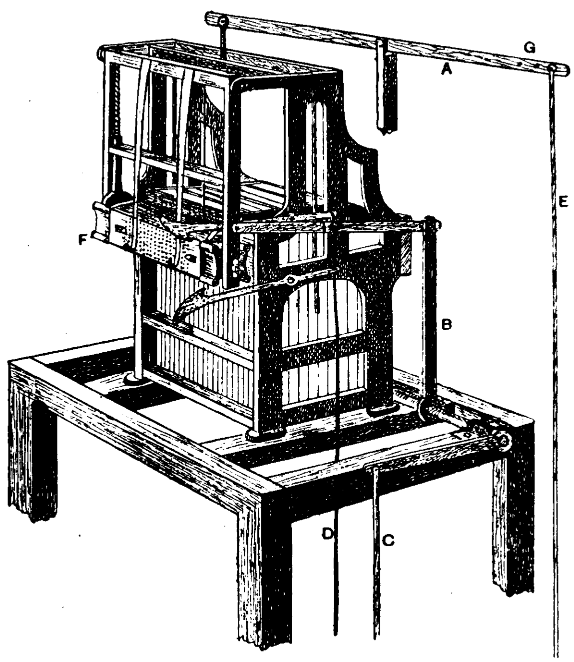

Fig. 17

17, and as well as being fastened to the loom frame, it should be stayed to the top of the machine. One end of the lever is fastened by a link connection to the centre of the bar across the griffe frame, care being taken that the connection is so made as to draw up the griffe vertically, and not have any strain on the slide rods or spindles that are used for keeping the griffe horizontal when rising.

The other end of the lever is connected to a crank on the crank-shaft of the loom by a rod, E (Fig. 17); also shown at A (Fig. 18), where the crank is also given.

In hand-loom machines the griffe is frequently pushed up from below instead of being drawn up from the top as is shown in Fig. 17. The method of doing this is similar to that given for lifting the griffes of twilling jacquards.

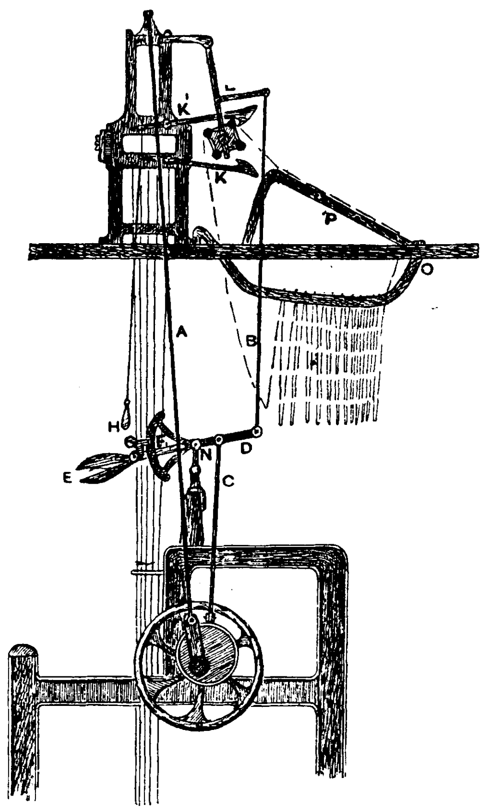

Fig. 18

F (Fig. 17) is called the cylinder or barrel, evidently taking its name from the round cylinders or barrels used in the old machines, but is in reality a square prism. It is made of wood, and perforated on each side with a set of holes—a hole for each needle in the machine; its use is to draw round the chain of cards and press each one against the needles, or horizontal wires, in the machine. In order to keep the cards firmly on the cylinder, flat steel springs are sometimes used, as shown, attached to the top rail of the frame which holds the cylinder; and there are also steel wires which pass down in front of the cylinder over the ends of the cards. These springs are useful when only a small number of cards is used and the machine driven quickly; with a large set of cards, where there is plenty of drag on them from their own weight, they are not necessary, and but seldom used; but they are in common use in the Yorkshire districts.

It will be seen from the illustrations (Figs. 17 and 18) that the cylinder hangs in a frame suspended from the top of the machine ; this is called the swing or batten motion, to distinguish it from the horizontal or sliding motion which is shown at Fig. 20 (No. 1) and in Fig. 27. The swing motion is the simpler of the two, and is cleaner, requiring less oil ; but the sliding motion is steadier, and does not swing the cards so much, consequently is more suitable when the cylinder has to travel quickly. The swing motion also requires the machine to be higher ; with a slide motion the frame is usually cut off a little above the griffe.

The cylinder has to travel out and in when the machine is working, so that it may be turned round and bring a fresh card against the needles for each shot. There are many methods of accomplishing this, which may be divided into two classes—viz. independent motions, or those which are driven from the loom independently of the machine ; and self-acting motions, or those which drive the cylinder out and in through the rising and falling of the griffe. The latter are the simpler, but the former are much better, causing less wear and tear on both the cards and machine, as will be explained further on.

It will be seen in Fig. 18 that as the cylinder travels out it will be caught by the hook K^1, and turned round ; the head or lantern of the cylinder is made of iron, as shown, so that the hook, or shears, will take a firm catch on it. To prevent the cylinder from turning more than one card at once, and to keep it steady so that it will always come in fair against the needles, it is held firm by a hammer pressed on it by a spring. This pressure is applied in different ways, one of which may be clearly seen in Fig. 17, and another in Fig. 27. When taking out the cylinder, or wanting to run it round quickly to draw over a number of cards, the hammers can be held up by a hook or sliding catch, which should be fitted to the machine for the purpose.

One of the best independent motions for driving the cylinder is shown in Fig. 17 ; and that shown in Fig. 18 is also a very good one for small machines, perhaps the most convenient that is made ; but the former is much stronger. In Fig. 17 a connecting-arm from the frame of the cylinder is attached to the lever B. The connecting-arm should have a slotted joint, so that it can be made shorter or longer, if required, for the purpose of regulating the pressure of the cylinder on the needles.

The lever B is on a horizontal shaft, bracketed to the frame of the loom, or to the beams on which the machine rests; or some machines have bearings attached to their framing for it. There is, of course, a lever, as B, and a connecting-arm at each side of the machine. There is another lever on the end of the shaft, at right angles to B, which is connected with an eccentric on the crank-shaft of the loom by a rod, C, in the same way as the rod C is connected with the eccentric in Fig. 18. The eccentric can be set to bring the cylinder against the needles at any required time, independent of the lifting motion of the machine, which cannot be done when the self-acting motions are used. The

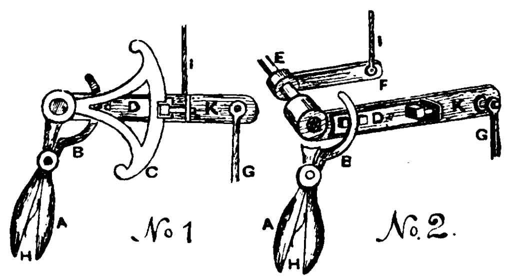

FIG. 19

larger the eccentric, the greater dwell the cylinder will have against needles. The method of working the cylinder in Fig. 18 is somewhat similar, and can easily be seen; but it will be observed that a good deal of pressure will be put upon the studs on which the cylinder frame, or batten, hangs, particularly when the cylinder is being pressed in, as this is effected by drawing down the lever L; however, in a light machine this does not matter much.

The principal feature in this motion is the escapement apparatus for the purpose of disengaging the cylinder from its connection with the driving eccentric when it is required to turn some of the cards back. Fig. 19 (Nos. 1 and 2) shows this arrangement. The motion is not quite the same as that given in Fig. 18, but is on the same principle, and one may be easily understood from the other. In Fig. 18 the latch G comes out of the notch in the quadrant F, when the handle E is pressed close; the handle is on the lever D, having its fulcrum on the shaft N, and the quadrant F is connected to the eccentric rod C. The quadrant is loose on the shaft, and the lever is fast on it. Fig. 19 is a more convenient motion. The two halves of the handle A are held apart by the spring H, and this, through the hook B on the inner end of the handle, presses the latch or catch on the slide D into the notch on the quadrant C. The quadrant and handle are one piece, and are fast on the shaft E, and a lever F on this shaft is connected to the batten of the machine, in the same manner as shown by D and B in Fig. 18. When there are two or more machines, one of these levers would be required for each. The lever K is loose on the shaft E, and the rod G connects it with the eccentric, same as is shown by the rod C in Fig. 18. In No. 2, Fig. 19, the quadrant is left out to show clearly how the hook B acts on the slide D, and also to show the lever K on the shaft. The two halves of the handle, being pressed out by the spring, keep D in position, firmly pressed inwards; but when the handle is pressed the hook B presses the slide D outwards, leaving the quadrant free to pass up or down; and by pulling down the cord H (Fig. 18), which raises the shears K and K^1, the cards can easily be turned back by working the handle up and down, as the under shears will catch the cylinder and turn it the reverse way. The weaver must be careful not to jerk the motion and throw the cards off the cylinder or damage them; but a very little practice will enable anyone to turn them back quite easily and quickly. This motion answers very well for one, or perhaps two, small machines; for a 400 or 600 machine, or any smaller size working spottings, &c., it is very convenient, but when large mountings are required, as in 800 to 2400 machines, it is quite too weak for the work; even if made strong enough it would not be satisfactory, as the strength of spring that would be required to bear the strain and keep the catch in the notch would make it a very difficult matter to use the motion for reversing the cyiinder. For heavy machinery the method of working the cylinder shown in Fig. 17 is far preferable, and separate motions for turning back the cards can be fixed on the machine. These will be explained further on.

Instead of the eccentric and crank for driving the cylinder and raising the griffe being as they are shown in Fig. 18, though a plan frequently in use, it is neater, and perhaps better, to have the eccentric at the back of the fly-wheel, and the fly-wheel either cast with one half solid, or have a plate fastened across two or more of the spokes, to which the connecting-rod can be attached with a bolt fastened in a slot. The amount of lift can be increased or diminished, either by shifting the top of the connecting-rod along the lever G (Fig. 17), or by increasing or reducing the throw of the crank at the fly-wheel.

Self-acting motions actuate the cylinder through the rising and

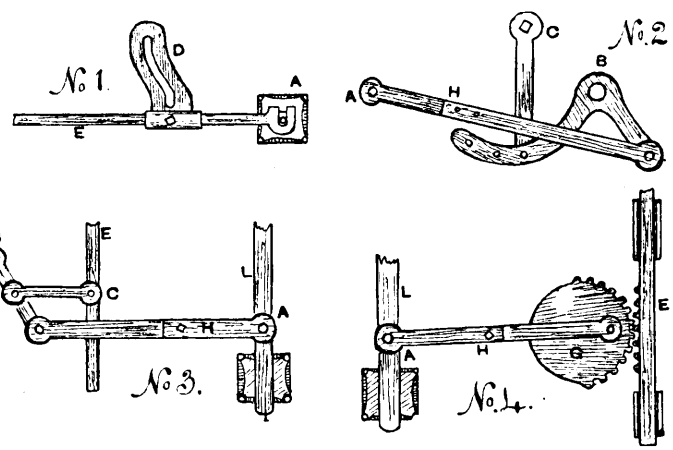

FIG 19A

falling of the griffe without requiring any special connection from the loom. One of the most convenient of these is that frequently used on hand-loom machines, and known as the S iron or swan-neck motion. It is shown in Fig. 19A (No. 1), and another form of it on a swing cylinder motion is shown in Fig 16. D is the swan-neck or S iron. In the groove in it a roller stud on the griffe frame travels, sliding in and out the cylinder A as the griffe falls and rises. E is the slide bar, which may be flat or round; if round, there must be some means of keeping it from turning in its bearings, which is generally accomplished by having a crossbar bolted across the two slide bars behind the machine.

No. 2, Fig. 19A, is a motion for the same purpose, but consists of a series of levers; and No. 3 is an arrangement of a similar nature. B is the fulcrum of the levers, or fast pin by which they are connected to the machine. C shows the attachment of the levers to the slide rod of the machine. A is the connection with the cylinder frame. As the griffe rises or falls it will easily be seen that the cylinder will be driven out or in.

The connecting-bar H is in two parts, slotted and bolted together at H to admit of regulating the position of the cylinder.

No. 4 is a motion on a different principle; it is a French motion. It will readily be seen that the cylinder is driven out and in by the toothed wheel, which is wrought by a rack on the slide rod E. This slide rod works outside the framing of the machine, as is common in the French machines. One point must be observed about these motions—viz. that they must have a certain amount of dwell at the bottom of the stroke, or when the cylinder is in. The reason of this dwell will be explained further on, but the method of obtaining it may be given here. In the swan-neck motion (No. 1), any desired dwell can easily be obtained at either top or bottom by the length of the slot that is in a vertical direction, as when the stud is passing through this portion of the slot no motion is given to the cylinder. In the lever motions Nos. 2 and 3, as well as in No. 4, the dwell is got by the levers or arms passing the centres; in Nos. 2 and 4 it is by the lever or arm H passing the back centre, which may be considered as a crank; and in No. 3 it is the short lever C passing the centre that gives the dwell.

Fig. 20 is a view of the interior of a single-acting jacquard machine with the framework removed; only one row of hooks and needles are given, to avoid confusion. The blades or knives of the griffe, with a support running across their centres, are shown at B. A is the face-plate or needle board, sometimes made of iron, but better to be of hard wood. C is the spring-box, the detail of which is given in Fig. 24. E, E^1 are the hooks, and F, F^1 the needles. D is the grating through which the hooks pass, and are supported by it. It will be seen that the hooks and needles are arranged in rows of eight: a 400 machine would have 50 or 51 of these rows in it; 500 machines are usually arranged in rows of 10, and 600 machines in rows of 12. The hooks should be set perfectly upright or vertical, and should be close up against the knives, but not pressing against them. There should be a provision made for shifting both the grating and the knives, so as to admit of both them and the hooks being properly set in relation to each other ; but if set correctly by the maker, which they should be, no alteration is necessary. A (Fig. 21) is a side view of four hooks and needles, with the ends of the knives of the griffe shown at *a*, *a*, *a*, *a*.

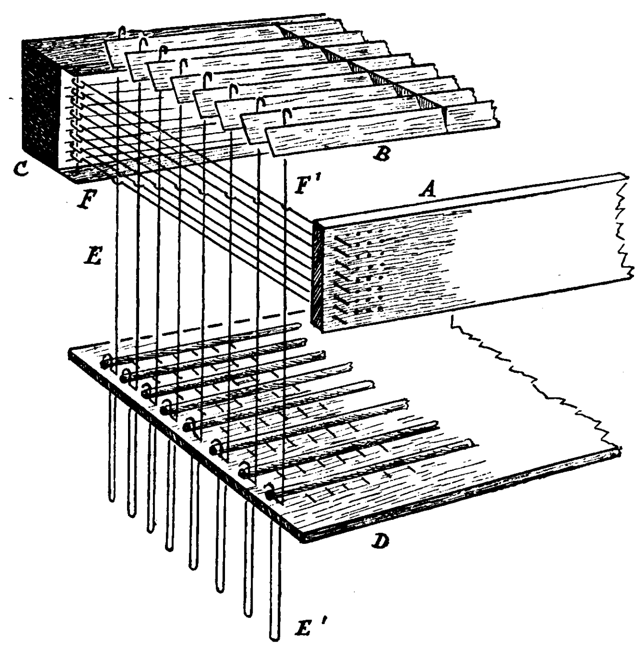

Fig. 20

When the machine is working the needles are acted upon by perforated cards cut from the pattern. Suppose we take plain cloth—that is, a pattern in which each half of the warp, or every alternate thread, is raised and sunk alternately ; then, if the first card acts on all the odd numbers of the needles, and the second card on all the even numbers, this repeated would make plain cloth. Whenever a hook of the jacquard is to be raised a hole is cut in the card for the needle connected with that hook, and a card with all the even numbers of holes cut in it will cause the griffe to raise all the even-numbered hooks. Refer to *b* (Fig. 21), where the second and fourth holes are cut in the card. If the card is pressed against the needles, as at *c*, the first and third needles will be pressed back, and will push the first and third hooks back from their position—shown by the dotted lines—to the position in which they are shown in B (Fig. 21); but the second and fourth hooks are not moved, as their needles pass through the holes in the card. If the griffe is now raised, the blades or knives will pass the

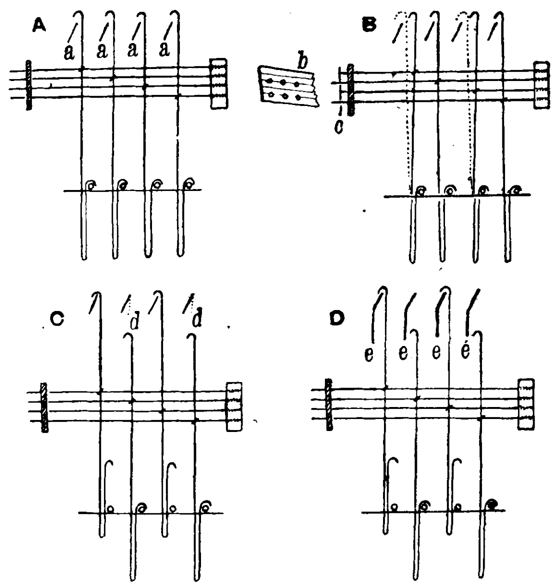

Fig. 21

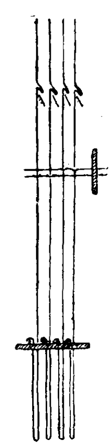

Fig. 22

first and third hooks, but will lift the second and fourth; and if the odd numbers of holes are cut on the next card, the first and third hooks will be lifted when it is pressed against the needles, as shown at C (Fig. 21), thus making the cross-shed; and this explains the principle of working any pattern by the jacquard without taking into consideration the intricacies of mounting, &c. In C (Fig. 21), it will be seen that if the knives *d*, *d* were upright instead of slanting, they would come down on the heads of the hooks that are under them, but, being slanted, their lower edges pass the heads of the hooks, and press them away as the griffe descends. Sometimes, even with slanting knives, if there is much vibration in the hooks, or if the loom 'bangs off,' some of the hooks are liable to get under the knives and be 'crowned,' or bent down. To avoid this deep blades are often used, principally in double-acting machines, so that the lower edges of the blades will not pass the bottom hook, as shown at D (Fig. 21). This prevents any danger of crowning, but it darkens the machine a little—that is, makes it more difficult to see down into it if any of the wires require to be examined; it also requires the heads of the hooks to be somewhat higher above the heads of the needles than is necessary with the narrow blades. Another principle has been tried—viz. that of making the heads of the hooks as shown in Fig. 22, and using narrow blades. This effects its object well, but there is too much friction of the knives against the hooks, and the latter are liable to wear out too quickly. A good machine with firmly set hooks should work very well without these protections if it is steadily placed above the loom, and it is better not to be resting on the loom framing, if convenient to have it so. It will be seen from the foregoing explanation that the proper time, or, rather, the necessary time, for the cylinder to press against the needles is just after the griffe begins to rise. When the griffe is down the top edges of the knives should be $\frac{3}{16}$in. or $\frac{1}{4}$in. lower than the turned points of the hooks, and before this edge rises up to the hooks those that are not to be lifted should be full back, or the cylinder should be close in, having the front of the head of the hooks $\frac{3}{16}$in. or $\frac{1}{4}$in. behind the blades. The cylinder should have a short dwell in this position; and if it has a longer dwell it may assist to reduce the friction of the heads of the hooks against the knives; but if it has too great a dwell it may have to travel out and in too quickly to make up for the lost time, which will probably not be compensated for by the advantage of the increase in the dwell. Now, when the cylinder is driven with an independent motion, as in Figs. 17 and 18, it is easy to set the eccentric so that it can be brought in at any required time; but when a self-acting motion is used, it is plain that if the cylinder must press against the needles when the blades of the griffe are passing the heads of the hooks in rising, it must also press against them in the same position when the griffe is falling, unless some special escapement motion could be devised to avoid it, and this is where the dwell is required, and where the evil effect of the motion takes place; and it is worse in a double-lift machine with one cylinder, as the heads of the hooks in it are larger, or have a longer turn on them. A little consideration will suffice to show that when the brander or griffe is falling, say, with one-half of the hooks hanging on its knives, and the cylinder is brought in against the needles before the hooks are quite down, as it must be, it will either cause the hooks to be shot off the knives, or will put a considerable strain on them, as well as upon the needles and cards. It is for this reason that these motions are objectionable, particularly in power-loom work, where the speed is high and the hooks are strong. In hand-loom work it is not so objectionable, as there is more spring in the wires, and the heads of the hooks need not be too large, and, besides, the speed is less and the wear and tear not so great; but, even with this, if a hand-loom machine that has been in use for some time be examined, it will be seen that the points of the hooks are considerably worn, and that the edges of the knives are hollowed out like a coarse saw by the friction of the hooks on them. This latter will partly arise from the lifting of the hooks.

In the old Jacquard, given in Figs. 15 and 16, the hooks are shown resting on a perforated board, and it was mentioned that in order to prevent them from turning round a frame lay in the turned-up portion of the hooks. The grating in Fig. 20, through which the turned-up bottoms of the hooks pass, readily accomplishes this object. Sometimes flattened hooks are used, as in c (Fig. 23), with the needles twisted once or twice round the hooks; this makes a firm arrangement, but if anything goes wrong with a hook it is not easy to get it clear of the needle. When the needles were made with a full twist or loop on them, as at B, the same was the case; they are now usually made as at A, and if arranged in the machine as in Fig. 20, there is no danger of the hooks sliding out of the recess in the needle, and if a hook gets bent or broken, it can be taken out and replaced by a new one without disturbing the needles.

Fig. 16 shows how the needles press against the springs in the spring-box, which is much the same as that at present in use. Fig. 24 is the present arrangement. No. 1 gives a plan of the end of a needle, B. C C is the horizontal wire which supports it as shown in section at C C in No. 2. D (No. 1) is a section of the vertical wire shown at D D (No. 2), which passes through the loops or eyes on the ends of the needles, and keeps the springs from shooting them too far forward. A (No. 2) is a wire which passes down at the outside of the box over the ends of a row of springs, so that by drawing out this wire any of the springs can be drawn out without taking off the spring-box,

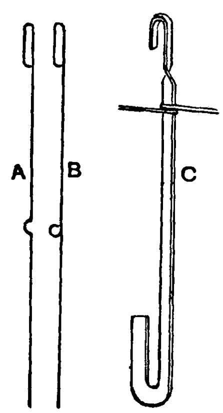

FIG. 23.

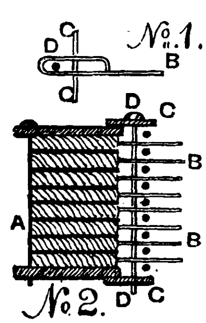

FIG. 24

as the springs pass through the box. The springs should be strong enough to keep the hooks and needles steady, but if unnecessarily strong they give the card and cylinder unnecessary work.

In some machines there is no spring-box. The hooks are made double, as shown in Fig. 25, and rods, as *a*, *a*, run along between the rows of hooks; the spring of the double wire keeps the hooks steady. There is a clap-board used, similar to that in the French draw loom, (Fig. 13), which is pressed against the needles with springs; this board is connected with the face-plate by a bar at each end, forming a frame. The needles do not project much through the face-plate, but when the cylinder is pressed against it, it slides back on the needles, and presses the clap-board back, which also allows those needles to go back which the card presses against. The needles are not looped on the hooks, but have a turned catch in front of them as shown. The bottom of the hook rests on a hole board, C, through which the tail cords pass; and through the hooks at D are wires fixed in a frame which rises and falls when the hooks are raised, and keeps them from turning round, same as explained in Fig. 15. Machines of this description are at present being made in France, and work with a rising and falling shed, which will be hereafter explained (see Fig. 30).

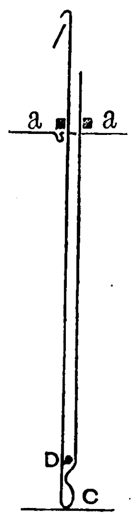

FIG. 25

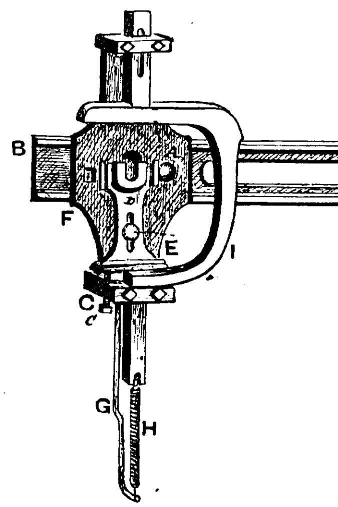

FIG. 26

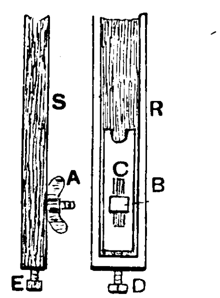

FIG. 27

In working, the card cylinder must be so set that it will come forward fair on the needles—that is, that when it comes forward the points of the needles will enter fair into the centres of the holes in it. For the purpose of setting it there must be provision made in the fittings so that it can be moved laterally or vertically. In the swing motion the frame can be moved laterally by means of the two screw studs on which it hangs. C, Fig. 27, shows the bearing on which the stud of the cylinder revolves. This bearing can be raised up or down in the frame R—a side view of which is given at S—by slackening the bolt B with the wing nut A, and adjusting the bearing with the set screw D or E.

A method commonly adopted by tacklers or tuners to see that the needles are perfectly fair in the centres of the holes in the cylinder, is to rub their fingers on some dirty oil, and touch over the points of the needles with it. They then bring in the cylinder against the needles with a card on it, in which about half of the holes are cut. The points of the needles mark the card where there are no holes, and it can easily be seen whether the mark is in the centre of where a hole should be, or not.

One of the best bearings and attachments for a cylinder with a horizontal slide motion is given in Fig. 26. D is the bearing for the cylinder E, and C the bolts for setting it. F F is the bracket which holds the hammer and bearings, which can be set in position on the slide bar B by the bolt A. I is the hammer held down by the spring H attached to the rod G.

The cards are kept in position on the cylinder by pegs or studs, originally made of wood, and driven into the cylinder. Now they are made of brass, and set in a slotted bracket, so that they can be shifted in order to have the holes in the cards corresponding exactly with those in the cylinder. The pegs should also be set on springs, so that if a card gets off them, and between them and the needle plate, they will yield or sink into the cylinder, and not break the card. In all good machines they are made in this way.

When the motion for driving the cylinder is not fitted with an escapement for the purpose of turning back the cards, it is necessary for the convenience of the weaver to have a motion on the machine for the purpose.

Figs. 28 and 29 show two varieties of these motions. A is the cylinder head; C, the catch for reversing the cylinder; F, the spring for returning the catch to its position; E, a cord which hangs down, with a knob on the end of it, in a convenient position for the weaver to catch and work the motion. In Fig. 28 the motion is on the opposite side of the machine to the shears, but might be on either side, and the weaver has to raise the shears to turn the cylinder, which she can easily do by catching the knob for raising the shears in one hand, and working the reversing motion with the other. The cylinder must be full out for this motion to turn it properly, and this prevents the weaver from tearing the cards on the needles, as she might easily do by trying to turn the cylinder when it is too close in. In Fig. 29, B is the shears for turning the cylinder, and both it and the pushing catch, C, pass through a keeper or bracket, D, on the side of the machine. There is a rise on C a little back from the point, and when the cord E is pulled down C is shot forward by the lever, which has its fulcrum at G, and in going forward the rise on it comes into contact with the bend in the shears, and raises them up so that it can turn the cylinder when it catches on the head of it. Both these are good and convenient motions. For the latter the cylinder should be about half-way out when the cards are being turned back.

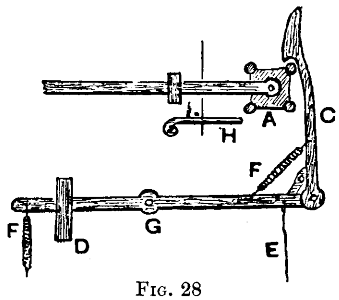

FIG. 28

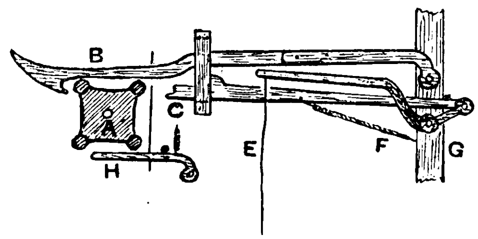

FIG. 29

Sometimes the cylinder may not be completely turned by the shears when the machine is working, by reason of the cards catching, or if the shears are too long, or it may arise from other causes. In this case the cylinder would come in with one corner against the needles, and be pressed heavily against the needle plate. Some of the levers would probably be broken, or the cylinder might be shot out of its bearings and fall, breaking the yarn, or perhaps injuring the weaver. To avoid this, small snecks, as at H, Figs. 28 and 29, are set so that when the cylinder is square it will pass over them; but if turned angularly its lower edge will catch on the point of the sneck, as the cylinder is coming in, and turn it square. The sneck is held up with a spring so as to allow the cylinder in turning to depress it. Sometimes the sneck, as at H, is liable to cause broken shots; for if the weaver turns back the loom, and the cylinder moves out sufficiently far to be turned to its angular position, and remains there, it will, in coming in, be turned square by the sneck, and thus a card would be passed over without a pick being put in for it. This is sometimes remedied by putting the sneck above the cylinder, instead of below it, which would turn it the reverse way; but this might come wrong at other times. The better plan is to keep it below, and let the weaver get to understand what she is doing, as it is not very difficult to learn.

The setting of a jacquard machine for working consists in adjusting the cylinder motion so as to bring in the cylinder at the proper time, and press it sufficiently close against the face-plate to keep the hooks clear of the knives of the griffe, without pressing it too close; and regulating the lifting of the griffe to suit the time for shedding, and to give the size of shed required. The shed must be open for the shuttle to pass through; the time for picking is when the cranks of the crank-shaft of the loom are at the bottom centre, therefore the shed should be almost fully open at this time. The lifting of the griffe can be made a little earlier or later to suit circumstances, but very little alteration can be made, as it takes a full revolution of the crank to raise and lower the griffe. Further consideration will be given to jacquard shedding after double-acting machines have been explained.

The motion for working the cylinder, if an independent one, should be rigid and strong; for if there is any spring in it, though the cylinder may be brought in sufficiently close when there is much cutting on the card, if a blank card or one with very little cutting on it comes on, the extra pressure on the needles, especially with a large machine, may prevent it from getting in sufficiently close to clear the hooks from the griffe. With self-acting motions there may sometimes be some trouble in this way, as the weight of the griffe may not be sufficient to press in the cylinder. In this case the griffe may be weighted, or may be allowed to drop quicker, or the lifting rod and lever may be made to assist in pressing it down somewhat.

Before starting the machine the needles should be examined to see that they are all free, and that they will spring out easily after being pressed back. The griffe should be perfectly horizontal and all the knives properly set; the holes in the cards and cylinder should exactly correspond, and when the cylinder comes in the needles should be fair in the centre of the holes; if not, the cylinder must be set as described (see description of Figs. 26 and 27).

The driving of heavy single-acting jacquards will be further considered under Twilling Jacquards.

When any of the hooks or needles in a jacquard get bent or broken, they can easily be straightened, or taken out and replaced by others. By putting a thin blade of iron or wood down through the needles alongside of the hook to be replaced, and springing open the passage, the old hook may be drawn out and a new one put into its place. The tail cord must, of course, be cut off the bottom of the hook, and a new one tied on. For changing a needle take off the spring-box and draw up the pin which fastens the row of needles at the back; then the needles in this row may be taken out till the defective one is reached, and the row made up again; or, the old one may be renewed without taking any of the others out. A flat blade is used to slide through the hooks and keep clear the place for the needle to be put in.

Card Frames.—The cards for jacquard work are usually hung on a frame as O, Fig. 18, wires sufficiently long to catch on both sides of the frame being tied to the lacing of the cards. The number of cards between each wire may vary to suit the space and the quantity of cards. Sixteen to twenty suit very well, the former for small and the latter for larger sets, and for very small sets twelve or fourteen might be more convenient. The frame may be made of round iron rod, or of flat or bar iron, and should be of the shape shown in the sketch, and not semicircular, as is usually the case, which presses the cards together in the centre; almost flat at the bottom, with just enough of a slope to make the cards slide back, is much the best. Of course, for a few cards it does not matter much what shape it is. P (Fig. 18) is the frame for the rollers over which the cards travel to the cylinder. They should be so sloped as to make the cards travel up nicely with sufficient drag on them, and not too much; on this depends a good deal the proper working of the cards, particularly when the machine is running at a high speed, and when springs are not used to steady them on the cylinder. It is usual to have a roller below the cylinder, attached to the frame which holds the cylinder, and the falling cards pass over it. Sometimes the cards, when falling, are shaken, so that some of the wires may not catch on the frame, but pass through it, or the ends of some of the wires may be bent and cause the same result; if the weaver neglects to put these up on the frame before the cards work round to those that have fallen, the wire may catch on it and prevent the cylinder from turning, or, perhaps, pull it out. Sometimes a crank or bend is made in the frame at the outer end, so that the wires can pass up through it without catching. The frame should just be sufficiently wide to enable the cards to pass freely through it with, say, one-eighth of an inch clearance at each side; then, if three or four inches at the outer end is cranked, or set out so as to be a little wider between the two bars than the length of the wires, they will pass up through without catching. Frames of the shape described are, of course, only suitable when the cards are to be wrought forwards—that is, with the cards falling between the cylinder and the machine; but if they require to be wrought both backwards and forwards, as is sometimes the case, the card frame must be made more of a semicircular shape, and the rollers must be set so as to give a sufficient fall to the cards, and keep them firm on the cylinder.

As has already been said, the nature of the shedding of a single-acting jacquard is objectionable for speed in working, for ease on the yarn, and for heavy work, or for well-covered work. The jacquard harness is levelled so that the yarn is all sunk, and the shed is entirely a rising one; it can easily be understood that when the griffe rises to open one shed, it must again fall before it can begin to rise to form the next shed. Now, mostly all tappet motions, and a great many dobbies or shedding motions, either have the yarn springing up and down from the centre, or have one portion rising and the other portion falling at the same time, so that in them the second shed could be open at the same time that the griffe in the single-acting jacquard had fallen to begin to rise the second shed; but as this would be much too soon, they can take a greater time to accomplish the work, and thus have a much slower and steadier motion.

It has been attempted to work the single-acting jacquard on the centre-shedding principle, and machines are at present being made in France of this class. It is only necessary to let the board on which the upright hooks rest fall at the same time that the griffe is rising in order to accomplish what is required, and the method of working is good, and would suit well in dobbies where the heddles can be taken firmly down. But in the jacquard the drawback is in the harness:

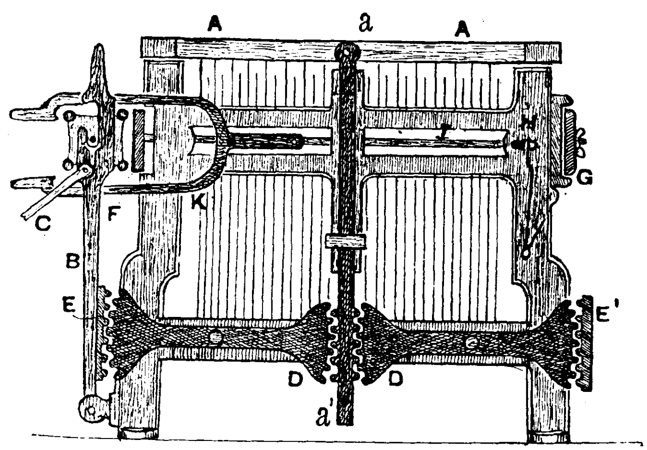

Fig. 30

the constant rising, and falling causes a vibration in it, and does not admit of nearly so firm work as when the rising shed alone is used.

One of these machines is shown in Fig. 30; they are a very compact and neatly made machine, and contain a much greater number of hooks than one of the English machines. Fig. 26 gives one of the hooks in this machine, and the way in which it acts is there explained. It will be seen that the frame for the cylinder is inverted; F is the face-plate or needle board as it rests when the cylinder is not pressing against it, being held in this position by the spring H pressing on a stud on the bar I, which extends from the face-plate to the clap-board G. The cylinder frame is driven by a rod, C, connected with a lever. E, E^1 are two racks on the ends of the hole board on which the hooks rest, and D, D are two levers with quadrant racks on each end, which work into the racks E and E^1, and also into the racks on the slide bar a^1. This slide bar is fastened to the griffe A A, which is raised by a connecting-rod from a horizontal lever to the stud a. As the griffe is raised one end of the racked levers, D, is also raised, and the other end sinks, taking down the hole board by pressing on the racks E and E^1. The hole board is fixed so that it will easily slide up and down. If the griffe is raised two inches, the hole board falls rather more than one inch.

This is a very good motion, perhaps could not be surpassed for the purpose, but, as I said before, has the objection which all similar contrivances for the purpose must have—viz., causing too much vibration in the harness. All the cords constantly dancing up and down causes an unsteadiness and swinging that is not to be found in the ordinary jacquard harness. These machines have sixteen rows of needles in them, which are much closer set together than those in this country, and give a large number of hooks in a small-sized machine, which is a great advantage when extensive patterns are required. In this machine the half-card contains 440 holes, or 880 holes to the full or double card. The pitch is shown at A, Fig. 31, which represents the end of one of these cards, and a piece of one of the usual 8-row cards as here used is shown at B for contrast, the black dots in both cases representing holes.

These machines have not been adopted here, nor is it likely that they will be, although they are said to work well in France. They have been tried here, and the difficulty lay in setting the cards properly so as to act correctly on the needles, and keeping them so for any length of time. The least contraction or expansion of the paper, or any irregularity in the cutting, any bend in the points of the needles, or, in fact, anything but perfect exactness, interferes with the working: there is too great compactness in the machine, and in the ordinary wear and tear of work a little allowance is necessary for success. Considering that these are working, it would appear that the pitch and size of the holes in our cards are unnecessarily large, except where small machines answer and saving of space is no consideration ; in that case the extra paper required for the cards might be more than compensated for by the strength of the machine, and the saving of trouble in attending to it.

The method already mentioned of getting over the disadvantage of the single-acting jacquard is not likely to gain general favour, and is not required, as it is surpassed by the double-acting jacquard, or that in which there are two griffes, one rising when the other is falling, forming a counterpoise as well, making the shed more after the

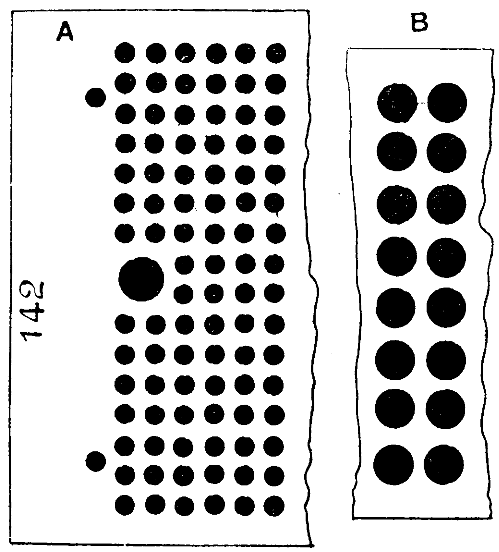

Fig. 31

principle of ordinary tappet shedding. In a loom fitted with a single-acting jacquard, if there is much weight to be lifted, it will turn round the loom so that it will rest in no position but with the griffe down, and this is frequently of so much annoyance to the weaver as to necessitate a counterpoise being applied to balance it. Sometimes weights are used, and sometimes springs. With the double-acting lift nothing is required, and this was first used in Cross's counterpoise harness (about 1816).

In the double-lift machine there are double the number of hooks that there would be in a single-lift machine of the same size, but the same number of needles; each needle is connected with two hooks, as shown in Fig. 32, which gives one row of hooks and needles for an 8-row or 400 machine. There are two griffes, one working above the other, as shown at A and B, Fig. 33. E, E is the top griffe in both; C, C is the bottom griffe, shown complete at A, but at B the side-bar of the frame is omitted, leaving only the knives to show how they fall in between those of the bottom griffe; D, D[1] are the two slide rods or spindles which keep the griffes steady in their traverse. There must

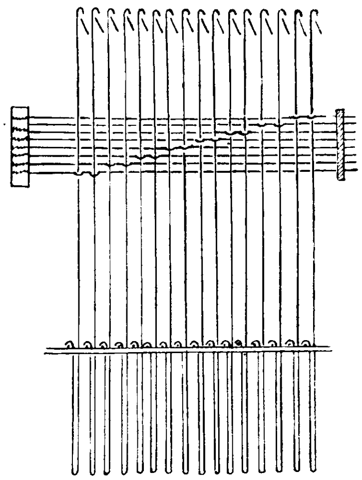

FIG. 32

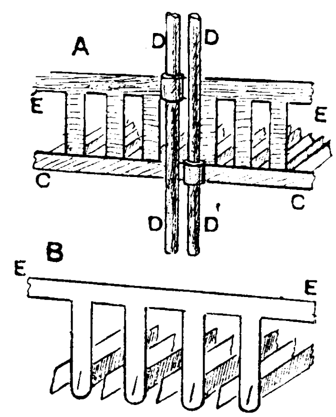

FIG. 33

be a sufficient space between the frame C of the lower griffe and that of the upper griffe, E, to allow of the required draw being given to form the sheds without them coming into contact. In these machines, although there are 16 hooks in the row, they only act as eight, so far as forming the pattern is concerned, as two hooks are governed by one needle; the additional hooks are solely for the purpose of obtaining a rising and falling shed. Each pair of hooks is connected together at the bottom by a piece of strong cotton cord, called the tail cord or tug cord, as shown in Fig. 35. The griffes are raised by two levers arranged side by side, and similar to the one shown in Fig. 17. These levers are wrought by rods connecting them to a double crank, or sometimes to a tappet, on the tappet shaft of the loom. The common form of crank is shown at A, Fig. 34. B is the tappet shaft, and on the end of it is fastened a disc. A second disc, which carries the double crank, G, is bolted against this one, and can be shifted to whatever position is required to give the tread at the correct time. The cylinder is driven from an eccentric on the crank-shaft as before described. One of the griffes rises for each shot, the other falling at the same time; but the cylinder must come in for every shot, and it is here that the principal fault in this machine lies. Not only has the cylinder to travel at a high speed, but when one griffe is at its highest position, it has to press against the needles, so as to clear away

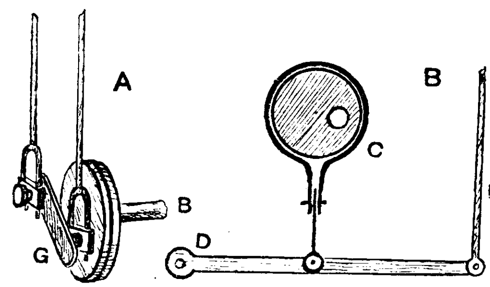

FIG. 34

those hooks that are not to be lifted by the lower griffe, which should now be beginning to rise; and in consequence of the needles being attached to two hooks, one belonging to the upper griffe, and the other to the lower one, it follows that those needles that are pressed in by the cards have to spring back the hooks connected with them that are raised by the upper griffe, which is a severe strain on both needles and cards. To prevent the hooks being pushed off the upper griffe, they must have larger turns on them than would otherwise be necessary.

Fig. 35 shows how the raised hooks can be allowed to yield to the pressure of the needles. A, B, C, D are four hooks connected with two needles, 1 and 2. When the hook A is raised, if B, which raises the same warp—as will be seen by the connection of the tail cords with the harness at E—is not to be raised for the next shot, the needle 1 is pressed back by the card, and presses the hook B back from its knife as shown, the dotted line being its original position; the A hook, being connected with the same needle, must also be sprung back, but its head cannot get back, as it is held on the blade of the griffe, so that the wire would require to spring, if some escape were not made for it. The lower ends of the hooks are made V-shape in the grating, so that when raised, if pressed on by the needles, they can move forward as shown, the dotted line showing the original position of the hook A. When the hooks fall, they fill the slots in the grating, and are thus kept steady. G shows the tail cords as connected with the harness when both hooks are down; E shows them when one hook is up and the other down, and if the hook B was raised for the next shot, the tail cord on it would be tightening up as that on A would be falling, and the harness attached to them would be caught up a second time from the middle position, thus forming centre shedding with any portion of the harness that is raised several times in succession. With plain-texture cards the upper and lower portions of the shed would pass each other in the centre when the sheds are being reversed, all the even numbers of hooks being on one griffe, and all the odd numbers on the other.

The tail cord consists of two pieces of cotton cord, one fastened to each hook of a pair, then the two ends are together tied to the bunch of neck twines that are to hang from these hooks, as shown in Fig. 35, and at A, Fig. 36. When one hook is raised and the tail cord drawn up with it, the other portion of the tail cord, which is tied to the other hook, is slackened—as shown at A, Fig. 36—which causes a certain amount of friction on them. Also, when one hook of the pair is falling with the descending griffe, and the other hook rising, the pluck occasioned thereby on the cords, when the hooks are passing at the centre, has a tendency to wear and break them. Although this does not occur when the lingoes are of a moderate weight (18 to 25 per lb.), and when only a few neck twines are tied to each tail, yet when a large number of neck twines (say 20) are tied to each tail, with weighty lingoes, as may frequently be the case in weaving small patterns on woollen and worsted goods, the breakage of the tail cords is a common source of complaint, which not only gives the trouble of renewing them, but is liable to cause defects in the cloth, by the weaver not observing the breakage for some time, as one hook of the pair may be

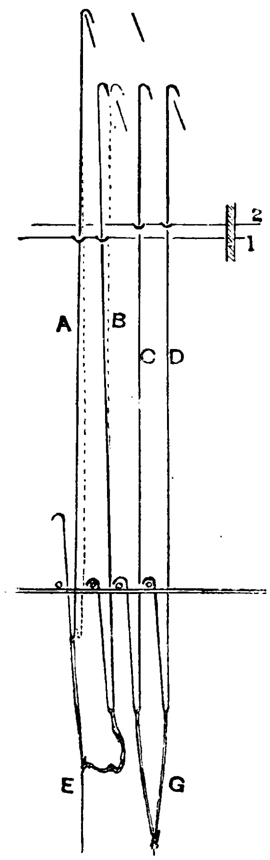

FIG. 35

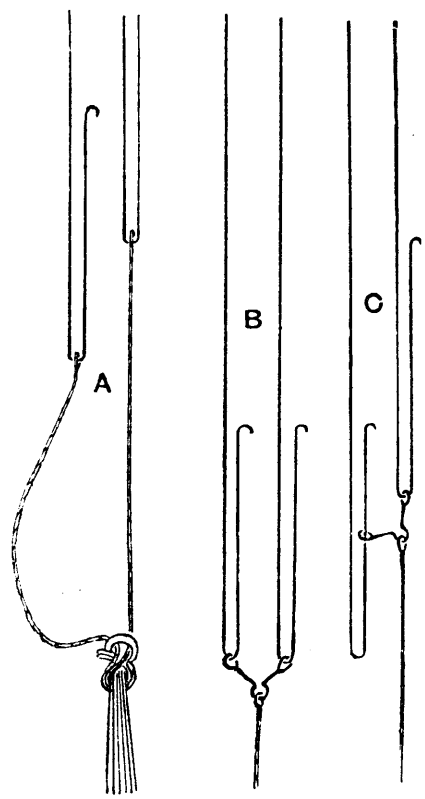

FIG. 36

raising the neck twines—that is, in case of the tail cord to only one of the hooks breaking. To remedy this Messrs. Hancock, Rennie, and Hudson have this year (1890) introduced a patent link connection for joining the tail to the hooks, which only requires one cord, or double cord, to be used, instead of two as before. This is shown in Fig. 36 at

B. When one hook is raised and the other down, the link is in the position shown at C. The old method is shown at A. When one hook is rising and the other falling, the partial turning of the link causes a loss of time equal to about a quarter of an inch of lift, and this eases the sudden pluck on the tail cord. When both hooks are down there is also a loss of a quarter of an inch in the lift when one hook begins to rise, caused by the turning of the link.

This patent works very well, but, except when heavy weights are

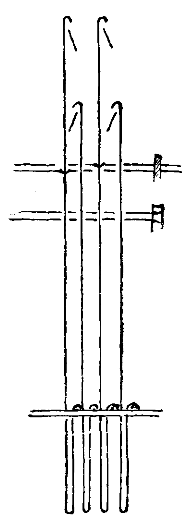

Fig. 37

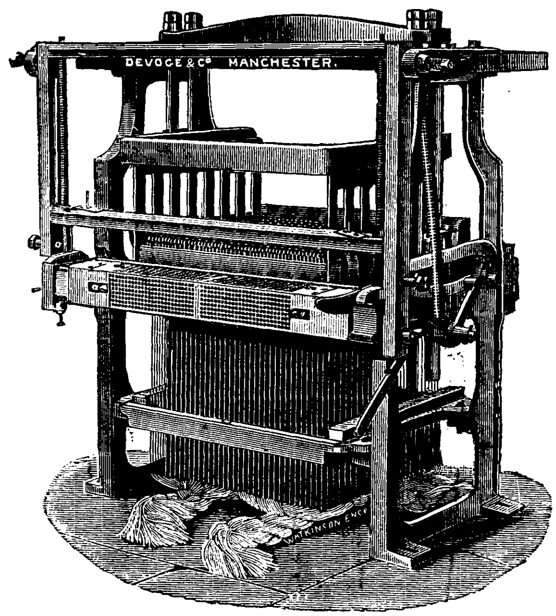

Fig. 38

on the hooks, is not likely to supersede the older methods. These links are fitted to machines by makers in Manchester and Bradford.

Before the form of griffe shown in Fig. 33 was adopted the hooks were made of two heights, as shown in Fig. 37, and one griffe wrought above the other, instead of the one set of blades or knives passing through each other; but this method was given up on account of the vibration of the long hooks, which made it uncertain whether they would remain on the knives or keep clear of them when required.

Fig. 37 shows this arrangement of hooks for a double-cylinder machine; for a single-cylinder machine with two griffes the heights of the hooks would be similar, but the heads would all be turned in the same direction, and the knives sloped to suit this, as is done when the hooks are all of the one height; each needle would be connected to a short hook and a long one. The short hooks give much more certain work, and can have the cylinder set so as to press back the hooks only as much as is required, whereas with long and short hooks allowance had to be made for the uncertainty of the vibration and the difference in the length of the two sets of hooks.

Fig. 38 is a view of one of the best makes of double-lift jacquards with a single cylinder.

The machine is made by Devoge & Co., of Manchester, but is not here given as being specially recommended in preference to others; it is only given as an illustration. Those wanting to buy a machine had better see what are in the market, and select what they consider most suitable to their work and price. This applies to all the machinery given in these articles. There is rarely a best machine for all purposes.

These machines are much in use, and can be run at a high speed, say 160, or even 180, and by many are preferred to the double-cylinder machines, as there is no danger of one cylinder getting before the other, and the cards are all laced in one set; besides, it may be more convenient for working, as some arrange their machines so that the cards for one loom hang to the back, and those of the next to the front. When these machines are to work at a high speed, the slide-motion cylinder will probably be found the most satisfactory. Fig. 39 illustrates one of these machines with slide cylinder motion and the

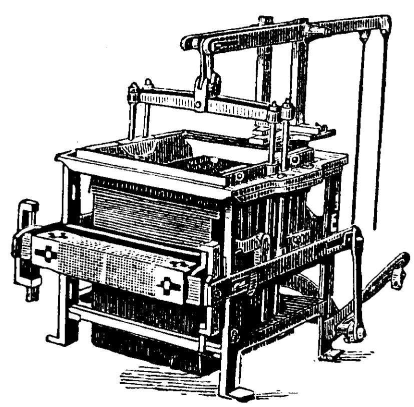

FIG. 39

levers for driving it, the connections being as before given. The levers for raising the griffes are also shown, but here go to the back, whereas they are usually at the side.

The most perfect jacquard machine in the market is undoubtedly the

DOUBLE-ACTING JACQUARD WITH TWO CYLINDERS

The only drawback to this machine is, except what may be said against the method of shedding, the liability of one cylinder to be turned out

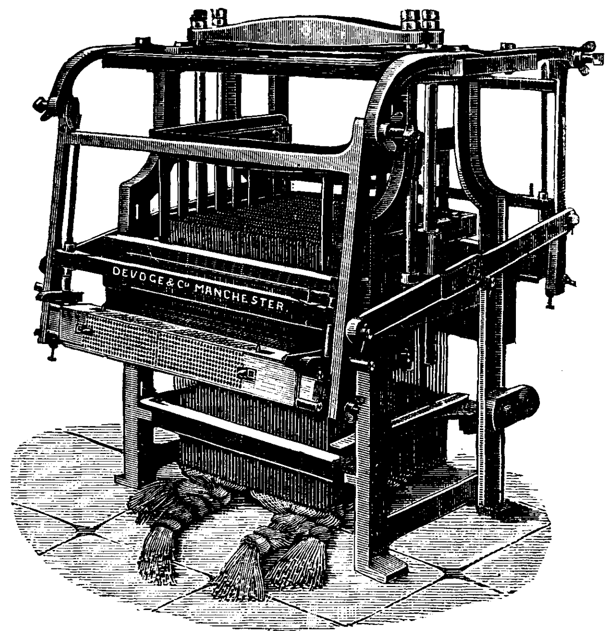

FIG. 40

of time, or get a shot or two before the other, so as to put the cards off their proper rotation; but this is only a difficulty in the hands of inexperienced weavers; nevertheless it exists. The effect will be to spoil the pattern on the cloth, giving the twill a mixed or broken-up appearance. There are motions in use for stopping the loom, unless the cards come in rotation, but many prefer to work without them. Fig. 40 is a view of a two-cylinder machine made by Messrs. Devoge & Co., with swing-motion cylinders, which are, perhaps, the best motions for these machines, as they do not require to travel quickly. A very good speed for the machines to work at is 160 to 180 or 200 picks per minute, and the cylinders would only travel at half this speed. The cylinders should be driven by an eccentric, same as given for the single-acting machines, but instead of being on the crank shaft, it should be on the tappet shaft, which runs at half the speed; and as the two cylinder frames are connected together, when the one is going out the other is coming in, so that one eccentric making a revolution for two beats of the slay

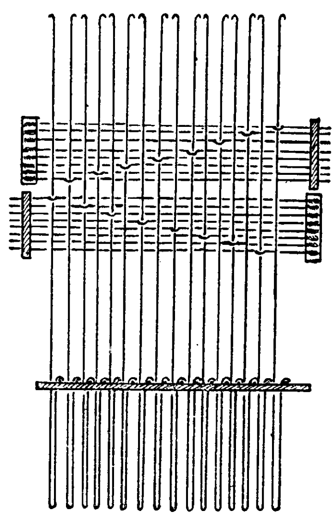

FIG. 41

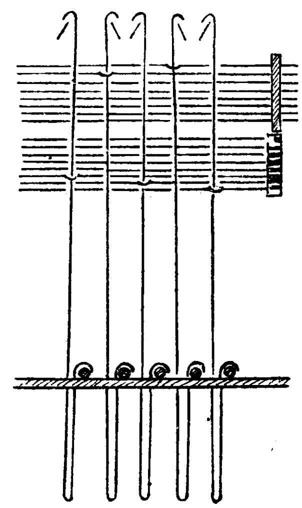

FIG. 42

will drive both cylinders. Sometimes the eccentric is on the tappet shaft, inside the framing of the loom, and is connected with the top lever, as shown in Fig. 34 (B). C is the eccentric, D the fulcrum of a short lever attached to it, and E the upright rod attached to an arm or lever on a horizontal shaft supported by the machine, or on the top of the loom. A lever from this shaft on each side of the machine drives the cylinders. The eccentric may be on the end of the tappet shaft, same as it is shown on the crank shaft in Fig. 18; but it might not always be convenient to have it here, and perhaps the most desirable way to have it at any time is to have a pinion on the crank shaft with, say, twenty teeth in it, and a stud wheel alongside with forty teeth gearing into it. On this stud the eccentric can be fixed, and will give a very steady and convenient method of driving. The griffes are raised in the same way as for the double-lift jacquard with one cylinder. (See Fig. 34 (A)).

Fig. 41 shows the arrangement of a row of hooks and needles for a double-cylinder machine. The top needle of the upper set and the bottom needle of the under set are attached to two adjoining hooks, which are connected together with the same tail cord. This arrangement is to enable the cards when working at both sides to act on the correct hooks, which will be better understood by referring to the description of lacing cards for these machines. In Fig. 41 it will be observed that all the hooks are vertical. Sometimes the hooks are slanted a little, as in Fig. 42, to give more space between the hooks at the top, without increasing the width of the machine, and there is a slight difference in the arrangement of the hooks and needles, as is shown. Both work very well.

Fig. 43 shows a two-cylinder machine, by Messrs. Devoge & Co., with a slide motion for the cylinders, which would be driven in the same way as the swing motion.

It has been said that the shedding of a single-acting jacquard is of the worst description for general weaving. That of the double-acting machine is by no means perfect either; some prefer the single- to the double-acting for making fine damask. Jacquard shedding cannot be regulated in the same way as tappets or the best shedding motions can. In tappets the dwell can be regulated to suit the cloth required, and the time of the shedding can be made early or late as desired. In jacquards this cannot be done to anything like the same extent. The shed must always be open in time for the pick, and the pick should begin when the cranks are about the bottom centre, a little earlier or later, as desired. The jacquard must have the shed open at this time, and must keep it open till the shuttle passes through.

It has been said that the usual method of raising the griffe or griffes is by a crank (or a stud in the wheel, which is practically a crank) on the crank shaft for a single-acting machine, and by a double crank on the tappet shaft for a double-acting machine. Now, a crank gives a continuous eccentric motion with a slight dwell when it is at both top and bottom centres. Sometimes a tappet is used to raise the griffes instead of a crank, and of course any required dwell can be made on a tappet; but then it must suit the jacquard, and the greater the dwell, the less time is occupied in the rising and falling of the

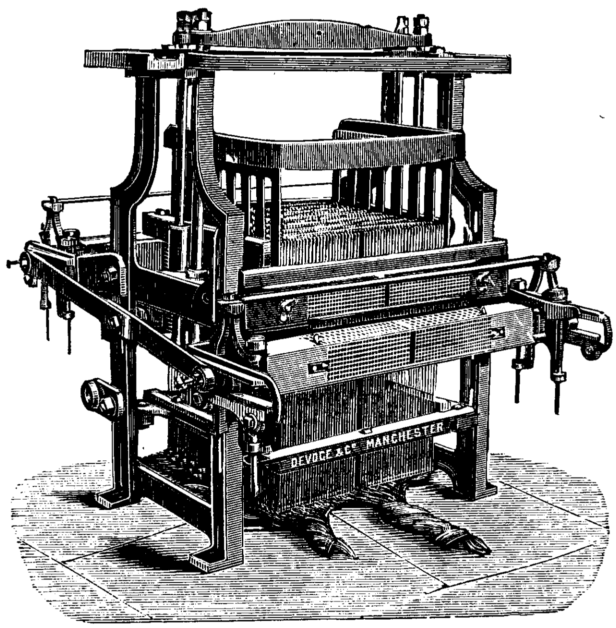

FIG. 43

harness. If the harness is plucked up or dropped down too quickly, the result is a dancing or unsteadiness of the cords, and in a double-lift machine there will be a considerable plucking when the hooks that are rising take up the cords that are falling. In order to keep the cords as steady and free from vibration as possible, if there is any swinging in the weights or lingoes, it is a common practice to put a frame round these, with wires run through it at whatever distance apart is thought desirable, so as to partition them off in bunches and keep them from swaying about.

The smoother and slower the harness can be raised and lowered, the better. Therefore, to get a high working speed, the time or the portion of a revolution of the crank shaft given to the rise and fall must be as great as possible, so that very little could be gained by using a tappet. If a tappet is to be used, a box tappet will be required, or is more satisfactory for a single-acting machine, in order to make the griffe in falling follow the tappet and avoid any plucking or jerking ; sometimes a fork lever, with the tappet or wiper working between the prongs of the fork, is used for the same purpose. For a double-acting machine double wiper tappets, acting on levers or treadles, are sometimes used, the griffes falling of their own weight ; the tappets are nearly round eccentrics, or like plain tappets with a very short dwell, not more than one-fourth of a revolution of the crank shaft. It may therefore be considered that the harness should always be moving either up or down, with a small pause when the griffes are at the top and bottom, to admit of an easy turn and to allow the shuttle time for its passage through the shed. With the crank drive the shed will require to be opened a little wider than if the dwell was as great as it should be, especially in wide looms, in order to let the shuttle get through freely ; but it would be more desirable, and a saving of strain on the yarn, to have the dwell greater, and not open the shed any wider than is necessary to admit the shuttle.

Speaking generally, the usual rule for the time of shedding may be said to be to let the shed be closed when the cranks of the loom are at the top centre, or perhaps one-sixteenth of a revolution farther forward, and let the shed be full open when the cranks are about the bottom centre. It therefore follows that the single-acting jacquard must open the shed in a little less than half a revolution of the crank shaft, and close it in the same time ; but the double-acting machine takes nearly a full revolution (three-quarters, or a little more, should do) to either rise or let fall one of the griffes. It will be evident that there is a considerable difference in the nature of the shedding. A single-acting machine requires the weft to be beaten up on a closed shed (the time of the crank in coming from the top to the front centre being taken up with rising the griffe from the bottom up to catch the hooks), whereas in a double-acting machine the case is different; though the shed is closed at the same place, or in the same position of the cranks, the griffes are in an entirely different position. The closed shed with the single-acting jacquard is when the griffe is down, but with the double-acting machine it is when the two griffes are on a level—that is, halfway up. Of course, more or less of the yarn may be at the bottom position, so that there may be no closed shed, or in no position of the griffes may the yarn be all on a level, unless none of the hooks are on either of the griffes, or if one griffe has all the hooks on it. When the single-acting machine begins to open the shed, the driving-crank of the griffe is upright or at the top centre, and in the position to give the slowest motion to the griffe; whereas for the double machine the lifting cranks are horizontal when the shed is closed, and in the position to give the griffes the quickest motion; therefore, when the lay gets to the fell of the cloth in a single-acting machine, the shed is still close, whereas with a double-acting machine it is fully half open. From this it follows that, to get a close covered cloth, the double-acting machine is the better, as the weft is beaten up in a crossed shed; but to get a clean-surfaced fabric, with the weft lying straight between the two portions of the warp, the single-acting jacquard is better. It is for this reason that the single-acting machine is preferred by many workmen for making fine damask, which does not require much covering to give it a good appearance, and there is less chance of having cut weft and of looping when striking on the open shed. Of course the weft may be cut in a hard fabric by the reed having to strike too heavily against it, and in this case striking on a crossed shed might prevent the cutting, by the weft going on easier.

In hand-loom linen damask the shot is struck up when the shed is about half closed; the warp is held so firm in the loom that there is no spring in it, and the weft does not rebound. A cleaner surface is thus made on the cloth than if the weft was struck up in a closed or cross shed.

In a single-acting machine the faults in the cloth are more readily seen than with a double-acting one, as, in case of a hook missing the knife, in a single machine it would show in a short time, whereas in a double-lift machine one hook of the pair might be missing the knife and the other taking it, so that it might be some time before it would be observed. One of the tail cords breaking might have a similar effect.

The foregoing gives a general description of working the jacquard; but no hard-and-fast lines can be laid down—a little variation may be necessary at any time, to suit circumstances and the class of work.

JACQUARD STOP MOTION

When working with two cylinders, one may happen to be turned at a time when it should not, and thus put the cards out of rotation. Many attempts have been made to overcome this difficulty by stopping the loom when the cards get out of the proper order, but none of the methods adopted have ever gained much favour. Recently a new motion has been patented, and is being applied to machines by Messrs. Devoge & Co., of Manchester. It is called the 'Devoge jacquard stop motion.'

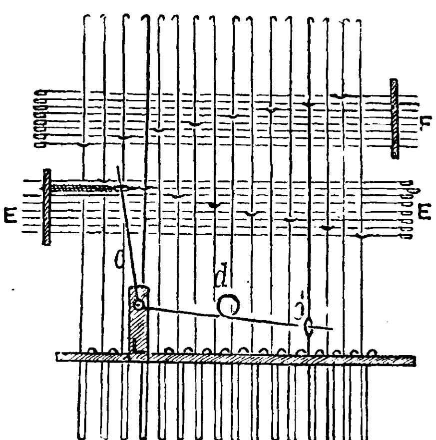

FIG. 44

Fig. 44 shows how it may be applied to a machine. The hooks A and B and the needles E and F are those here used to work the motion. They may be at either side of the machine, but should be at the side of the belt handle. One hook must belong to the front cylinder needles, and the other to the back ones. The hook A requires a lingo attached to it to draw it down after being lifted. The hook B is attached to a lever connected to the side of the loom, so that when one end is raised a hammer on the other end pushes off the belt handle (a lever and bracket are supplied for the purpose). C C[1] is a wire bell-crank lever with a turn or loop on it at D to act as a spring. The fulcrum is at L, on a piece of iron bolted to the edge of the machine; the lower end of this lever passes through an eye in the hook A at C^1, and the upper end passes through an eye in the needle E. There is a spring on the point of the needle E, between the face-plate and the eye, which the lever goes through, and which holds the needle back as shown.

Each time the hook A is raised the lever presses forward the needle E, and with it the hook B, which would then be raised by the lower griffe, unless the card pressed the needle back again and pushed it off. Thus, by having a hole cut in the cards for the needle F, and none for the needle E, the hook B would never be raised; but if a hole is cut for E in a card following one in which a hole was cut for F, the hook B would be raised and the loom stopped. It is, therefore, only necessary to arrange the cutting of the cards to allow the loom to work when they are following each other in rotation; but as soon as one card gets out of order the loom should be stopped, though, perhaps, not till it has run for a few shots. Thus—

Number of cards—

1	3	5	7	9	11
●	·	·	·	●	●

Cut the large dots for the needle E.

2	4	6	8	13	12
●	●	●	·	·	·

Cut the large dots for the needle F.

This gives a repeat of twelve cards; but any number to suit may be used. Thus—

Number of cards—

1	3	5	7	9	11	13	15
●	·	·	·	●	●	●	●

Cut the large dots for the needle E.

Number of cards—

2	4	6	8	10	12	14	16
●	●	●	·	·	·	·	·

Cut the large dots for the needle F.

This gives a repeat of sixteen cards. The even numbers of cards go to the front or top cylinder, and the odd numbers to the low cylinder, and it may be seen that a hole in an even-numbered card following one in an odd-numbered card will not stop the loom; but a hole in an odd number following one in an even number will stop the loom, as it is the hook B rising after A that stops it; therefore any suitable rotation of cutting may be adopted, and the stoppage can take place either at short or long intervals, as desired, the principle being to raise the hook A two or three times, and push the hook B back again by having no hole cut for the needle E. Then leave A down for three or four shots, and cut holes for E, which have no effect unless the cards get out of rotation, and one of those with a hole cut to raise the hook A comes before one with a hole cut for the needle E, when B will be raised and the loom stopped. This is a good arrangement, and works very well.

Another motion for a similar purpose, invented by the writer, is shown in Fig. 45. It is based on the following principle: Suppose a cord is taken from any two hooks of the jacquard, and passed round a pulley on the 'hound tail' or long lever of the weft fork motion; if the cord is left slack, so that raising one of the hooks will just tighten it, then raising both hooks together will lift the lever, and can be made to stop the loom. The difficulty to be got over is that one of the hooks must belong to one griffe, and the other to the other one, in order to make the motion act with the two sets of cards. As the two griffes pass each other at the centre, or at the half-lift, this must be taken as the full lift, the cord must be stopped here, and not drawn any farther; for the remaining portion of the lift the hooks must draw a spring. This can be easily arranged by having loops on the cord passing round wires in the cumber board, or by having the two ends of the cord passing through a small hole board, and having knots or beads on them, beneath it. Other methods may also be adopted.

One of the most desirable arrangements is shown in the figure: A, A are the two hooks; B, B are two small springs by which the two levers, C, C are attached to the hooks with cords; D is the frame for holding the levers, and is fastened to the top rail of the loom, under the jacquard, or in any convenient place. It will be observed that the front bar of the frame passes above the levers, so that it will prevent them rising above the half-draw of the hooks, in which position they are shown. E, E are two cords connected with a jack or tumbler, F, on the end of a bell-crank lever, G H L, having its fulcrum at H, which may be on the same stud as the weft fork lever, or in any convenient place.

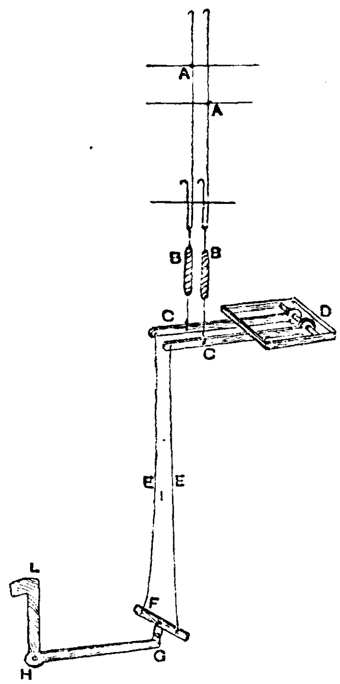

FIG. 45

The weight of F and G keeps the cords in tension, and the point L of the lever is set behind the lever on the loom which carries the weft fork, at such a distance from it that when one of the cords E is drawn it does not act on it; but when both hooks are raised, drawing up the two cords, the point L of the lever presses against the weft fork lever, pushing off the belt handle and stopping the loom.

The lever G H L may act directly on the belt handle, if desired; in this case it would be fixed outside the loom framing. The cards are cut on the same principle as for the last motion, but the same holes will do in both sets of cards, as the two needles are acted upon by the same number of holes in both back and front sets; that is, for two hooks coming beside each other.

The following order of cutting will answer :—

Number of cards—

1	3	5	7	2	4	6	8
●	●	·	·	·	·	●	●

Cut the large dots on the number of cards given, and of course they must be cut to suit the needles connected with the hooks used.

The above gives a continuous working of the motion, but it would be sufficient for it to work at intervals having 8 or 10 shots between them, as—

Number of cards—

1	3	5	7	9	11	13	15	17	19	2	4	6	8	10	12	14	16	18	20
●	●	·	·	·	·	·	·	·	·	·	·	●	●	·	·	·	●	●	·

This will not allow the loom to run for more than 20 shots after the cards get out of order.

Some other motions are in use, but these are simpler.

Before describing twilling machines or any special make of jacquards, it may perhaps be better to explain the mounting of ordinary machines, according to the usual methods adopted in some of the leading districts.

CHAPTER III

FULL-HARNESS MOUNTINGS

THE mountings that will be alluded to in this section are all intended for 'full harness'; that is, the ordinary method of jacquard weaving when applied to such fabrics as damask, dress goods, and, in many cases, to double cloths, handkerchiefs, &c.

Full harness, or, as it is termed in some hand-loom districts, shot and draft, to distinguish it from the 'pressure harness' system, holds the first place amongst mountings, as by it can be done what cannot be done by any other method, and everything can be done by it that can be done by any harness, or combination of harness or heddles; though it does not follow that it would be desirable to adopt it in every case. In a full harness each thread in any part of the tie can be lifted independently of the others; in wide fabrics, or in order to reduce expense in narrow ones, recourse is had to gathering or repeating the tie, and like threads in each repeat must be lifted together; but in a single tie any one thread can be lifted independently of any other. In full harness there is one thread of warp drawn into each mail or eye of the harness, and one shot is given to each change of card. Other descriptions of harnesses are known as 'half harness,' 'split harness,' 'pressure harness,' 'gauze harness,' double-cloth and quilt harnesses, &c.

Half harness is the term applied to that description of harness in which the half of the warp (every alternate thread) is drawn into the harness, and the other half passes through it loosely. This is mostly to be found in the manufacture of gauze or leno curtains, and is wrought with a shaft mounting in front of the harness.

Split harness is applied when two threads are governed by each hook of the jacquard, and the ground of the cloth is wrought by some other means, as shafts through the harness. This is to be found in the silk trade.

Pressure harness is when several threads of warp are drawn into each mail, and when the harness is drawn it remains stationary for several shots of ground texture, for which the sheds are sprung or pressed open by heddles.

Gauze harness is a harness fitted up with doups for weaving leno and gauze, and is mostly full harness.

Double-cloth and quilt harnesses are for weaving these fabrics.

Mounting, or gaiting, is a term that may be taken to apply to the building of the harness and the preparing of everything in connection with it. The form of 'tie' to be adopted will depend to a great extent on the nature of the fabric to be made, and to the style of pattern which is to be applied to it. For instance, dress goods may be required, and the pattern may consist of small sprigs or objects repeated over the surface of the cloth, forming a simple repeating pattern. Again, handkerchiefs, napkins, or table-covers may be wanted, which will require a bordered 'tie,' and may have both single and double mounting in them. Sometimes the manufacturer mounts his looms to what he considers a desirable 'tie' (or arrangement of cords) to admit of having a good variety of patterns wrought on it for whatever class of goods he is likely to make, and then he has the patterns made to suit the tie or mounting. Sometimes patterns are procured which will give the best possible effect on the least possible machinery, or the least number of hooks of the jacquard, and the mounting is then arranged to suit the pattern. On this method often a very considerable saving of machinery can be effected by turning over or gathering the harness; or, by arranging a variety of turns over, or gathers, and repeats, a very diversified effect can be obtained with a small number of hooks, as those accustomed to the larger forms of shaft mountings will readily understand. Thus, if we take 100 hooks of the jacquard as equal to 100 shafts, it will easily be understood that a large variety of beautiful patterns can be produced with either a straight or zigzag draft, though they will be mostly of a set or conventional type. The objection to mounting a loom in this way is, that if a change of pattern to a free or running style is required, it is necessary to cut down the harness and remount it, probably requiring new machinery as well. It may, however, suit to adopt both methods; that is, to have a few looms for working conventional patterns on small jacquards, say 200 hooks, and others mounted for free patterns requiring, say, 400 or 600 hooks in the machine. Of course this entirely depends on the nature of the orders likely to be received, and manufacturers must use their own judgment, in which, however, they are more likely to err on the narrow than on the liberal side of the question, the result being cramped and stiff patterns, with a probable loss instead of gain. Two styles of mounting harness are in general use—one, known as the 'London tie,' being used in Spitalfields by the silk weavers; the other is called the 'Norwich tie,' as it was there adopted in the early days of weaving. About 1830 the Norwich style was adopted in London, as the weavers' houses were too low to admit of the jacquards being set high enough to suit the London method, which, having a quarter-twist in the harness, requires more height than is necessary for the Norwich system, in which the harness passes direct from the jacquard to the cumber board in flat rows without any twist.

The Harness.—When about to mount a loom the first process is to prepare the harness. A harness is built up of several parts, the methods of preparing and building varying in different districts. A few of the best methods will be given. Fig. 46, Nos. 1, 2, and 3, show a complete cord of the harness in three methods of preparing it—A (Nos. 1 and 2) are the tail or tug cords looped to the hooks of the jacquard; these cords are only necessary on double-lift machines, and are usually put on by the machine-makers. They are made of twisted cotton, and are soft and pliable. L shows the knot, known as the 'tug knot,' by which the tail cords are looped on the hooks. B, B are two methods of knotting the neck or body of the harness to the tail cords; that in No. 1 is the usual method. C, C are the hecks, or guide reeds, through which the harness passes. G, G are the lingoes, or leads, formerly made of strips of lead, but now of wire. From the lingo to the mail or eye, F, through which the warp passes, is a double cord called the bottom piece, or hanger. From the mail, passing through the cumber board or harness reed E, is another piece of double cord, called the top or mid-piece, or the 'sleeper'; to this is looped or tied the neck twine in various ways, two methods of which are shown at D d d^1 (No. 1) and at D (No. 2); No. 3 shows levelling below the cumber board. with two methods for tying H and H^1. M is the snitch knot, which is much used for fastening cords that require careful adjusting. Sometimes it is a matter of choice to adopt any method of mounting, and sometimes one plan may suit circumstances better than another.

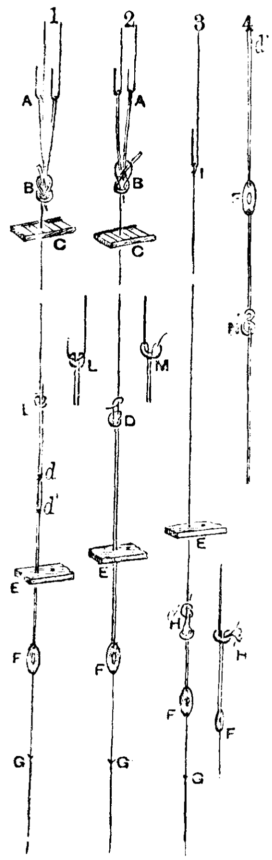

FIG. 46

Preparing Lingoes.—A prepared lingo is shown at No. 4, Fig. 46, this work being generally done by little boys or girls, or by old women. One of the commonest methods of preparing them is as follows:—Having prepared the mails, which are small eyelets of brass, copper, or steel of the shape shown at F, sometimes with round holes in the centre and sometimes with elliptical or long shaped ones, they are put into a dish or pan; a boy takes a piece of wire and strings a number of them on it. The wire is then fastened on a rack, or in any convenient place, by both ends, in a horizontal position. A bunch of small pieces of twine is tied up in a convenient place; these are to form the hangers, or to connect the lingoes with the mails. Having the lingoes conveniently placed, and being provided with a pair of shears, the boy sets to work. Taking a piece of twine, and pulling it through an end hole of a mail, he doubles it evenly, and, lifting a lingo, puts both ends through the eye in it, and casts on a knot, as shown at N (No. 4).

The loop on the twine there shown requires to be pushed up over the top of the lingo, then drawn tight, and the ends clipped off. This mail is then pushed along the wire, and the others proceeded with. The pieces of twine for forming the hangers, as well as the sleepers, are prepared by warping them off spools round two pins, and then cutting them across. Of course the pins must be set apart at such a distance as will suit the length of the sleepers and hangers required. The usual length of the hanger (when doubled) is 7 or 8 in., and that of the sleeper or mid-piece when it passes through the cumber-board, as in Nos. 1 and 2, Fig. 46, and as shown at No. 4, is 15 or 16 in. When a quantity of lingoes are hung on the mails, the top cords or sleepers may be put through the top holes in the mails, and tied with a weaver's knot, the ends being neatly clipped off.

A quicker method of preparing lingoes is as follows:—Two upright pieces of iron, as A, A, Fig. 47, are fastened on a board, or on a bench or

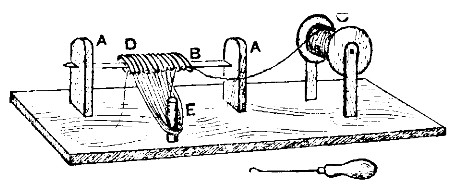

FIG. 47

table. A cut is made in each of these, so as to hold a piece of flat wire such as is used for coarse reeds. This wire is pointed at one end, so that by taking a handful of mails they can easily be gathered up on it. It is then placed in position, as shown at B; the mails, D, are shown on it, and C is a spool containing twine for the hangers. By rubbing the end of this twine with wax, so as to stiffen it, and gathering all the mails on the wire evenly together, the end of the twine may be run through the holes in all of them at once. This end is fastened, and with a hook, as shown at F, the twine can be drawn through the mails, beginning at the one farthest away from the spool, and passing from one to the other in succession, looping the twine round the pin E, which should be at such a distance from the mails as is required to make the hangers the proper length. If many mails are to be threaded at once there should be two or three pins as E, so as to avoid too much slope from them to the mails, which would increase the length of the hangers. The twine can be cut when the mails on the wire are completed, and the other ends of the mails turned round and treated similarly for the sleepers; but the pegs will require to be shifted, so as to get the required length of twine. When finished, these can be cut also, and the wire tied up in a convenient place, so that the lingoes may be hung on, as before described. The sleepers can then be knotted, if required to be.

After the lingoes are thus prepared the twine is frequently varnished, and sometimes twisted so as to prevent that of the hangers from rising up through the hole of the mail and getting in between the two halves of the yarn when the shed is crossing. This frequently happens if anything prevents the lingo from dropping. A common method of twisting them is for a boy to give them a coat of flour-paste or a light coat of varnish, then, having them hung on a rod which passes through the loops of the sleepers, he takes a handful of the lingoes, and, placing them on his knee, rolls them round with his hand till they are sufficiently twisted, then lets them hang down, and proceeds with another handful.

When the paste or varnish on these is set they can be well varnished. About two inches at the top of the sleepers must be left without varnish, to leave it soft and pliable for tying the neck to; the knots on all the sleepers must be brought up to about the point before they are twisted or varnished. When the lingoes are thus prepared and dry they can be tied in bunches, to be used as required.

Some do not varnish the twines till the harness is all mounted, and then varnish it all over. Others do not varnish at all. In this case the hangers are not twisted, and for light open sets of harness they need not be twisted at any time.

LINGOES OR LEADS

For pressure harness work the weights for drawing down the harness were originally made of lead, about the length and thickness of a thin pencil, but tapering to the lower end. The weight varied with the number of ends to the mail, the strength of the yarn, and the weight of the cloth to be made, ranging from 10 to 18 per lb., or lighter if for fine hand-loom work. For a linen damask as formerly made, with 6 or 8 threads in the mail, a very heavy lead was required, even in the hand loom, whilst a fine cotton two-thread harness would do with a comparatively light lingo. Strips of lead cut from sheets were used for lighter weights; these were then reduced to the proper size for drawing them through holes in steel plates. Now, lingoes for power looms are made of wire, and for ordinary damask or full harness work should range from 25 to 40 to the lb.; for heavier work, such as linen towels, worsteds, &c., 16 or 18 per lb., according to the weight of the fabric, are required. Lighter ones answer for hand looms: Murphy mentions as light as 110 per lb. for the centres of shawls, but 35 to 60 per lb. will be more frequently found. 25's to 30's are a good size for power looms; 12 in. long for 25's or 30's, 14 in. for 16's or 18's, and 16 in. for 10's or 12's are good lengths.

When there is a great slope in the border twines of a harness, it is often necessary to put heavier lingoes on it than on the centre, to keep the warp down. Of course, the less weight that has to be lifted is always a saving of power, and easier on the harness; therefore it is better to have two sizes of lingoes than to have them all weighty enough for the borders.

HARNESS TWINE

The size of harness twine used varies greatly; some prefer a fine, and others a heavy, twine. For the sleepers and hangers, 4 ply of 22's or 5 ply of 30's linen yarn is a very good medium size, and 4 ply of 14's or 5 ply of 18's or 20's is a very good size for the neck or body of the harness.

Sometimes, for heavy damask, cable cord is used for the body of the harness, and is a good wearing cord; it is especially suited when the neck cords are fastened to the sleepers below the cumber board. This cord is made of good flax yarn; 5 ply of 30's are twisted together, and three of these cords are then twisted together, or 3 ply of 18's afterwards made 3 ply. A better size for medium work is 5 ply of 35's made 3 ply, or 3 ply of 20's or 22's made 3 ply. Heavy harness twine requires to have heavier lingoes, particularly on those parts of the harness that are much slanted, in order to have the same effect on them that they would have on light twine. Some go to the opposite extreme, and use very light twine, such as 4 ply of 30's, which is only fit for very light work in a narrow loom, where there will be but little friction on the cumber board, and where no heck is required. Lighter twine will suit better for a hand loom than for a power loom; 4 ply of 30's for the harness of a hand loom, with lingoes of 50 or 60 to the lb., would do very well for a light cotton warp.

SETTING THE JACQUARD

The proper position for the jacquard, when only one is required on the loom, is so that the centre hook in it will be above the centre hole of the cumber board. This can easily be found by tying a plumb line to the centre hook of the machine and moving it, if necessary, till the plummet rests over the centre of the cumber board. In case the cumber board is not fixed in position, that of the jacquard may be found by having the plumb line to pass about half an inch more than the half breadth of the harness at the cumber board behind the top rail of the lay when it is full back, and it should also be at equal distances from each side of the loom. When more than one jacquard is required, they should be arranged evenly over the cumber board, and as close together as possible.

Sometimes the jacquard may be set farther forward or back to suit circumstances, such as getting card space, the only disadvantage being that there will be more slanting of the cords at one side than the other, and more friction on them in the cumber board, also more drag on the hooks on this side if no heck is used, and if a heck is used the cords will have to bear the friction on it. The more direct the cords of the harness can be, the better, and the above setting of the jacquard should be adhered to when possible, but it is not absolutely necessary for working to have it so.

It is always well to have the jacquards so arranged that they can be raised or lowered a little by having them resting on bars, which can be raised or lowered with screws. This is in case the harness is levelled higher or lower than might afterwards be desired; but if the breast beam of the loom, with the lay and back rail, can be raised or lowered, it will suit the same purpose, and it is better not to move the machine once it is fixed and the harness tied up.

The height the jacquard is to be above the loom must in many cases be regulated by circumstances; for instance, the height of the roof, or if the beams of the roof interfere with the working of it: sometimes the machines rest on the framing of the loom—that is, if the loom is made for a jacquard—and sometimes plain looms are used, and the machines rest on beams supported from columns, or from the roof of the house. This latter is the best plan, as it keeps the jacquard free from the shaking of the loom, which is particularly useful in the case of looms fitted with the knock-off motion. A good height for a jacquard, independent of circumstances, is to have 8 ft. or 8 ft. 6 in. from the mails to the bottoms of the hooks for a 10/4 loom—that is, one with about 100 in. reed space; 7 ft. to 7 ft. 6 in. for an 8/4 (82 in. reed space), and 5 ft. 6 in. to 6 ft. for a 4/4 (40 in. or 42 in. reed space), are very good heights. 5 ft. 6 in. is about right for a narrow harness, say 20 in. to 27 in. wide; 6 ft. would do for 80 in. wide, and 7 ft. or 7 ft. 6 in. for 90 in. wide, if necessary.

HECKS OR GUIDE REEDS

A heck is a frame of hard wood with wires across it, a wire for each row of hooks in the machine, from back to front. It should be made to suit the machine, so that when the harness passes from the hooks between the wires, it will go vertically down, and have no slant in it. In narrow hecks there is usually one cross-stay to support the wires, but for broader machines there should be at least two. The wire should be iron, as brass soon cuts with the friction of the cords, and then in turn cuts the cords. For a single-acting machine the wires should be loose, so that they can roll with the cords; but for a double-acting machine this would be of no advantage, as a portion of the cords are falling when the remainder are rising. If the machine is very wide, or has to be set forward or back on the loom, there should be cross rollers of hard wood above the wires, at right angles to them, to prevent the bottoms of the hooks from being drawn either backwards or forwards, which might push their heads on or off the griffe knives.

Sometimes glass rollers are used in the silk trade for this purpose, with mountings of the London tie, and while they are very smooth and polish the twines, they get too hot if used in warm power-loom factories working at a high speed. Hecks are not required for very narrow harnesses, as the cords do not diverge much from the vertical, and the friction on the heck being saved, the cords wear much longer.

In a wide harness it is impossible to draw an even shed without a heck, although in some districts they are hardly known, and the more any portion of the harness diverges from the vertical, the more irregular will the shed be.

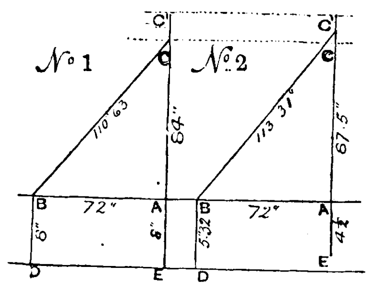

Fig. 48

Suppose we take an extreme case of a loom having three or four jacquards on it, the harness to be 96 in. wide, and the pattern to be for a table-cover; then, if we deduct 2 ft. from the width of the harness, it is possible some of the border twines may have to slant across 6 ft., or 72 in. Now make a triangle as No. 1, Fig. 48. Let the base, A B, be 72 in., and take it as the level of the cumber board. Take the vertical side, A C, as the height of the harness to the heck, viz., 84 in. Now calculate the length of the hypotenuse B C by squaring 84 and 72 and finding the square root of the sum, and it will be found to be 110·63 in. Again: Make another triangle, as No. 2, with base 72 in.; vertical side $3\frac{1}{2}$ in. longer than that of the former triangles, viz., 87·5 in. (this $3\frac{1}{2}$ in. is to represent the draw or lift of the harness). Calculate the length of the hypotenuse as before, and it will be found to be 113·31 in. From this deduct 110·63 in., the length of B C in No. 1, and the remainder, 2·68 in., equals the height that the cord B C has been raised, while the cord A C, which is vertical, has been raised $3\frac{1}{2}$

in.; and if we take into consideration that the side draw of the sloping cords, as B C, will pull the tail cord a little to one side and rise the vertical cords a little higher, while the sloping ones remain proportionately lower, 1 in. may be safely taken as the difference of the height that the two cords, B C and A C, would be raised by the jacquard, and all the other cords in the harness would vary, being less than this in proportion to their divergence from the straight or vertical line. It can thus be seen how the shed would require to be opened to let the shuttle through, and the irregular strain that would be on the yarn; and for any cloth that requires a fine surface, any irregularity of strain on the warp has a deleterious effect, very well known by experienced overlookers.

Some consider that the London style of harness is more suitable for working without a heck than the Norwich style, and adopt it to avoid using one, as it is severe on the harness twines. Some raise the machines very high to avoid using them, but for particular work with border ties they must be used to give a proper working harness. With the London mounting rollers should be, and are, used when there is no heck. These rollers are set as a coarse heck in a frame under the machine, and lie lengthways under it, just as they would do when used above a heck. The heck should be about 3 in. below the knots which fasten the tail cords to the neck twines. Some have the tugs, or tail cords, coming down through the heck; in this case the heck only takes the strain off the hooks of the machine, and has no effect on the shed, though sometimes this is mitigated by having more than one tug or tail cord, and the neck twines that slant in different directions are tied to different tail cords. The only point in favour of this is that it saves some trouble in tying broken harness twines when they begin to wear away by their friction on the heck.

PREPARING THE NECK OF THE HARNESS

The twine for the neck, as well as that for the other portions of the harness, is usually wound on spools, and when the neck is to be prepared it is warped from these spools to the length required, either on a hand warping mill or round two pins fastened in a wall or on a bench, as far apart as the length of the harness; three or four spools are put on pins, and the ends from them are taken and wound round the pins fixed for warping them on. When warped the twines may be cut at one end, and can either be tied in a bunch or stretched on a board and tied down on it, so that they may be kept straight and admit of any number of them being pulled out as they are wanted.

In some methods of mounting the neck twines are first tied to the tail cords; perhaps this is the plan most commonly adopted with double-acting machines. Sometimes they are tied to the sleepers first, and fastening them to the tail cords is the last process. This is called 'beeting' the harness. When single-acting machines are made with the hooks resting on a perforated board, they have tugs on the hooks; but when the wire hooks pass down through a perforated grating, tugs are unnecessary, and the neck twines are fastened to the hooks. When fastened to the hooks, or even when fastened to the tail cords, and a heck is not to be used, the neck twines should be formed into heads, either before they are tied up or afterwards, as may be desired. The reason of this is, that when a number of neck twines are tied to a hook or tail cord, and the hook is raised by the machine when working, the twines will be slanting in different directions, and when coming down again would be liable to catch on the knots of those that were not raised; and the head is for the purpose of keeping them together, so that they cannot separate for a short way down. One method of doing this is, after the bunch of neck twines is tied to a tail cord or hook, to take one of the twines and knot it round the others about $3\frac{1}{2}$ in. below the tail cord, and the same may be done with a second twine, if there are many in the parcel.

Sometimes the neck twines are all prepared in heads, and the following is a convenient method of doing so:—Fasten four flat pins of wood, as A, B, C, D, Fig. 49, on a board as F, or on the edge of a bench or table. C and D are firmly fastened, but A and B can be turned round to the position shown by the dotted lines when the screws holding them are slackened. The distance from C to D must be the length required for the neck twines. E is the twine coming from a spool on a wire. The pin A is pushed round to the position shown by the dotted line, and the twine is warped round C, B, D, passing over B and under C, so as to form a lease. When a sufficient quantity is warped, the crossing of the lease is pushed up towards C, and the pin A turned round into the centre of the twines, taking the place of B, which is turned back. The use of the two pins is to allow room for warping, C and A being too close together. The distance from the outside of C to that of A should be the length the head is required to be (about 3½ in. or 4 in.). The twines may now be cut at D, and a piece of cord looped round them and tied to D, so as to hold them steady, but allow them to be drawn out as required. The number of twines for each head can now be drawn out and tied round the two pins C and A, and when a number are done they can be slipped off the pins and put on cords or rods; the lease keeps the heads in order, and

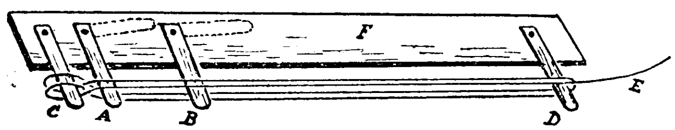

Fig. 49

the bunch can be hung up at the loom, and each head be taken in rotation by the mounter. The number of twines for each head is regulated by the tie of the harness.

Suppose a double-acting machine is to be mounted with the harness similar to that shown in No. 1, Fig. 46. The tail cords are usually put on the machine by the makers, but if they are worn out, or if new cords are required, putting them on is the first process. This can be done when the machine is on the ground, and the neck may also be tied to the tail cords before the machine is put on the loom. Some mounters prefer one method, and some the other, and the one which most conveniently suits the circumstances may be used. When the neck is attached to the machine before putting it on the loom, it is usual to turn it on its side on blocks or on a table. If the machine is on the loom, a board is tied up to make a seat for the mounter, and the bunch of neck twines is fixed convenient to his reach; or he may have a boy to draw them out for him, and hand him the number he requires. Beginning at the first hook, he takes a pair of tail cords, and having drawn them down straight and stretched them firmly, he loops the neck twines on them in the way shown in Fig. 46, and draws the knot fast. The distance from the bottom of the hooks to the neck twines should be 11 in. or 12 in. The first of these in each row is measured, and the mounter can then regulate the others so as to have all the knots in a line.

The number of neck twines that are to be tied to each hook is regulated by the tie of the harness. For each time that any repeat or portion of a pattern is to be repeated on the cloth there must be a twine attached to those hooks of the machine that are to work this repeat. For instance, if a 400 machine is used, and the pattern consists of a simple repeat on these 400 hooks, and this has to be repeated six times on the cloth, then six neck twines must be tied to each hook of the machine. Again: The pattern might be made for a 400 machine, 200 hooks to be repeated six times, 100 four times, and 100 three times; then six twines would be tied to the first 200 hooks, four to the second set of hooks (100), and three to the third set (100), and any mounting would be regulated in a similar manner.

Full particulars of ties will be given further on.

If all the hooks in the machine are not required, any number of rows or portions of rows can be left idle at one end, or at both ends if desired, or even at the back or front.

When all the neck twines are tied up, the next process is to draw them through the heck, which should be fastened firmly 2 in. or 3 in. below the knots connecting the tail cords and neck.

The jacquard is supposed to have been levelled and set in its proper position on the loom, and firmly fastened there, and the same may now be done with the cumber board.

CUMBER BOARDS AND HARNESS REEDS

These are both for the same purpose—viz., that of regulating the space which the harness is to occupy—and both answer the purpose equally well, generally speaking. The reed being stronger is, perhaps, more suitable for coarse work; and the cumber board, giving a more evenly distributed harness, is perhaps preferable for fine work. Be that as it may, both suit for any medium work, though some workmen are all against the reeds, and others all against the boards. Harness reeds are strong-made reeds of cane or iron, of the depth and fineness to suit the harness. Bridges are fixed in them about 6 in. apart, with perforations for stiff wire to be run through; as many wires as are required to suit the number of rows of the harness. A wire should be outside the harness at both sides, to prevent it rubbing against the ribs of the reed. The wires are made straight, drawn tight, and fastened at each end to holes in the yoke of the reed. The reed is set in a frame of wood or iron, so that it can be bolted to brackets on the loom.

Cumber or comber boards, also called hole boards, are made in various ways. Sometimes they are of wood about $\frac{3}{4}$ in. thick, and bored in a piece. These boards are strong enough to bolt to brackets on the frame of the loom. Sometimes they are thin, about $\frac{1}{4}$ in. thick, bored in the same way, and framed. The wood used is beech, sycamore, and sometimes walnut. The objection to these boards, particularly the thin ones, is that if the wood is not very well seasoned they are liable to warp and split. A great many prefer to use what are called 'slips'—that is, small pieces of wood of the depth required for the harness, and about $1\frac{1}{2}$ in. long or broad. The length, or long way of a cumber board or harness reed, is frequently called the width or breadth, same as weaver's reeds, as this is the width of the loom. The cross-way, or from back to front, would, in the same way, be the depth. These slips are made of boxwood, beech, or other clean hard wood. Some prefer beech or sycamore to boxwood. The twines cut into them all in time, but the hardness of the boxwood causes a very fine cut to be made in it, which cuts the twine. The others will not cut the twine so readily, and by the time the wood is cut too much the harness would require to be renewed as well as the cumber board. These slips are made about $\frac{1}{4}$ in. or $\frac{5}{16}$ in. thick, and are set in a grooved frame. The usual way of arranging the holes in a board is shown at A (Fig. 50), which is for an 8-row harness. B shows a patent method, devised for the purpose of giving more space between any two holes in each horizontal row. The arrangement of the holes is in 4-shaft satin order, and gives double the space between the holes of each horizontal line that A does, and of course it would take so much longer for the twines to cut through; but this would only be an advantage if the holes were set very close together, as otherwise the harness would be considerably off the level before the twines had cut from one hole into another. In any case, the irregularity of the holes will likely prevent it from ever taking the place of the older method shown at A, though it may be desirable sometimes.

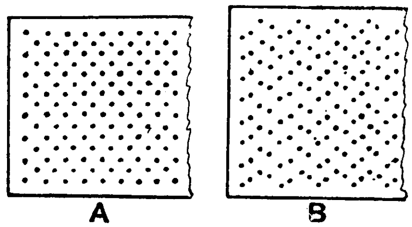

FIG. 50

The cumber board is fastened on two brackets—one at each side of the loom—and should be perfectly level and firm. It should be so far advanced as to allow the harness to pass within half an inch of the handrail of the lay when full back, and should be from 8 in. to 10 in. above the mails, the lower the better, as it keeps them steady; but the height may have to be regulated by the swords of the lay, as they must be clear of it, and in some looms they are higher than in others. When the cumber board is levelled and fastened, it should not be moved after the harness is tied up, as any change in its position must alter the level of some portion of the harness. This cannot in every case be adhered to, as in some cases it may be necessary to move it. In a small harness a good deal of shifting can be made that could not be attempted in a large or intricate one. In many places the harnesses are built in a separate room, or by the machine-maker, and sent to the manufacturer; but practical experience with particular work will teach anyone that it is most desirable to have everything about the harness as level and true as possible, and it takes a good deal of care to effect this, even without any shifting.

SLABSTOCKS AND LEVELLING FRAMES

'Slabstock' is a name given to the board used for fastening the mails on before they are levelled. It is about 6 in. deep and 1 in. thick, and should be as long, or longer, than the loom is broad, according to

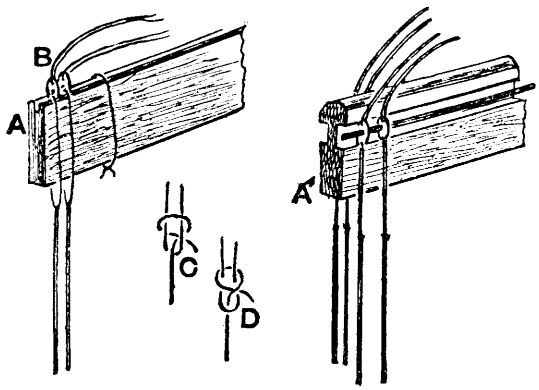

Fig. 51

the way it is to be fixed in the loom, which is usually by being bolted to brackets fastened on the sides of it.

There is a groove or rebate in the top edge of it for holding the mails, as shown in Fig. 51 at A and B. Sometimes the grooves are at both sides, as shown at A[1]. All the mails required for the harness are put on the one slabstock, which is set directly under the cumber board when the harness is being levelled.

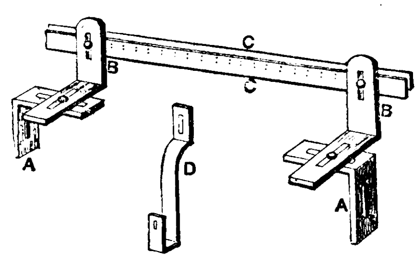

Fig. 52

A levelling frame is better than a slabstock; it is for the same purpose—that of keeping the mails firm and level when being tied to the neck twines. It consists of two flat bars of iron, C, C (Fig. 52), which can be bolted together in the form of a frame by the use of two stays, one at each end, and by the same screws be bolted to slotted brackets, A A, B B, fastened to the frame of the loom. Sometimes two hanging brackets, as D, are used, fastened from the top or heddle-bearer of the loom. The levelling bars, C, C, rest in these brackets, and can be fixed firm in them with a pin or cotter. If there is any yield or spring in the brackets, they can be stayed from the front of the loom as well, as the frame should be made very firm. The distance between the two bars should be 4 in. or $4\frac{1}{2}$ in., which will suit any harness; if only narrow harnesses, as 8-row, are required, it may be an inch narrower. The length of the frame must suit the breadth of the loom. It should be perfectly straight and level on the upper edges, and should have two rows of holes bored in it, about 2 in. apart, for pins and skewers to pass through above and below the wires on which the mails are strung, so as to keep them firm.

LEVELLING THE SLABSTOCK OR FRAME

Levelling a harness, or rather levelling the mails of the harness, is the most important part of the mounting, as, if the mails are not levelled as true as a straight-edge, good work need not be expected from the loom. The position in which they are levelled, in relation to the breast beam and back rail, will depend upon the nature of the cloth to be made, to a certain extent; but as a general rule, for ordinary work, the eyes of the mails should be half the depth of the shed required to be drawn below the level of the breast beam for hand loom work, and a little more than that for power-loom work. This is to have the top and bottom portions of the shed of an even tension, and to make both sides of the cloth equally good. The position of the back roll can be altered a little afterwards, if it is required to slacken either the top or bottom portions of the shed. Raising the back roll throws up the weft pattern to the under side of the cloth, and sinking the back roll gives the upper surface of the cloth a finer appearance, by tightening the top portion of the shed. A $3\frac{1}{2}$-in. draw of the harness is sufficient for power-loom work, and perhaps less would sometimes be preferable. Levelling the harness mails $1\frac{3}{4}$ in. for light work, and 2 in. for heavy work, below the breast beam should be a good average standard for a $3\frac{1}{2}$-in. draft of harness. The levelling frame or slabstock is levelled to this height by means of a spirit level and straight-edge, making allowance for whatever spring there may be in the harness after it is tied, and the wires drawn out of the mails. This can only be ascertained by experience, and depends principally on the tension the mounter puts on the twines when tying them; it will also depend upon whether the harness twines have any spring in them or not, but they should be well stretched before being used, to avoid this. A mounter who ties slackly will generally make a more level harness than one who ties tightly. About $\frac{1}{8}$ in. may be allowed for the mails to rise if the cords are slackly tied, and if tightly tied $\frac{1}{4}$ in. may have to be allowed, and sometimes more than this.

Sometimes the level is taken by placing a straight-edge on the race of the lay, when the cranks are at the back centre; then the under edge of the straight-edge should give the position for the tops of the mails on the slabstock, when it is fixed in its position in the loom. In levelling by this method the race must first be set at the proper height, and it must also be properly bevelled. From $\frac{1}{2}$ in. to $\frac{3}{4}$ in. below the breast beam is a good level at which to have the race, when the cranks are at the top centre, the latter for a low harness. The angle, or bevel, of the race may not at all times suit for levelling in this way. If not, the race should be made correct when possible; if it cannot be corrected, the harness must be levelled a little lower and the back rail kept down for working. A loom with the race bevelled for plain work is not suited for damask; the angle between the race and reed should, for damask, be about 93°, whereas for plain 87° would be more suitable.

TYING UP THE HARNESS

Having the neck attached to the tail cords and the levelling frame and cumber board fixed in position, the next operation is to get the prepared lingoes placed in the loom, whether on the levelling frame or slabstock. Suppose the levelling frame to be used. According to the number of rows in the harness or cumber board, pieces of reed wire are procured, one for each row, and as many lingoes are strung on each of these as will be required for each row of the harness, by running the wires through the mails. These wires are then placed in the frame and secured by skewers being put through the frame above and below them. The frame is then levelled and firmly bolted to the loom. The sleepers or mid-pieces of the lingoes are next drawn up through the cumber board, one through each hole required to be used, any surplus holes being previously marked out to suit the tie of the harness, which will be afterwards explained. When all are drawn through, the tying of the neck twines to the sleepers may be proceeded with.

This must be done in accordance with the tie of the harness. Thus, if there are four cords tied on the first hook of the machine, these must be taken down to the lingoes in the proper place in the cumber board, which may be seen by examining the particulars of the mountings, to be given further on. One method of fastening the neck to the sleepers is shown in No. 1, Fig. 46, at D, d, d^1. The twine is put through the loop of the sleeper at d^1 (or better to have a snitch on the sleeper, unless the knots are to be varnished afterwards), then a loop is thrown on at d, and the end tied at D, and clipped close. This method suits very well when the harness is liable to be altered, for if the knots are brushed over with paste they hold sufficiently firm, and can be loosed again at any time, if necessary. If varnished, it also answers equally well for any coarse harness; but if it is fine and much crossed, especially if the twines are strong or coarse, the knots are liable to catch on each other and raise more warp than should be when the loom is working.

A second plan is shown in No. 2, Fig. 46. In this case there are no sleepers on the lingoes; they are put on the levelling frame or slabstock without them, the mails and lingoes being connected by the hangers; the levelling frame is set in the loom as before, and the neck twines must be long enough to go down through the cumber board, through the top hole of the mail, and up again through the cumber board to where they are tied. The mounter, when about to tie them, takes one of the twines and casts a single knot on it, leaving the loop open, then puts the end of it through a hole in the cumber board and through a mail, and with a small wire hook draws it up again through the same hole in the cumber board, and through the open knot or loop he made on it, at the same time ; then, turning round the awl or piercer in the other end of the handle of the hook, he puts it through the knot and runs it up about 6 in. above the cumber board, draws it tight, and casts another knot above it with the end of the twine, as shown at D, No. 2, Fig 46. This makes a neat harness, and when a mounter gets accustomed to it he can proceed very expeditiously. This method is used in England ; the former is Scotch. The instrument used for drawing the twines through the cumber board consists of a wooden handle, in one end of which is a hook or barbed wire, same as is used for drawing the warp through mails, and in the other end is a round awl or piece of steel wire, tapered to a blunt point, which is used for running up the loop or knots so as to have them all about the same distance above the cumber board.

Beeting is another Scotch method of mounting. The harness may be beeted either above or below the cumber board; beeting above it was the old method, and single slabstock was used, as shown in Fig. 51 at A. When preparing it for the loom, the lingoes and mails are connected by the hangers in the usual way, and hung on the slabstock with the mails in the groove in it, as shown at B, Fig. 51. A piece of flat wire (reed wire) is run through the eyes of the mails, as many as are required for the whole harness, and is then tied down by cords fastened round it and the slabstock, at short distances apart. The slabstock is now put into a frame, or rack, with a rail as high above it as is required for the length of the sleepers. A spool of twine is fixed on a wire pin at the side of the frame, and with a needle, or otherwise, the end of the twine is run through a number of the mails and fastened. With a hook the sleepers can be reeled up to pins in the rail above the slabstock, on the same principle that they are done in Fig. 47. When the sleepers are all finished they can be slipped off the pins and cut.

The slabstock is next fixed in the loom and levelled with the upper edge of the rebate or groove touching the under edge of a straight-edge placed on the race of the lay when it is full back (for power looms).

The sleepers are then drawn up through the cumber board without their ends being knotted; they should be long enough to reach about 8 in. above it, and say 7 in. below, making 15 in. for their entire length.

Now, to beet the harness: Say there are two beeters, standing on the ground, with a supply of neck twines convenient to them; they pick up the sleepers from the first set of holes in the cumber board—that is, those that are to be connected with the first hook in the machine—and, having tied neck twines to them, hand them to the harness tyer, who is up at the machine. He takes the lot of twines and draws them all to an even tension, then, having drawn down the tail cords firmly and evenly, knots the neck twines to them.

One method of knotting the neck to the tail is to have the tail cords tied together so as to form loops; then, having straightened both the neck and tail cords, lay the neck against the loop of the tail, and take both firmly between the finger and thumb of the left hand, being careful not to let them slip, and casting a knot, as at C or D, Fig. 51, round the tail, with the ends of the neck draw it fast. In order to have all the tail cords plumb and the knots of a uniform height, the harness tyer sometimes has a cord tied across the top of the loom frame, at each end of the machine, at the height the knots are to be. On these he lays a straight-edge, marked as a guide for where the tail cords are to hang, so that he can regulate those of one row and have them plumb, and the knots even; when one row is finished, he moves the straight-edge to the next, and goes on with it. A newer method of beating is to prepare the lingoes with sleepers and hangers, the sleepers to be about $5\frac{1}{2}$ in. long. The slabstock A^1, Fig. 51, is used, or the other if preferred.

The mails are put upon flat wires as before, but instead of all going on one wire, half the number is put on each of two wires, and one of them is placed at each side of the slabstock, where it can be fastened with small staples. To facilitate getting the mails on the wires, when reeling the sleepers on the pin, as in Fig. 47, a lease can be made on the loops by giving them a twist when putting them over the pin.

A piece of twine can be fastened in this case, and the loops afterwards cut. The mails can then be taken off in order, and run on the wire for the slabstock. When the mails are fixed on the slabstock it may be laid on the ground, or set in a frame, and the neck twines tied to the sleepers; and when all are tied, they can be drawn through the cumber board or harness reed. Afterwards, all are taken and fixed in the loom. The cumber board must be set so high above the knots on the sleepers that they will not come into contact with it when the shed is opened (that would be 4 in. or $4\frac{1}{2}$ in. above it). The neck twines are then tied to the tail cords as before.

This makes a very good harness, and has the advantage of having no knots on the neck twines above the cumber board, which is very important in an intricate harness with the cords close together, as the knots when varnished are liable to catch on each other, or on twines slanting across them, and lift them as they are being drawn up. When a harness is mounted in this way it is not easy to make any alteration on it, or to re-level any portion of it if necessary. If the sleepers are tied in loops, same as used in No 1, Fig. 46, they can be connected to the neck twines by having the latter double and putting both ends of the neck through a snitch on the sleeper, or the neck twines may be double and the two ends of the sleeper when untied may be put through a snitch on the looped end of the neck twine and tied; in this way they could be altered or adjusted afterwards if necessary, but if they had to be varnished the knots would be rather rough.

The following method of mounting is adopted in the damask hand-loom districts of the North of Ireland, and is used for particular power-loom work as well. It is a slower process than the preceding, but cannot be surpassed for getting a level harness, and the mails can be regulated as desired—that is, to have the back rows getting gradually a little higher than the front ones, which can only be accomplished in the preceding methods by tying them a little tighter, or by having the frame sloped a little.

The lingoes may be prepared as before, with the sleepers 5 in. long when tied and clipped. The neck twines are put down through the cumber board and knotted loosely in bunches underneath.

The levelling frame is set in the loom, the top edge of it being at the level that the eyes of the mails in the front row are to be hung.

No wires are required. The lingoes are taken in bunches and put astride on the frame as required, and boys fasten them up to the neck twines by throwing on a snitch and running them up to somewhere about the height they will be wanted when level; in doing so the knots on the sleepers must be kept up as close to the snitch as is convenient for tying them, as, if left too low, they would interfere with the warp in shedding. When all the lingoes are hung inside the levelling frame—or they may be hung first, and the levelling frame put up afterwards and levelled—the mounter may begin to level the mails.

He uses a fine piece of waxed cord with a small weight at each end, which he lays across the levelling frame as a guide, and levels each row from back to front in succession. The front mail may hang with the top of its eye level with the cord, and the others rise a little higher, till the back one is perhaps, with the bottom hole, level with the levelling cord, or $\frac{1}{8}$ in. higher than the front one. The levelling can easily be accomplished by sliding the snitch up or down the neck twines; and when the correct height for the mail is got, the neck twine is tied as at H, No. 3, Fig. 46, when it is to be varnished, or as at H^1 when it need not be varnished; in the latter case cable cord is used for the neck, and it is split at the end, when drawn through the snitch, and then knotted.

VARNISHING A HARNESS

Varnishing is for the twofold purpose of making the harness twines wear better, and keeping them from being affected by the atmosphere.

Sometimes the harness is only partly varnished, particularly when it is liable to be changed in a short time, and then it can be loosed down and used again.

If it is to remain for a length of time—that is, for steady work—it should be varnished all over, but care should be taken to get a good varnish, as some of them destroy the twines, and others come off and are useless.

The common varnishes are made principally from shellac, beeswax, and turpentine, and can be procured at any heddle-maker's. Sometimes white wax dissolved in turpentine is used to rub the twine at the cumber board, for fine harnesses for silk and other light work, the remainder being left unvarnished. Sometimes the neck of the harness and the sleepers are varnished, and the knots above the cumber board are brushed with paste, as each row is tied, to keep them from slipping.

Perhaps the best varnish is boiled oil, which, when well dried, gets very smooth after working for some time, and keeps the twines soft and pliable. It takes some time to dry, and does not suit well for using in a dusty place, but answers very well when the harness is built in a room for the purpose, and is afterwards taken to the loom.

Sometimes a very small quantity of beeswax or white wax is added to the oil to give it more firmness, and sometimes driers are used to make it dry more quickly; but it is better to do without driers, as they harden the twines and are injurious. Varnish should not be disturbed till quite dry, as, if the twines are separated and the loom started when it is soft, the outer surface will rub up and make a rough harness. The twines are separated by running a wire skewer between each cross-row. French chalk dusted down through the harness assists in smoothing it, and prevents too much friction when it is being started to work.

TO ARRANGE THE TIE OF A HARNESS

What is known as the tie of a harness is the arrangement or manner in which the harness twines are connected to the hooks of the jacquard—*i.e.* the number of twines that are tied to each hook, and the position they are to occupy in the cumber board. Ties for ordinary damask work may be divided into three classes—viz. straight, or single; lay over, or repeating; and gathered, or centred.

Straight or Single Tie.—This tie is only required when there is no repetition of any portion of the pattern, as in silk markers, and occasionally in handkerchiefs, d'oyleys, tablecloths, &c. Only one harness twine is tied to each hook of the jacquard, and there must be as many hooks as there are threads of warp. The twines are tied to the jacquard and taken down through the cumber board in regular order from first to last, and the warp is drawn into the mails in the same order. Any pattern that it is possible to put on the cloth can be wrought with this method of mounting.

Lay Over or Repeating Tie.—This is, perhaps, the commonest tie, and is used for all such patterns as Fig. 53, where one small portion, as that enclosed by the dotted lines, will, when repeated several times, cover the entire surface of the cloth.

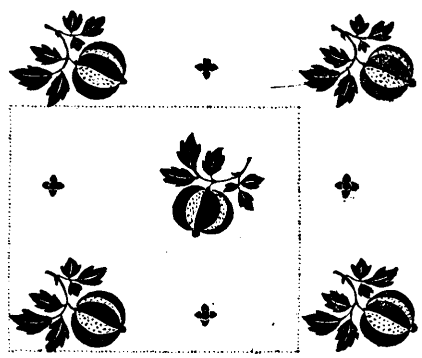

FIG. 53

Gathered or Centred Tie.—This tie can be used when both halves of any figure or border, &c., are alike when turned over ; it will only require half the number of hooks to work a figure or border, when gathered or centred, that would be required for a single pattern.

All other ties are combinations of these.

Fig. 53 shows a pattern for a lay over, or repeating tie, such as might be used for dress goods, handkerchiefs, &c. The complete extent of the pattern is enclosed by the dotted line ; this is called one 'repeat' of the pattern, because this portion repeated over the cloth makes up the entire figuring on it. To ascertain how this may be woven, or what number of hooks of the jacquard will be required to weave it, the number of threads contained in 1 in., or other given space, of the cloth required must be known. If the pattern is to be on the cloth say 2 in. × $2\frac{3}{8}$ in., and there are to be 100 threads of warp and 120 threads of weft per inch, then 200 hooks of the jacquard and 240 cards would be required to weave it, each hook representing one thread of warp, and each card representing one shot of weft.

Figs. 54 and 55 show mountings on jacquards with 208 hooks in each, the former tied on the Norwich principle, and the latter in the London style. In both cases only 200 hooks are used, the remaining eight hooks being left idle for selvages, if required. These mountings are made for four repeats of the pattern, which would only make 8 in. of cloth; but there may be any number of repeats, say 13, to make 27 in. of cloth or $28\frac{1}{2}$ in. of warp in the loom, with, say, 92 threads per inch. There must be a harness twine for each repeat of the pattern tied to each hook of the machine; when four repeats are used, four twines are tied to each hook, as in Figs. 54 and 55. The harness reed

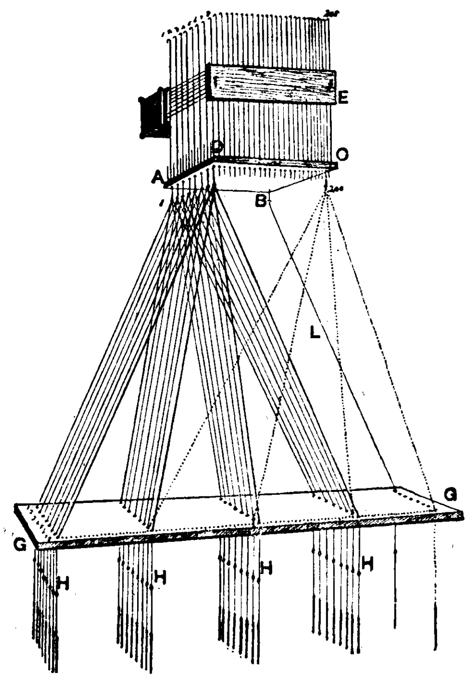

Fig. 54

or cumber board, G, must be of the same set or fineness as the weaver's reed (if finer, it can be used by passing over the surplus holes). It is divided into four portions, leaving 200 holes for each repeat, and the twines are, in Fig. 54, taken straight down from the hooks to the holes in it, as can easily be seen. In this figure the cross-rows of the cumber board at the first of each repeat are shown filled; but in mounting, the back row, taken from the hooks A to B, would be filled