JACQUARDS, PART 1

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JACQUARDS

(PART 1)

Serial 498A | Edition 1

JACQUARD CONSTRUCTION

INTRODUCTION

1. Purpose of the Jacquard.—The weaves for fabrics to be woven on looms with cam or dobby shedding attachments must necessarily be limited in the number of ends having different interlacings, since the largest number of harnesses usually employed in a dobby is 30, while the scope of cam-looms is considerably less than this. Dobbies can be constructed with a somewhat larger capacity, but their use is not advisable, since the slight gain in capacity is more than offset by the detrimental effect, on the warp, of a larger number of harnesses, and the increased skill required on the part of the weaver. When making a weave for a loom with a 30-harness dobby, the designer is limited to the use of 30 ends working differently, that is, interlacing with the filling in a different manner from other ends. It is true that by using different methods of drawing in the ends through the harnesses, a weave can be made to occupy as many ends as may be desired; many different effects may thus be produced that at first glance appear to require that a very large number of ends shall work differently, although when any such fabric is analyzed, the entire weave will be found to contain not more than 30 ends that interlace with the filling in a different manner.

When, therefore, a cloth is to be woven with a weave that necessitates a greater variety of interlacing of the ends than is possible when using a dobby, it becomes necessary to use a shedding machine of greater capacity—the *jacquard*. The principal distinction between the dobby and the jacquard is that whereas the dobby employs harnesses through each of which are drawn a large number of ends that consequently work alike, the jacquard employs a shedding mechanism and harness arrangement by means of which each end of the warp may be operated independently if so desired, it being thus possible to have every end of the warp interlace with the filling in a manner different from that of any other end. Jacquards are usually arranged, however, so that 4, 5, 6, 7, or 8 ends work alike.

2. Invention of the Jacquard.—The jacquard machine derives its name from its inventor, Joseph Marie Jacquard, a mechanic of Lyons, France, who first turned his attention to improving the means of raising the harnesses in looms for figured weaving during the latter part of the 18th century, although it was not until early in the 19th century that he finally perfected the machine bearing his name.

The jacquard machine is considered one of the most nearly perfect inventions ever made, for the reason that not alone the principle, but even the essential parts have remained practically the same as originally conceived by Jacquard, although, of course, in the modern jacquard many improvements have been made that have added greatly to its efficiency.

3. Classes of Jacquards.—A jacquard machine is a mechanism placed above a loom for the purpose of automatically selecting and raising the desired warp ends so as to form the required shed for the insertion of each pick of filling. The expression *jacquard loom*, which is frequently used, is a misnomer, since the term jacquard applies to the shedding mechanism only; this can be applied to almost any ordinary loom by making slight alterations. In Fig. 1, a jacquard machine is shown placed above a loom and connected to it

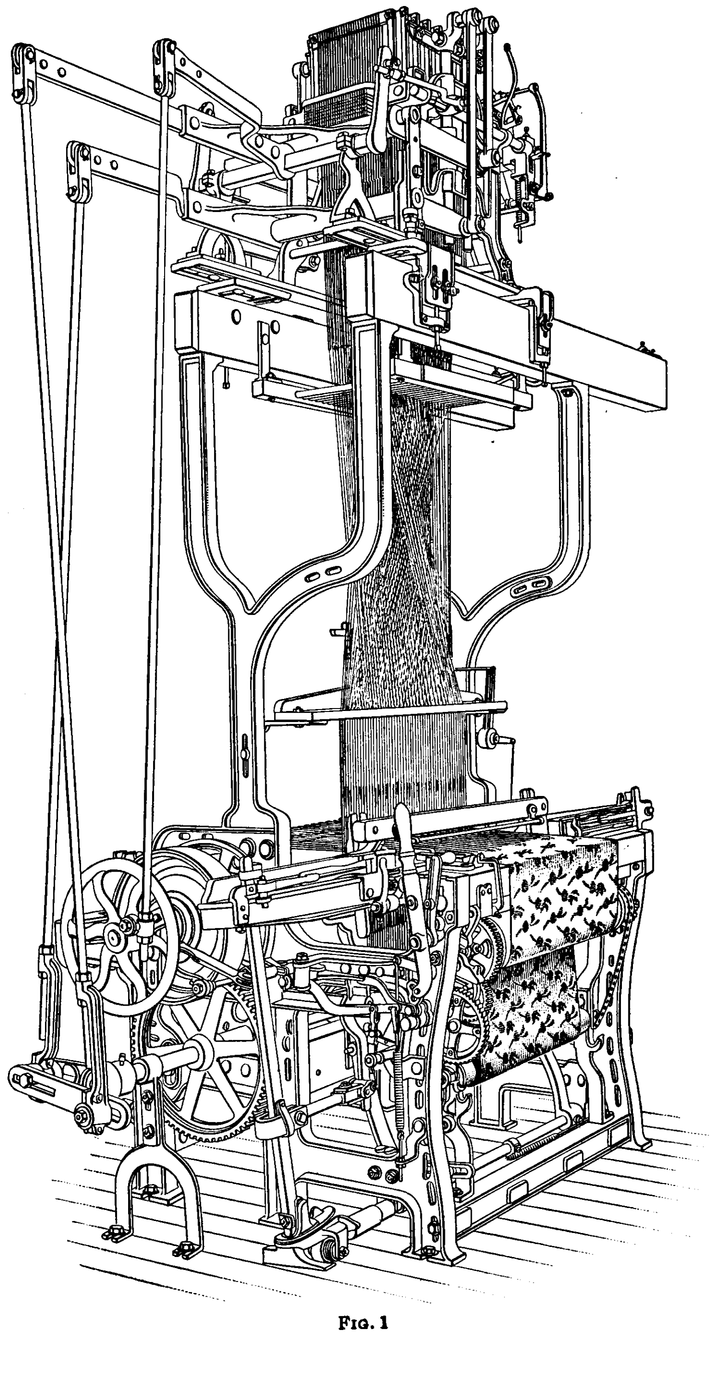

Fig. 1

in the manner usually employed. This illustration gives the appearance of the jacquard machine and loom together when in operation.

The jacquard machines most frequently used at the present time may be divided into three general classes, as follows. *single-acting*, or *single-lift*, jacquards, which may be either *close-shed* or *split-shed* machines; double-acting jacquards with one cylinder, which are known as *double-lift single-cylinder* machines; and double-acting jacquards with two cylinders, known as *double-lift double-cylinder* machines.

SINGLE-LIFT JACQUARDS

GENERAL PRINCIPLES OF CONSTRUCTION AND OPERATION

4. Fig. 2 shows a perspective view of a **single-lift jacquard** complete, while Fig. 3 shows a cross-section through certain of the essential parts of this machine. Those parts shown in both figures are lettered alike and reference should be made to each when studying the descriptions.

The lower part b of the jacquard is known as the *grate*, *grating*, or *rest board*. The hooks a pass through this grate and by means of their curved points a_1 are supported by it. The neck cords a_3, to which the harness lines are fastened, are attached to the lower ends of the hooks, and by this means the warp ends are raised and lowered as desired. The arrangement of the harness lines is shown in Fig. 1; they are attached to the hooks and pass downwards to the warp ends that they govern.

In order to accomplish the raising of the hooks and, consequently, the lifting of the harness lines and warp ends, it is necessary that some mechanism shall first select the hooks that it is desired to raise, after which some other mechanism must be brought into use to raise those hooks. The latter mechanism, or the lifting of the hooks, will be considered first, because it is necessary to understand this part of the

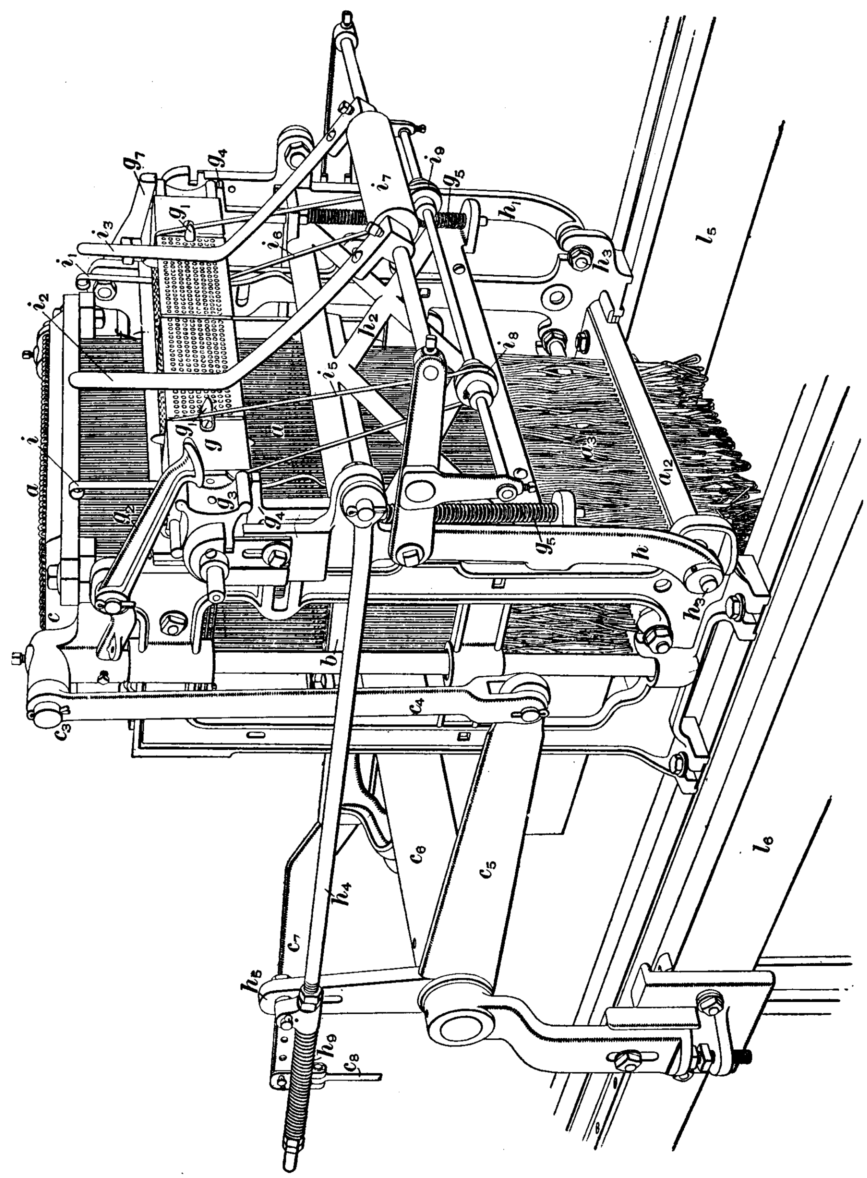

FIG. 2

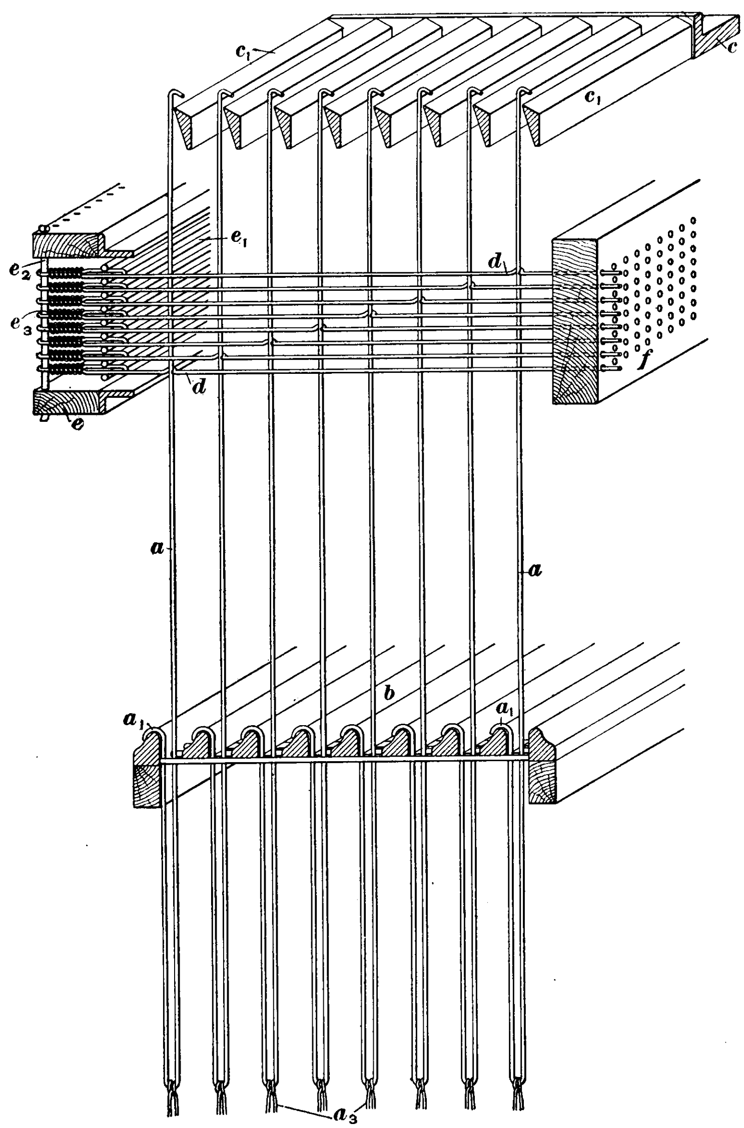

Fig. 3

machine in order to comprehend that directly connected with the selection of the hooks.

5. Referring to Figs. 2 and 4, a lever c_7 attached to a shaft c_6 is raised and lowered by means of a rod c_8, which is fastened by a stud, or crankpin, to a wheel c_{10} on the crank-shaft c_{11} of the loom. Also attached to the shaft c_6 are two arms, the one shown in Fig. 2 being marked c_5. These arms are connected by means of rods c_4 to studs c_3 on the casing c of the *griff* (sometimes spelled *griffe*), or *grife;* only a

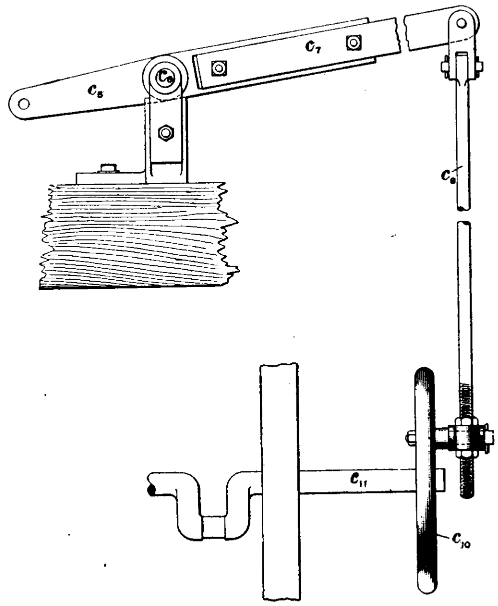

FIG. 4

portion of the griff is shown in Fig. 3. The casing c extends around the knives c_1, thus forming a rectangular frame, with the knives, which are shown broken in Fig. 3, extending from side to side. As the rod c_8 is alternately lowered and raised, it will in turn raise and lower the griff, and since the rod c_4 and stud c_3 are duplicated on the other side of the machine, although not shown in Fig. 2, the griff will thus receive an equal lift at each side. Since the upper curved ends of the hooks *a*, Fig. 3, can be made to assume such a position that they will be caught by the griff in rising, the hooks and, consequently, the harness lines will be lifted by the griff.

6. Referring next to the mechanism that selects the hooks to be raised, each hook is connected to a wire *d*, Fig. 3, known as a *needle*, that runs at right angles to the hooks and is connected at one end to a spring contained in the *spring box e*. Thus the needles are constantly being pushed forwards by these springs and held in such a position that they will cause the curved top of the hooks to become engaged with the griff. Provided that there were no mechanism to offset the action of the springs, all the hooks would occupy this position continually and would consequently be lifted by the griff each time it was raised. At the end opposite the springs, the wires pass through, and project slightly beyond, the *needle board*, or *face plate*, *f*. The cylinder *g*, Fig. 2, is capable of being brought against the needle board, and also contains holes that exactly correspond with the position of the needles as they project through the needle board. Thus, if nothing intervened between the needle board and the cylinder, all the hooks would be lifted by the griff in rising, since the needles are perfectly free to be pushed forwards by the springs.

7. The Cards.—Laced together and passing around the cylinder, as shown in Fig. 1, are a number of **cards** similar to the one shown in Fig. 5. This card is shown with all the

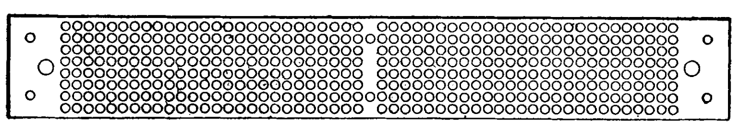

FIG. 5

holes cut, but it is possible to have any part of the card uncut, the number of holes cut and their position depending on the hooks that it is desired to lift.

If a number of cards, all similar to Fig. 5, should be laced together and passed around the cylinder *g* and the machine then operated, the needles would still retain the position that would cause the hooks to be lifted by the griff, since the holes in the cards would exactly correspond with those in the needle board and cylinder. On the other hand, should the cards not be cut at all, every needle in the machine would be pushed back, the hooks would not engage with the griff, and all the harnesses would remain down. It is by cutting some of these holes and not cutting others that some ends of the warp are raised and others left down, thus determining the weave.

The large holes, one at each side of the card shown in Fig. 5, are known as *peg holes*, and it is through these that the pegs g_1 shown on the cylinder g pass, thus holding the card in the exact position desired. The two small holes at each end of the card and also the two in the center are known as *lace holes* and are used when lacing the cards together; that is, attaching them to one another by means of cords so that they form a continuous chain.

One card determines the raising and lowering of the ends for only one pick; consequently, as many cards must be cut as there are picks in one repeat of the weave being produced, and these cards then laced together and passed around the cylinder. At each pick of the loom a new card is brought against the needle board and determines the hooks to be raised and those to remain down for that pick. In order to accomplish this, it is of course necessary to revolve the cylinder. The mechanism that has this for its object will be described later, as it is desired at present to deal only with those parts that bear directly on the lifting and lowering of the hooks.

8. The operation of the parts so far referred to is as follows: One face of the cylinder g together with a card is brought against the needle board f. Wherever a hole is cut in the card, a needle will project through, and the hook controlled by that needle will remain in such a position that its curved upper end will be caught by the griff when rising. Wherever the card is not cut, the needles coming against the card will be pushed back and the hooks controlled by those needles will be moved out of the path of the griff and will consequently remain down. As the crank-shaft of the loom revolves, the rod c_8, Fig. 4, will be lowered, thus raising the griff. As the griff is raised, all hooks controlled by needles passing through holes in the card will be caught and carried up by it, while all hooks controlled by needles that are pushed back by the card will escape the griff and remain down. In this manner the *shed* is formed.

During each revolution of the crank-shaft of the loom, the griff is both raised and lowered; consequently, the machine is *single-lift*. Before forming the shed for the next pick, all the warp ends are brought level at the bottom of the shed, thus forming a *close-shed*.

DETAILS OF CONSTRUCTION

9. The **griff** of a jacquard consists of the casing c, Fig. 3, and knives, or blades, c_1. There are as many of these knives in a jacquard as there are hooks in the short row, the number in this case being eight, although the number of hooks in both the short and long rows is dependent on the total number of hooks in the machine. The sides of the knives facing the hooks are beveled off or else the knives are inserted in the griff in a slanting position, in order to lessen their liability, when they are descending, of striking and bending the tops of the hooks that are down. If the sides of the knives were vertical, their lower edges in dropping would be certain to strike the tops of the hooks that were down. Even knives similar to those in Fig. 3 will at times strike and bend the tops of the hooks. When a hook is bent in this manner it is said to be *crowned*.

Another construction of the knives that also tends to prevent the crowning of the hooks is shown in Fig. 6. In this case there is, in addition to the slanting portion of the knife, a part that is vertical, the whole forming a knife deep enough to have its lower edge below the top of the hook, even when the hook is down and the knife up. With this construction there is of course no possibility of hooks being crowned, but the additional depth of the knives makes it more difficult to see into the machine if it is desired to examine any of its parts.

The construction shown in Fig. 7 is another method that is sometimes adopted. In this case the tops of the hooks are extended above the highest point reached by the griff in its lift and, consequently, the knives are at no time in such a position that they can strike the tops of the hooks. The

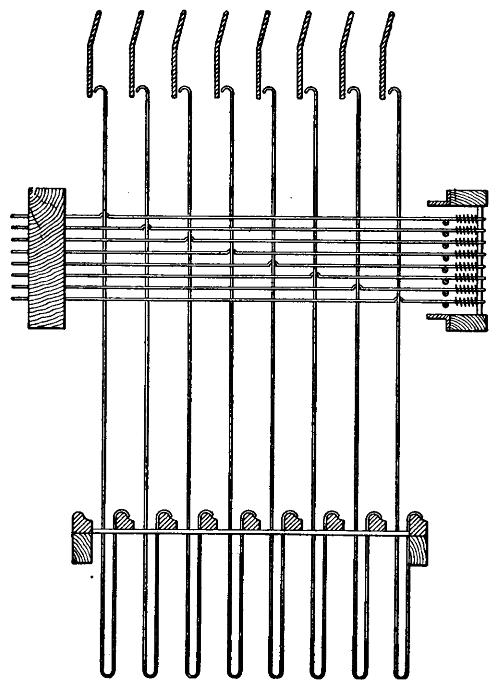

FIG. 6

disadvantage of a machine having its hooks and knives constructed in this manner is the rapid wearing away of the hooks, caused by constant chafing against the knives.

10. The Needles.—Fig. 8 is a plan view of a complete needle, similar to the top one shown in Fig. 3. The former represents the needle as it would appear when looking downwards on it; the curved part that operates the hook is shown.

bent horizontally. In Figs. 6, 7, and some others, the curve of each needle is shown as if inclined upwards; this is for the sake of clearness, as the needles are actually bent horizontally out of a straight line. Each needle in a vertical row differs from any other in the same row as to the position of the curved portion made to receive the hook. The top one has the curve at the longest distance from the spring

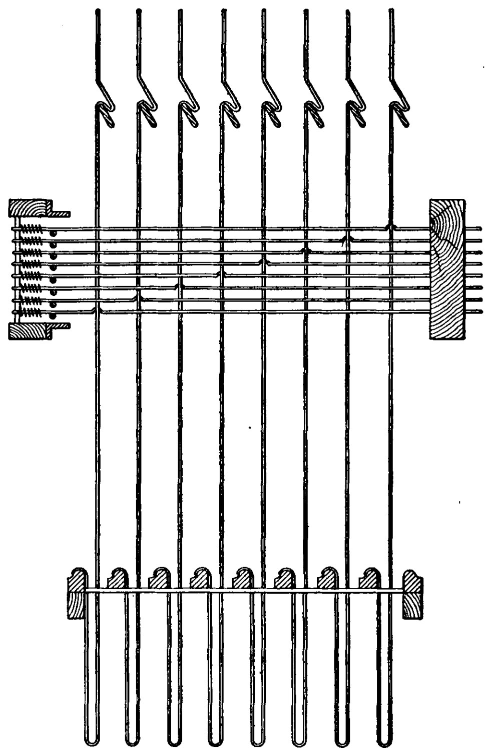

FIG. 7

box; the second one, a little nearer; and so on, until the bottom needle has the curved part nearest the spring box. As the hooks of a 400-hook machine are arranged in eight long rows, each cperated by a different knife, this variation in the construction of the needles is necessary in order to bring the curved part of each in the exact position to receive its hook. The hook passing through any one needle is locked in position by the other needles in the same vertical row, as shown in Fig. 3. On one side of each hook is the curved part of its needle, while the other seven needles pass

FIG. 8

on the other side of it. In this manner the hooks are prevented from moving out of their correct position, although any hook may be readily removed from the machine in case it is desired to fix any of the parts.

Other styles of needles are sometimes adopted, the middle portion of one of which is shown in Fig. 9. In this style the hook passes through a loop formed by the needle making

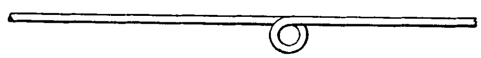

FIG. 9

a complete turn. The style of needle shown in this figure is not as commonly adopted as that shown in Fig. 8, since the latter is more easily removed in case repairs become necessary.

11. The Spring Box.—The construction of the **spring box** is shown in Fig. 3. It consists of top and bottom pieces connected by flat wires e_2, one wire passing through the eyes, or loops, of the needles in each vertical row. Rods e_1 connect one end of the spring box to the other and serve to separate the horizontal rows of needles. Carried by each needle is a spring e_3 that is compressed between the wire e_2 and the shoulder on the needle. These springs keep the needles pushed forwards except when they are pressed back by the cards.

12. Jacquard Harness.—The harness of a jacquard is entirely different from the harness on looms using cams or dobbies. A view of one line of a jacquard harness, together with all its attachments, is given in Fig. 10, the different parts with their letters of reference being as follows: *a*, the

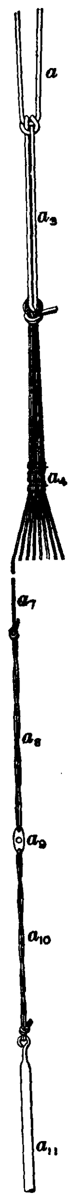

FIG. 10

jacquard hook; a_3, the neck cord, which is threaded through a hole in the *bottom board* a_{12}, Fig. 2; a_7, a harness line, 8 of which are attached to the neck cord in this case, all threaded through holes in a board known as the *comber board* extending across the loom, as seen in Fig. 1; a_8, the top loop, mid-piece, or sleeper, which is made of a double thread twisted and varnished; a_9, the mail, or eye, which contains three holes, the warp end being drawn through the center one; a_{10}, the bottom loop, or hanger, made of a double thread twisted and varnished; a_{11}, the weight, or lingoe. The sleeper, mail, hanger, and lingoe are frequently spoken of as one piece and are then known as the **coupling.** A harness line is sometimes spoken of as a *mail line.*

The action of the griff on the hooks is non-positive, since it simply raises the hooks without lowering them; consequently, some such attachment as the lingoe must be adopted to lower the hooks when the griff drops.

All parts of a jacquard harness are not necessarily similar to those shown in Fig. 10, since in many cases different methods of construction are adopted. This illustration, however, shows the general principles involved.

CYLINDER MOTIONS

13. Method of Turning the Cylinder.—The cylinder consists of four flat faces, one of which must press against the needle board at each pick of the loom. It is impossible to turn the cylinder when it is against the needle board, and it therefore becomes necessary to move it from the needle board in order that it may be turned.

The method adopted to turn the cylinder is shown in Fig. 2. As the cylinder g is moved from the needle board, the hook g_2, sometimes called the *pawl*, or *catch*, which is pivoted to the frame of the machine, will catch the *head*, or *lantern*, g_3 of the cylinder and turn it quarter way around, thus causing the next face of the cylinder to be presented to the needle board when the cylinder is again brought in. To prevent the cylinder from turning more than quarter way around, and also to keep it steady, so that it will always return squarely against the needles, it is held firmly by a hammer g_4, which is pressed against the lantern of the cylinder by springs g_6.

14. Mechanism for Moving Cylinder From Needle Board.—Several cylinder motions are applied to jacquard machines, all of which may be divided into two general classes, known as *self-acting cylinder motions* and *independent cylinder motions*, according to whether they are or are not actuated by the griff. All cylinder motions, whether independent or self-acting, should be provided with some means of regulating the time at which the cylinder is brought against the needle board, in order that the cards may act on the needles at the proper time. The motion must also give to the cylinder a dwell during the time that it should be kept pressed against the needle board, to allow the griff sufficient time to rise and thus escape the hooks that are pressed back by the card acting on the needles.

15. Independent Cylinder Motions.—An independent cylinder motion may be defined as one that moves the cylinder in and out by means of some mechanism entirely separate from the jacquard machine itself. This mechanism is usually driven by an eccentric on the crank-shaft of the loom.

A good type of this class of cylinder motions is shown in Fig. 11. The cylinder is supported by two arms h, h_1 that are pivoted at the points h_3. These arms are connected by a cross-piece h_2, the whole being known as the *cylinder gate*. Connected to the arm h is a rod h_4 attached to a bracket h_5 carried by the cross-shaft c_6, while a similar rod connects the arm h_1 to the bracket h_6, which is at the other end of the cross-shaft c_6. Connected to the shaft c_6 is the lever c_7 that is worked by the rod attached to the wheel on the crank-shaft of the loom. As the lever c_7 is thrown up by the revolving of the crank-shaft it acts through the shaft c_6

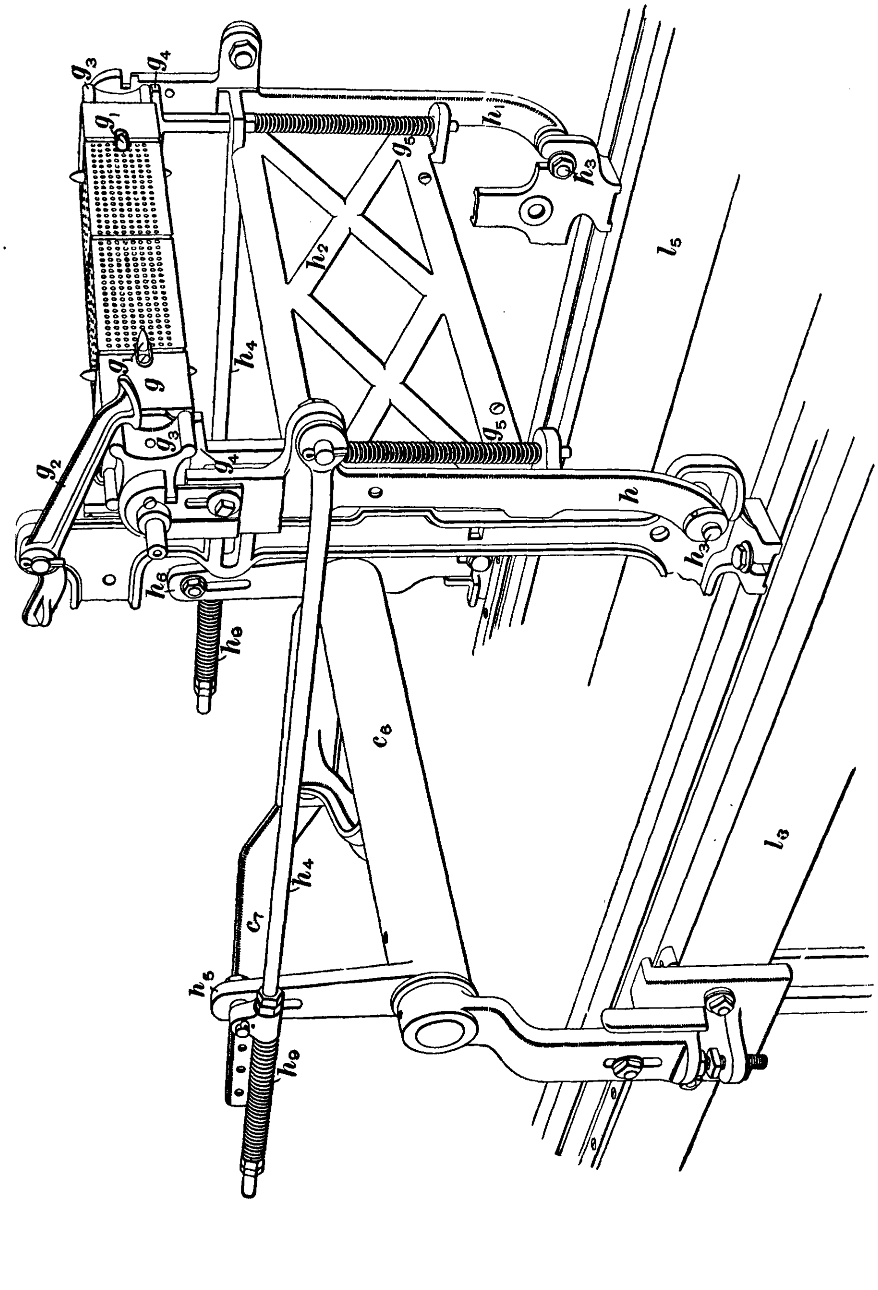

FIG. 11

brackets h_5, h_6, and rods h_4 to throw the cylinder gate away from the needle board; while, on the other hand, when the lever c_7 is brought down, the cylinder is brought in against the needle board. Springs h_9 are attached to the rods h_4 in order to prevent the breakage of any parts should an obstruction come between the cylinder and the needle board.

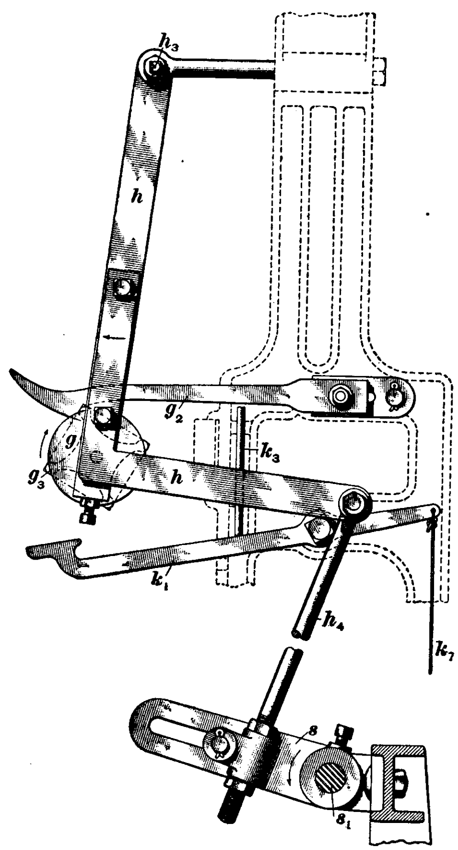

FIG. 12

16. Another independent cylinder motion is shown in Figs. 12 and 13. The cylinder *g*, Fig. 12, is supported by a lever *h* pivoted at h_3 and connected by a rod h_4 with a swivel-joint to an arm *s* that is setscrewed to the shaft s_1, which is carried in bearings supported by the framework of the loom. A segment casting s_2, Fig. 13, is also setscrewed to the shaft s_1 and contains a slot with which a projection s_3 engages. This projection is carried by a sliding plate s_{12} supported by a casting s_4 that is loose on the shaft s_1. A stud s_5 of the plate s_{12} extends through a bracket, or projection, s_{11} of the casting s_4. The plate s_{12} also carries two other projections s_6, s_7, which are in contact with an arm s_8. This arm is pivoted to another arm s_9 fast on the shaft s_1 and cast in one piece with s_2; a spring s_{10} attached to the arm s_9 tends to force the upper end of the arm s_8 to the right, thus keeping the projection s_3 in the slot of the segment casting s_2. By this means, although the casting s_4 is loose on the shaft s_1, it will communicate to the latter any motion received when the projection s_3 is engaged with s_2, as the latter is fast to the shaft. Connected to the casting s_4 is a rod t that is operated by an eccentric t_1 on the crank-shaft of the loom. The action of this motion is as follows: As the eccentric t_1 revolves with the crank-shaft, the rod t is alternately forced up and down, imparting motion to the casting s_4 and consequently, by means of the connection that s_3 makes with s_2, giving an oscillating motion to the shaft s_1. This motion of the shaft being communicated to the rod h_4, Fig. 12, through the arm s, moves the cylinder g in and out.

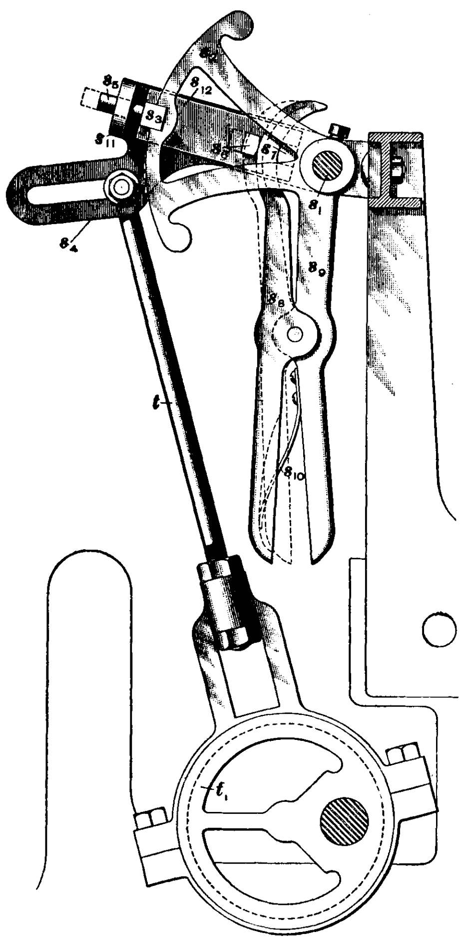

Fig. 13

On its outward movement, the lantern g_3 of the cylinder engages a pawl, or latch, g_2, thus turning the cylinder one-quarter of a revolution.

The advantage of an independent cylinder motion is that it is possible, by timing the eccentric, to bring the cylinder in against the needle board at any desired time; and by timing this motion correctly, there will be no danger of the needles being pressed back by the cards during the time that the hooks are held by the griff.

17. Self-Acting Cylinder Motions.—A self-acting cylinder motion may be defined as one that is actuated by some part of the jacquard machine itself; this part is in almost every case the slide rod that is connected to the griff.

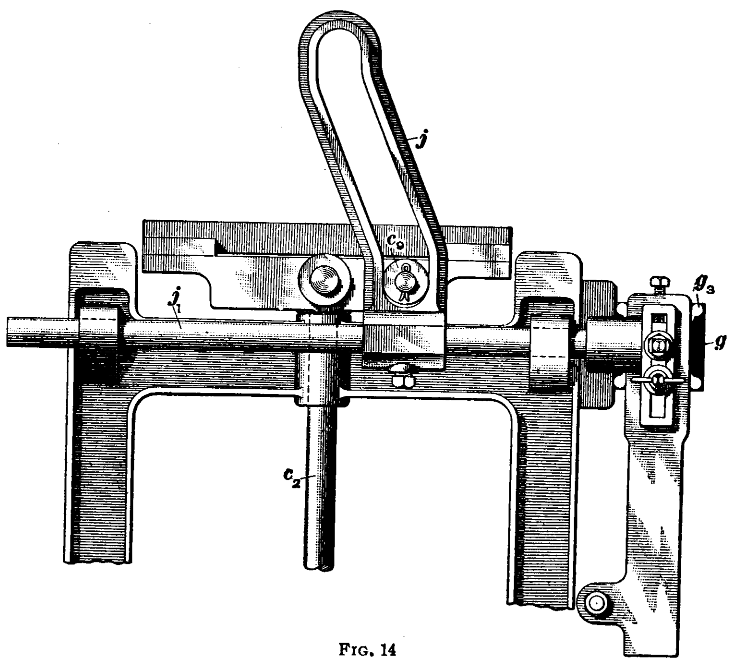

FIG. 14

Figs. 14, 15, and 16 show different types of the self-acting motion, all of which actuate the cylinder by means of the rising and falling of the griff.

Referring to Fig. 14, the griff carries a stud on which is a roller c_9 that works in the slot of the casting j, known as the *swanneck*. This swanneck is setscrewed to a rod j_1 that works in bearings fastened to the side of the machine and is connected at one end to the cylinder *g*. Thus, any vertical movement of the stud fastened to the griff will give to the swanneck a horizontal motion, since the lift of the griff is exactly perpendicular while the slot in which the stud works is oblique. Moreover, any horizontal movement of the swanneck will, in turn, be imparted to the rod j_1, since these two parts are securely fastened by the setscrew. Moving the rod j_1 in its bearings will also move the cylinder *g* in the corresponding direction. Consequently, as the griff is raised and the stud brought to the upper part of the

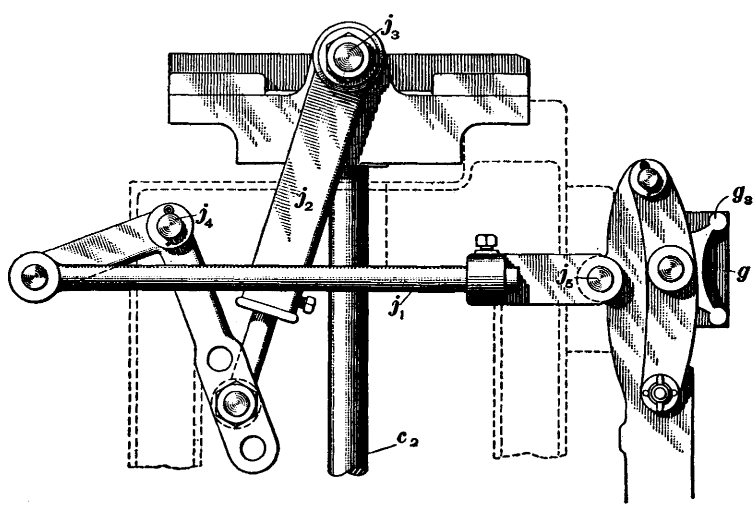

FIG. 15

slot in the swanneck, the cylinder will be pushed from the needle board; while, on the other hand, as the griff is lowered and the stud brought to the lower end of the slot, the cylinder will be brought in against the needle board. With such a motion as this, shown in Fig. 14, the dwell is given to the cylinder by means of that part of the slot in the swanneck that is exactly perpendicular.

18. Fig. 15 shows a cylinder motion that is similar in principle although slightly different in construction from that shown in Fig. 14. In this case the stud on the griff, instead of carrying a roller working in a slot, is connected to an arm j_2, as shown at j_3. Fulcrumed at j_4 is a lever that serves to convert the vertical motion of the arm j_2 into a horizontal motion of the rod j_1, which is connected at the point j_5 to the cylinder frame. As the arm j_2 is raised and lowered by means of the action of the griff, the rod j_1 will be moved back and forth, which will result in the cylinder being alternately moved from, and brought against, the needle board.

19. Fig. 16 illustrates a self-acting motion that contains an escapement feature not found on any of the motions previously described. In this motion, the rod j_6 is connected at one end to the stud on the griff, while its other end is connected to a lever consisting of two parts j_7, j_8, each of which is fulcrumed at j_9. A strong spiral spring j_{10} connects these two parts, causing them to act similar to the levers shown in previous illustrations of self-acting motions and convert the vertical motion of the rod j_6 into a horizontal motion of the connection j_{11}. This connection is fastened to the cylinder frame and, consequently, as it is moved back and forth, the cylinder will be moved out and in.

The action of this motion is as follows: As the rod j_6 is lowered by the action of the griff it will carry with it the part j_7, which, being connected to the arm j_8 by the spring j_{10}, will lower this upper arm and cause j_{11}, together with the cylinder, to be brought in toward the needle board. The spring j_{10} is sufficiently strong to resist the action of the needles against the cards; consequently, all those needles that do not come opposite holes punched in the card will be pushed back. If, however, any obstruction comes between the cylinder and needle board, when the cylinder is brought in, the spring j_{10} will yield and thus prevent the breakage of any of the parts of the cylinder motion. Since all cylinder motions must have a certain length of dwell in order to permit the cards to keep the needles pressed back until the griff has been lifted above the heads of the hooks, this motion is set in such a manner that the cylinder will reach the needle board before the rod j_6 has reached the limit of its downward stroke. This will cause the spring j_{10} to be extended and the two parts j_7, j_8 pressed apart. When the griff begins to rise again, the two arms must be brought

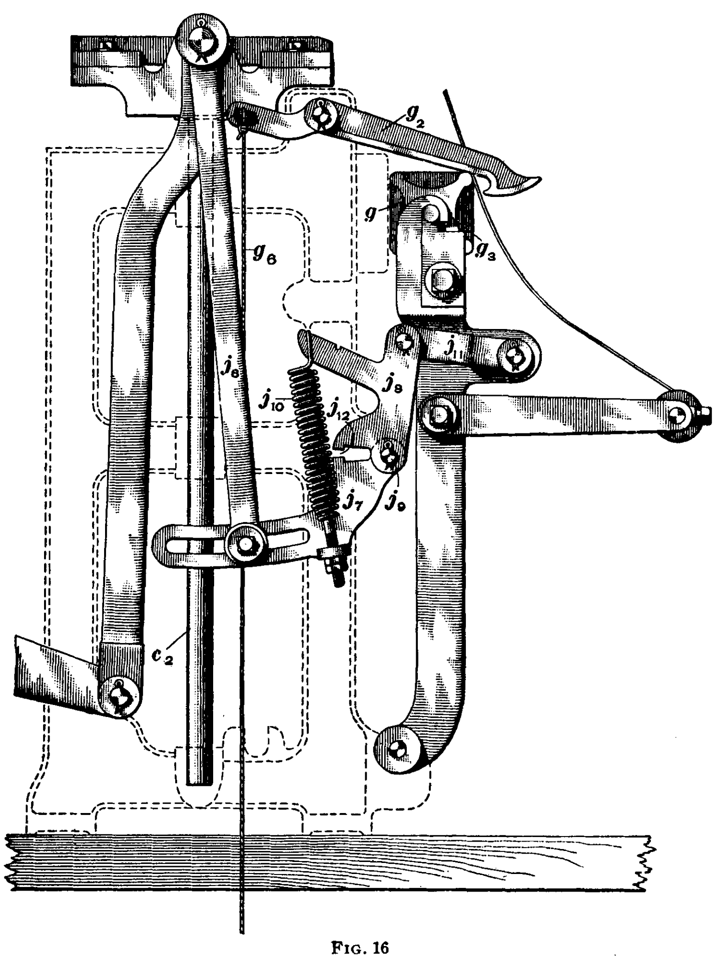

FIG. 16

together at the point j_{12} before any movement of the cylinder can take place, thus allowing the griff to rise above the heads of those hooks that are to be left down.

20. On all jacquards, the cylinder is provided with a motion by which it may be turned back by hand, in case the cards are by any means working ahead of their correct position, as, for example, when the filling has run out and the loom run a pick or more without filling. Such a motion is shown in Fig. 17. Connected to the cylinder is the cylinder head, or lantern, g_3, which is acted on by a pawl k_1 pivoted at a point k_3 to a casting k_2 that is loosely pivoted at k_4. A spring k_5 throws the upper end of the casting k_2 to the left until the part k_6 that is attached to the pawl comes in contact with the supports of the cylinder. When, however, it is desired to turn back the cylinder, the cord k_7 is pulled down and thus pulls the casting k_2, together with the pawl k_1, to the right, and the pawl k_1 engaging with the lantern g_3 turns the cylinder. The position of these parts when the pawl k_1 is in contact with the lantern g_3 is shown by the dotted lines in Fig. 17.

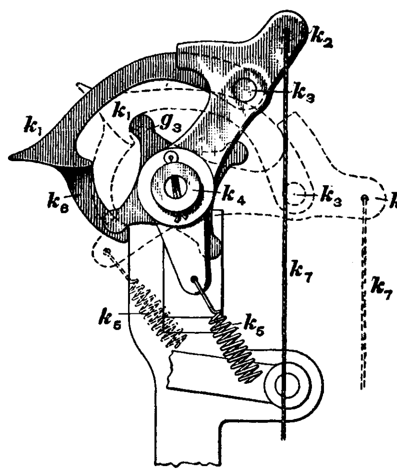

Fig. 17

21. Another type of reversing motion is shown in Figs. 12 and 13. In this case, when it is desired to turn the cylinder independently of the loom, the lower ends of the arms s_8, s_9 are pressed together, against the tension of the spring s_{10}, Fig. 13. When this is done, the arm s_8 will assume the position shown by the dotted lines, thus moving the plate s_{12} to the left and disengaging the projection s_3 from the slot in the segment casting s_2. Then by drawing the lower ends of the arms s_8, s_9 first to the right and then to the left the shaft s_1 will be turned, thus operating the cylinder g, Fig. 12. This action alone turns the cylinder in the same direction that it is turned while the loom is running, but in case it is desired to reverse the motion of the cylinder, the cord k_7 is drawn down, which raises the pawl k_1 into contact with the lantern g_3 of the cylinder g. At the same time that the pawl k_1 is raised, a rod k_3 that rests on the pawl k_1 will be brought into contact with the pawl g_2, raising it out of contact with the cylinder; consequently, if the handle formed by the arms s_8, s_9, Fig. 13, is moved when the pawls are in this position, the cylinder will be turned in the opposite direction to that in which it moves when the machine is running. It is not advisable at any time, under ordinary conditions, to turn the loom backwards.

22. Card Cradles.—Owing to the large number of cards necessary on the jacquard machine, considerable strain would be brought on the cylinder if it were obliged to sustain their entire weight. It is also even more important that some provision should be made for assembling and keeping the bulk of the cards in a convenient position so that they may be taken by the cylinder in proper rotation and presented to the needles.

In order to accomplish this to the best advantage, a **card cradle** similar to that shown in Fig. 18 is generally used. The cards as they fall from the cylinder g pass over a roll l_2 and then between the beams l_5, l_6 on which the jacquard machine is placed. Attached to these beams are two curved iron rods l, l_1 so adjusted that the distance between them is only very slightly in excess of the length of a card. Wires l_4 slightly longer than the cards are attached to the set of cards at regular intervals, generally a wire at about every fourteenth, sixteenth, or twentieth card. After the cards pass over the roll l_2, they fall between l and l_1; but when a wire reaches these rods its ends rest on them, thereby supporting the cards. As the cards are taken by the cylinder, the wires l_4 pass beyond the rods l, l_1, the cards passing over the roll l_3 to the cylinder g.

23. The pegs g_1, Fig. 2, inserted in the cylinder so as to pass through the peg holes in the card and thus insure its occupying the correct position, are sometimes permanently fastened to the cylinder; but since in such cases it is impossible to adjust them so that the holes in the card will correspond exactly to the holes in the cylinder, this practice is not to be recommended. They should rather be attached

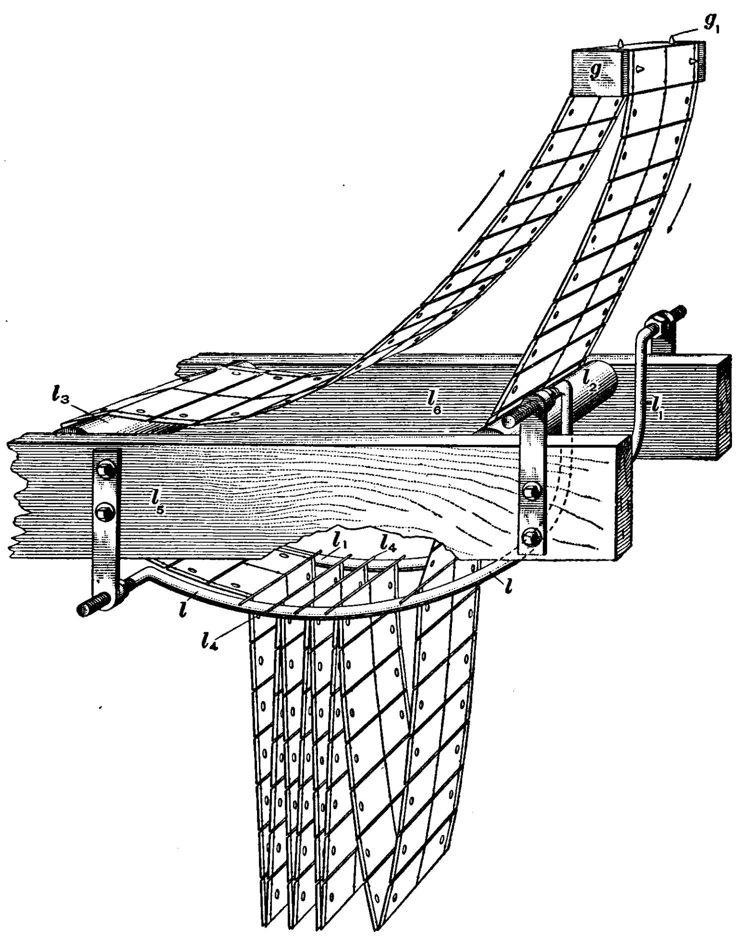

Fig. 18

to a socket or plate, set into the cylinder, in such a manner that they may be adjusted to meet the requirements of the cards.

Owing to the speed at which the cylinder of a jacquard rotates, and because of its somewhat irregular, or jerky, movement, certain appliances are added for the purpose of keeping the cards in place on the cylinder. Referring to Fig. 2, as the cards are brought up to the cylinder they pass beneath a roll i_7 and two springs i_2, i_3. These springs are so bent as to press each new card on to the cylinder so that its peg holes will engage the pegs g_1 and be pushed down on them instead of riding on the top of the pegs, as they would otherwise be liable to do. In addition to the pegs g_1 for keeping the cards in place on the cylinder, two springs i, i_1 are also provided for the purpose of pressing the card firmly in place on the face of the cylinder as the latter is brought in to the needles.

Some device must also be provided so that the cards will be positively removed from the cylinder after they have been presented to the needles, since otherwise they would be liable to stick on the pegs and be wound around the cylinder. One such device is shown in Fig. 2, and consists of two bands i_5, i_6 running around the cylinder and around two loose whorls i_8, i_9. As the cylinder rotates, these bands force the card to leave the pegs and fall into the cradle.

RISE-AND-FALL MOTION

24. Disadvantage of Single-Lift Jacquard.—One of the disadvantages of the ordinary single-lift jacquard is that all the warp yarn must be brought level at the bottom of the shed before the next shed can be formed. This necessitates considerable loss of time, and as a result the loom must be run at a much slower speed than is possible with open shedding. Various attempts have been made to overcome this defect, and at the present time many machines are made that claim to overcome this fault.

25. The **rise-and-fall motion**, Fig. 19, is frequently applied to jacquard machines for this purpose. When the hooks are not raised by the griff, they are supported by the grating *b*, Fig. 3, through which the lower ends of the hooks pass. The object of the rise-and-fall motion is to lower this grating at the same time that the griff is raised, and vice versa, thus producing a *split shed*, since the yarn becomes level at the center of the shed. Referring to Fig. 19, the griff *c* is raised and lowered by the connecting-rod m_1, which is attached to the lever *m*; the rod c_2 is connected to the

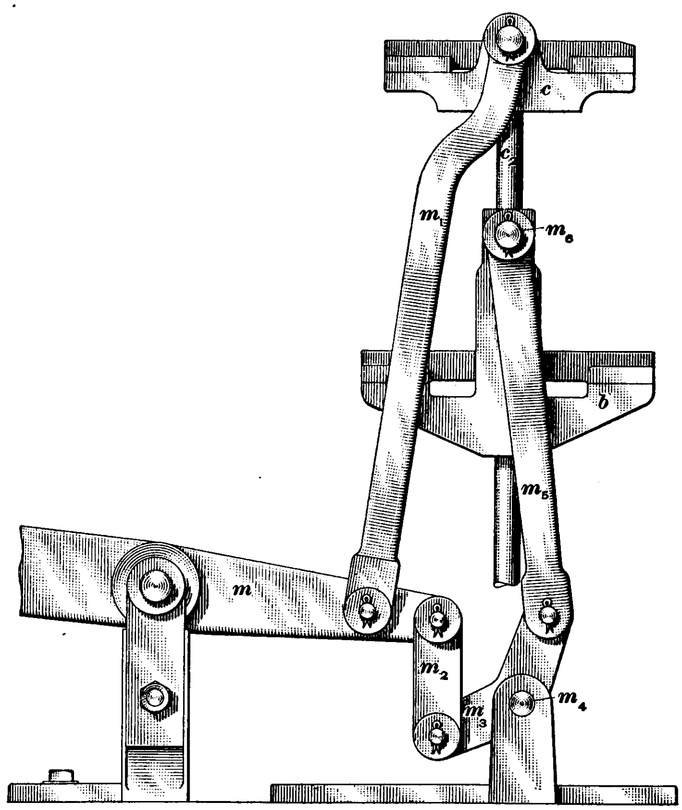

FIG. 19

griff *c*, and consequently rises and falls with it. The action of these parts is very similar to the action of the griff in the ordinary single-lift machine. In this machine, however, the grating *b*, Fig. 19, instead of being stationary, slides on the rod c_2, motion being imparted to it by the rod m_5, which is acted on by the elbow lever m_3 attached to the lever m by means of the connection m_2. The connections from the lever m to the griff c and grating b are therefore such that as the griff is raised the grating will be lowered; while, on the other hand, as the griff is lowered the grating will be raised. Thus the hooks that are caught by the griff will be lifted as the griff is raised, while the other hooks will be lowered, through the action of the grating.

This motion has found considerable favor and is easier on the yarn than the ordinary single-lift machine, since in forming a shed the yarn passes through only half the distance that is necessary with a single-lift machine.

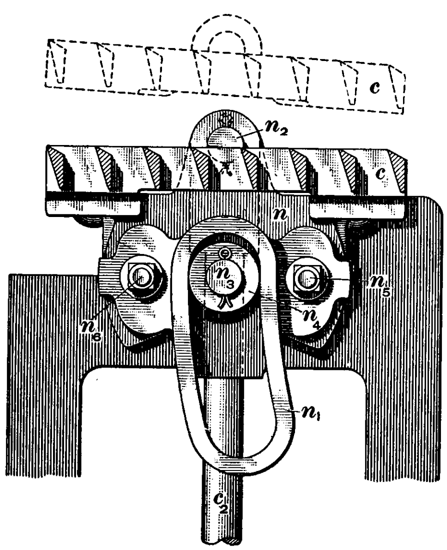

Fig. 20

26. Angular-Shed Motion.—To the rise-and-fall jacquard machine, there is sometimes attached a motion known as the **angular-shed motion,** shown in Fig. 20. Its object is to raise the hooks at the back of the machine higher than those nearer the front. As the mail eyes in the harness lines controlled by the rear hooks are farther from the cloth being woven than the mail eyes connected with the front hooks, the additional lift given to the rear mail eyes provides a means of keeping the warp ends in the top shed in the same plane when lifted. The griff c, instead of being firmly attached to the lifting rod c_2, swings on a stud n_3 that is carried by the rod c_2. Connected to the griff c is a casting n that carries a loop n_1 in which works a bowl n_4 carried by a stud n_5. The bowl n_4 and stud n_5 are of course stationary, being attached to the frame of the machine, while the casting n and collar n_1 rise and fall with the griff c. Owing to the shape of the collar n_1, as the griff is raised it will be turned slightly on the stud n_2, the position that it assumes when up being shown by the dotted lines in Fig. 20. In this manner the knives at the back of the griff are given a greater lift than those at the front. The nuts n_3, n_4, Fig. 20, are simply adjusting nuts, by means of which the griff c may be given its correct position.

DOUBLE-LIFT JACQUARDS

DOUBLE-LIFT SINGLE-CYLINDER JACQUARD

27. The Griffs.—The construction of a **double-lift jacquard** is such as does not necessitate all the warp yarn being brought level before commencing to form a new shed. In order to accomplish this, two griffs are employed, one

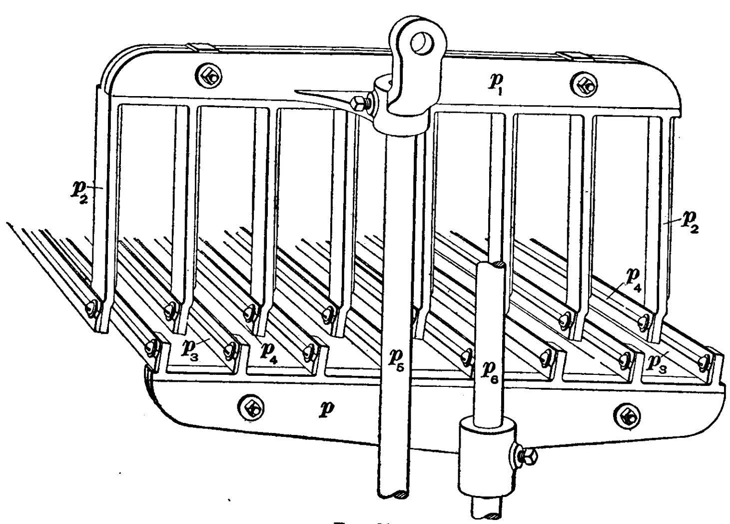

FIG. 21

being raised on one pick and the other on the next pick. The manner of arranging this part of the machine is shown in Fig. 21. in which p is the framework of one griff and p_1 the framework of the other. The griff knives p_3 are fastened directly to the framework p, while the knives p_4 are fastened to arms p_2 that extend from the framework p_1. This method of connecting the griff knives is adopted in order to allow them to pass each other, as is necessary when one set of knives is raised and the other lowered. The arms p_2 must be long enough to allow the two griffs to pass each other sufficiently to form the desired size of shed without having the knives of the griff p come in contact with the framework of the griff p_1. The rods p_5, p_6, Fig. 21, which are duplicated on the other side of the machine, are slide rods to keep the two griffs steady when rising and falling.

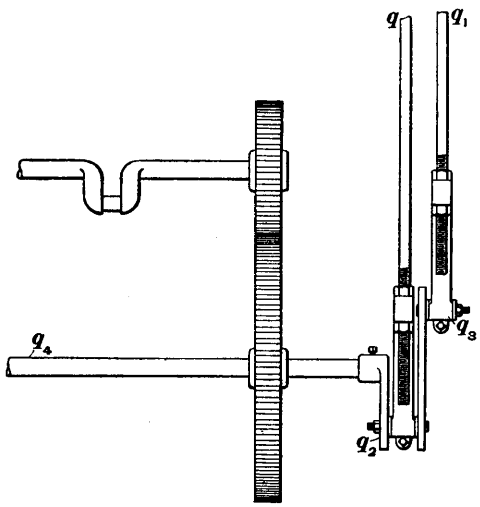

Fig. 22

The griffs are raised and lowered by means of two levers placed side by side, each of which is very similar to the lever that actuates the griff of a single-cylinder jacquard. These levers receive their motion from two rods q, q_1, Fig. 22, that are connected to a double crank q_2, q_3. The crank is fastened to the end of the camshaft q_4 of the loom; consequently, it makes one complete revolution while the loom is making two picks, the rod q lifting one griff on one pick and the rod q_1 lifting the other griff on the next pick.

28. The Hooks and Needles.—As it is often desired to raise certain ends on two or more successive picks, a different arrangement of hooks from that described must be adopted in a double-lift jacquard, since with this machine if a hook is raised on one pick, it must necessarily drop with its griff and lower the ends controlled by it on the next pick. To obviate this difficulty, two hooks are used in a double-lift

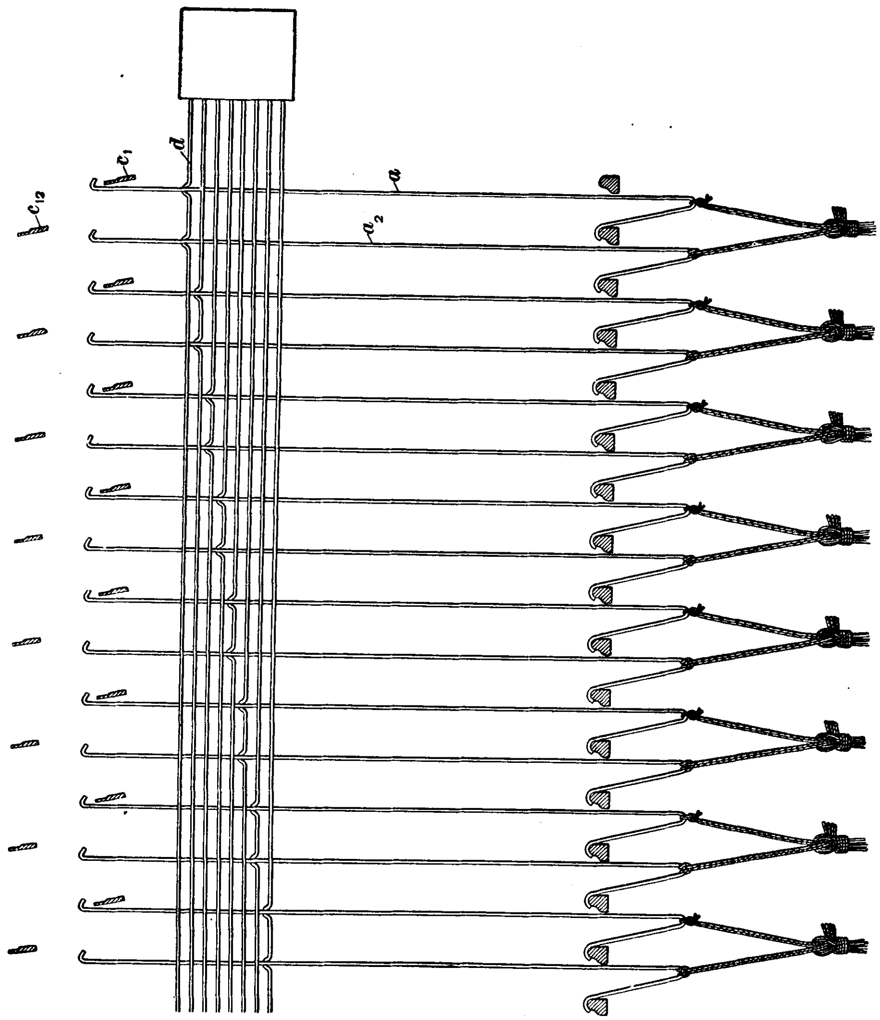

Fig. 23

machine, each controlling the same ends as one hook in a single-lift jacquard and being operated by one needle in the case of a single-cylinder double-lift machine; consequently, in a double-lift single-cylinder machine there are twice as many hooks as in a single-lift jacquard of the same capacity, although the number of needles is the same in both instances. The arrangement of the needles and hooks and also the neck cords of a double-lift single-cylinder jacquard is shown in Fig. 23.

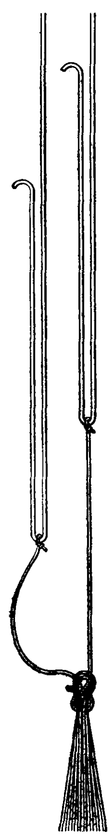

FIG. 24

Since each alternate hook is controlled by one griff while the remaining hooks are controlled by the other griff, and since the action of the two hooks is governed by a single needle, the ends controlled by these hooks may be raised on any pick as desired, regardless of which griff is raised. For example, consider the ends operated by the two hooks a, a_2, Fig. 23, which are controlled by the needle *d*. The hook *a* is raised when desired by the griff blade c_1, while the hook a_2 is raised by the blade c_{12}. If the blade c_1 is down and there is a hole in the pattern card to allow the needle *d* to pass through, the hook *a* and, consequently, the ends that it controls will be raised when the griff is lifted. On the other hand, if the blade c_{12} is down and a hole in the pattern card for the next pick comes opposite needle *d* and allows it to pass through, the hook a_2 will be caught and raised by this blade, and the same ends will be again lifted.

29. The Neck Cord.—Fig. 24 illustrates one manner in which the neck cords are attached to the harness lines on a double-lift jacquard. The neck cord shown in this illustration consists of two parts, one part being attached to one hook and the other part attached to the other hook of the pair that controls the same harness lines. When one hook is raised by its griff, the neck cord attached to that hook will, of course, become tight, while the neck cord attached to the other hook will become slack. This position is shown in Fig. 24. When both hooks are down, both neck cords become tight.

Another method of connecting the neck cord to the hooks is shown in Fig. 25. In this case only one neck cord is necessary, it being connected to the harness lines in the usual manner, and also to a small metallic-link arrangement that is free to slide on the lower bends of the hooks. As one hook is raised this link will slide up on the other hook, which will of course remain down, thus allowing the neck cord to be lifted by the hook that is raised without interference on the part of the other hook. With this arrangement a hook is raised slightly before it starts to lift the harness lines, since there is a slight loss of motion due to the turning of the link arrangement on the hook that is down.

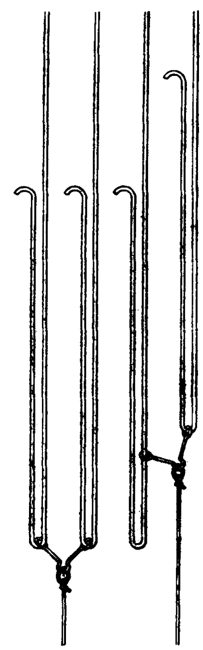
FIG. 25

A double-lift jacquard does not form a true open shed, but what is known as a **compound shed.** As shown in Figs. 23 and 24, if the same harnesses are to be lifted on two consecutive picks, the neck cord attached to the hook that is raised on the first pick will drop to the center of the shed before the neck cord that is to lift the harness on the second pick becomes tight; consequently, in this form of shedding there exists a stationary bottom shed, but at every pick the top shed is lowered to the center and those harnesses that were raised on the previous pick and that are required to be raised on the next pick are again lifted to the top, while those that are required to be down on the next pick continue their movement to the bottom shed. A similar action occurs with the link arrangement shown in Fig. 25 as when two neck cords are used.

30. Before the style of griff shown in Fig. 21 was adopted, the hooks of a double-lift jacquard were made in two lengths and one griff worked above the other, instead of the knives of one griff passing through the other as is done at present; this arrangement is shown in Fig. 26. With this motion, the vibration of the long hooks was so great that in many cases they were caught up by the knives when they were intended to remain down and, consequently, they were discarded for the shorter hooks, which are much more certain in their action.

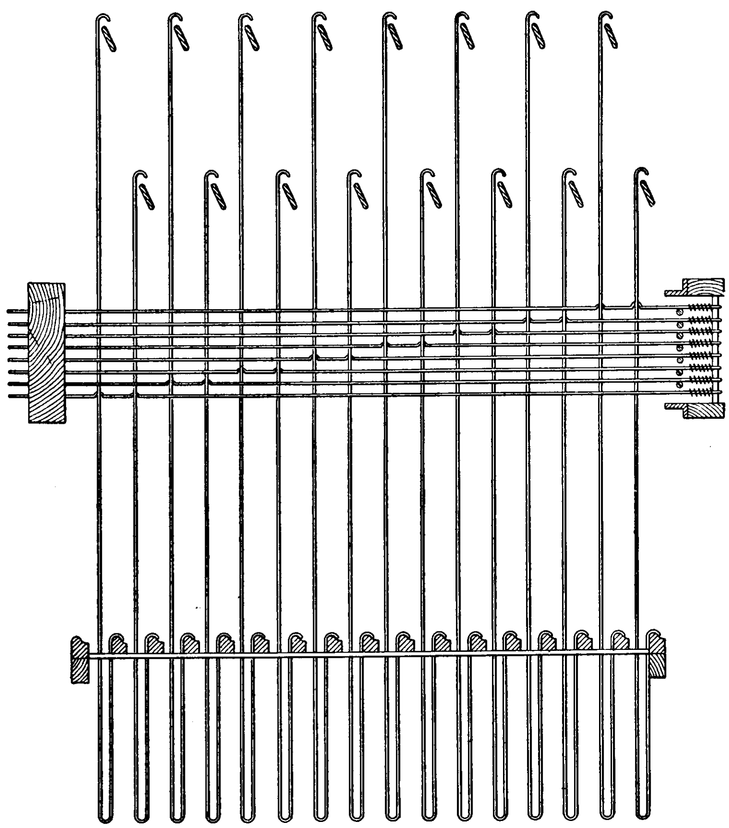

Fig. 26

31. Since in a double-lift single-cylinder jacquard one needle operates two hooks, when the needle is pushed back by the cylinder one of these hooks is liable to be held by the griff blade while the other is perfectly free to move. For instance, if the harness controlled by the hook a_2, shown raised in Fig. 27, is to remain down on the next pick, the pattern card will press back the hook a_1 by means of the needle, in order that it may escape the griff blade c_1 when it starts to lift. Since the hook a_2 is still on its griff blade c_{12} and is also being pushed back by the needle, considerable strain will be brought on the needle and hook unless some escapement device is provided.

This difficulty is overcome by making the bottom part of the hook **V** shape and having the opening in the grate through which it passes large enough for its widest part. This part rests in the grate when the hook is down and, consequently, when the hook is raised, there is considerable unoccupied space in the slot, which allows the hook to be pushed back by its needle without bringing any strain on it, as shown by the dotted lines in Fig. 27.

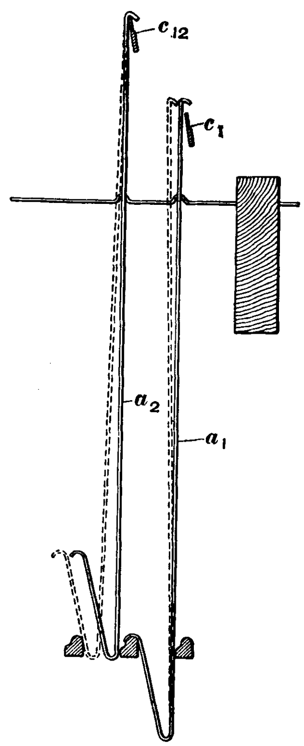

FIG. 27

32. Speed.—Double-lift single-cylinder jacquards can be run at a much higher rate of speed than single-lift machines, since the shed can be formed in much less time. One difficulty, however, is the speed at which the cylinder must move in and out in order to meet the requirements of the increased speed. For illustration, suppose that a double-lift single-cylinder jacquard is run at twice the speed of a single-lift machine (this speed is excessive but will serve to illustrate the point); the griffs in both cases will have the same speed, but the cylinder in the former case must attain twice the speed that it has in the latter case, since it must operate the needles for each griff. This increased speed of the cylinder tends to cause the cards to jump off the cylinder pegs, besides increasing the wear on the different parts; in order to overcome this defect two cylinders are sometimes applied to double-lift machines.

DOUBLE-LIFT DOUBLE-CYLINDER JACQUARDS

33. The arrangement of the hooks, needles, spring boxes, and needle boards in a machine that employs two cylinders is shown in Fig. 28. With this arrangement there are double the number of hooks and also double the number of needles that there are in a single-lift machine. The cylinders are placed one at each side of the machine, the griff blades of the two griffs being inclined in opposite directions and the two sets of hooks that are operated by these two griffs having their points turned in a suitable manner to meet the requirements of the position of the blades.

In this machine, the hooks are controlled by the needles in exactly the same manner as in a single-lift machine, but since there are two sets of hooks, two griffs, two banks of needles, and two cylinders, one cylinder will act on one set of needles and hooks on one pick, and the other cylinder will act on the other set of needles and hooks on the next pick. It is therefore necessary to have a card on one cylinder cut in a suitable manner for one pick, while a card on the other cylinder will serve for the next pick. To illustrate this point more fully, suppose that on the first pick of the weave the cylinder on the right is brought against the needle board; then if the holes are cut in this card correctly, the desired hooks will be lifted by the griff operating this set of hooks, and those ends that should be up on this pick will be raised, while the others will remain down. On the next pick the cylinder at the left will be brought against the needle board and the card will operate the needles in such a manner as to lift the ends correctly. Since the first, third, fifth, seventh, ninth, eleventh, thirteenth, and fifteenth hooks operate the same ends, respectively, as the second, fourth, sixth, eighth, tenth, twelfth, fourteenth, and sixteenth, it is possible for either cylinder to control every end in the warp.

When the cylinder at the left is pressing against the needle board, the griff that operates the hooks controlled by this set of needles must, of course, be down ready to engage with

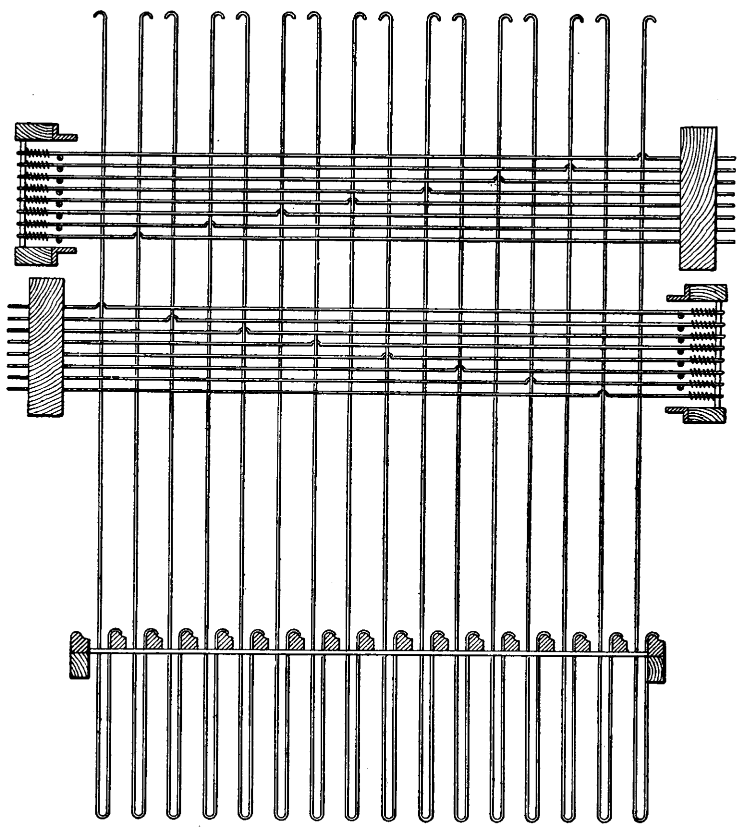

Fig. 28

the hooks that are to be lifted on that pick. On the other hand, when the cylinder at the right is pressing against the needle board, the griff that operates the hooks controlled by this set of needles must be down. The griffs of a double-lift double-cylinder jacquard operate in exactly the same manner as those of a double-lift single-cylinder machine and, consequently, one griff lifts the hooks on one pick and the other griff lifts the hooks on the next pick. Since in this machine there is one cylinder for each griff, it is necessary for the cylinders to travel at only half the speed of the cylinder on a double-lift single-cylinder jacquard. This is the chief advantage of this style of construction.

34. A difficulty that must be contended with when weaving on a double-lift double-cylinder jacquard is the liability of one cylinder getting ahead of the other. Since the first card on one cylinder operates the hooks on the first pick and the first card on the other cylinder operates the hooks on the next pick, this alternate use of the cylinders being continued throughout all the cards on both cylinders, if a card on one of the cylinders is skipped (which is spoken of as one cylinder getting ahead of the other), the cards will not be brought against the needle boards in proper rotation, and the warp ends will not be raised and lowered correctly to form the desired weave. This is the principal drawback to a double-cylinder machine, and by some manufacturers is considered of so much importance that they prefer the single-cylinder to the double, notwithstanding the high speed at which the cylinder must run when it is necessary to operate the needles for two griffs.

FIXING AND SETTING JACQUARDS

FILLING SKIPPING

35. Jacquard machines, like all other weaving mechanisms, require constant attention to keep them in perfect working order, and they are also liable to certain defects that do not occur with other shedding arrangements. One of the principal difficulties is known as **filling,** or **shuttle, skipping,** or **flying over,** the terms meaning that the shuttle in passing from one box to another passes over a number of ends in each repeat of the pattern that it should have passed under, each pattern in the width of the cloth showing exactly the same defect. There are many causes of shuttle skipping, one of the most important being that one or both of the peg holes is enlarged by the card being broken or worn, so that it is not held in the correct position on the cylinder. In this case some of the needles that should remain undisturbed are pushed back, because the holes in the cylinder are partially covered by the card; consequently, some of the hooks that should be lifted by the griff are pressed away from the knives and remain down, thus causing the ends that are operated by such hooks to remain in the lower shed instead of being raised so as to allow the shuttle to pass under them.

The peg holes are often broken by the cards having an irregular movement given them by the cylinder, which causes them to jump so that they do not engage with the pegs properly as they are taken by the cylinder. Broken peg holes are also caused by a broken lacing. In this case, when the cylinder is turned, the cards rest on it in whatever position they happen to be. If the lacing is very slack, this is liable to occur, even if it is not actually broken. If one of the springs that presses the card on the cylinder becomes broken, the card slides away from the cylinder slightly on the peg, owing to the latter being tapered, and when the card comes against the needles the peg hole is liable to be enlarged as the card is forced back close to the cylinder again. Sometimes the wires that are placed in the set of cards to hold them in the cradle will drop between the bars of the cradle and become caught so that as the cylinder takes the cards a great strain is brought on them. This will often draw the cards off the cylinder pegs, and when the cylinder moves in to the needle board the card is broken by the peg. If any of the cylinder pegs are loose, it is very evident that they are liable to be displaced and break the cards. Sometimes, also, the blades of the griff are not set close enough to the hooks, which of course causes the griff to miss them when they should be caught and raised. Often the cards of a set will not be uniform because they have been cut on different machines or because new and old cards are used in the same set. This will often cause certain cards to partially cover the holes in the cylinder and thus push the needles back so that the hooks will miss the griff. Sometimes the needle board will become loose and drop out of place slightly, thus causing the needles to bind so that they will not return the hook into position to be raised.

HOOKS MISSING, OR STITCHING

36. The defect known as **stitching,** or **hooks missing,** results when one or more hooks fail to be engaged and raised by the griff when they should. The effect of this in the cloth is that the ends controlled by those hooks remain down, when in reality they should be raised. This is somewhat similar to shuttle skipping, but in the latter case, usually a number of hooks fail to be caught by the griff, whereas stitching is generally the effect of only one or a few hooks failing to work properly.

There are a number of causes of this difficulty; one of the most important is that the needle operating the particular hook that is missing is bent so that when pressed back by the cylinder it binds in the needle board, and as the spring on that needle is of insufficient power to force it out again, the hook remains off the griff, and the warp ends controlled by it remain under the filling.

Sometimes the needle board becomes filled with gummy oil and dirt, so that the needles do not work freely in it, and are thus liable to be caught. Another cause is a broken needle spring. The spring also may be an old one and so worn that it is not strong enough to press back the needle. Sometimes stitching is caused by one of the pattern-card holes not being cleanly punched; thus, as the needle comes in contact with the card, the punched portion is forced into the hole of the cylinder, which will sometimes result in the needle being pressed back every time that side of the cylinder is brought in to the needles.

If a hook is bent back, it is liable to miss the griff and cause the ends controlled by it to weave under when they should be raised. Whenever hooks that should be lifted are being left down, a good method of determining whether the needles are coming against the card at the correct position is to rub a little black oil over their points and then bring the cylinder against the needle board. The points of the needles when treated in this manner will mark the card, and by noticing the places at which these marks come it can readily be determined if any of the needles are not passing through their holes in the cards.

ENDS FLOATING ON FACE OF CLOTH

37. Ends floating on the face of the cloth is a defect caused by hooks being engaged by the griff and raised when they should remain down, thus resulting in the ends controlled by such hooks being raised, whereas in stitching the ends are lowered, since the hooks fail to be caught by the griff. This is sometimes caused by vibration of the hooks, and sometimes by the blades of the griff being set too close to the hooks.

Again, some part of the cylinder mechanism may be loose or may have slipped so that there is sufficient lost motion to result in the cylinder failing to press some of the hooks clear of the griff. If a hook is bent forwards, it will be caught by the griff and raised when it should remain down.

The grate may become loose and slip slightly out of place, which in the case of a double-lift double-cylinder machine will cause the hooks of alternate rows to be caught on the blades of the griff, while the hooks in the other rows will miss the griff and fail to be lifted.

Atmospheric conditions cause the harness lines to shrink or lengthen slightly; in the former case this causes ends to remain above the filling when they should be below, and vice versa in the latter case.

CROWNING HOOKS

38. When the griff in descending strikes the tops of the hooks, it bends them, i. e., crowns them. There are several causes of this. Sometimes the grate is not in the correct position, and sometimes the griff itself is not set straight. Again, hooks may be crowned by the cylinder striking in too hard; this causes the hooks to vibrate, and in a double-lift machine, when the other griff descends, they will catch under the blade. Sometimes, also, the cylinder by coming in against the needles cornerwise will cause the hooks to be crowned.

TIMING THE GRIFF

39. The griffs of a jacquard correspond to the knives of a dobby or to the harness cams of a plain loom, and, consequently, making allowance for the difference of construction, the timing and setting is regulated by the same principles that apply to corresponding parts on other looms. When shedding by means of cams, it is possible to regulate to a certain extent the speed at which the harnesses rise and fall and in this manner bring as little strain as possible on the yarn. With jacquards, however, this is not possible, since there are numerous other motions to be considered that limit the time of forming the shed.

The shed produced by a jacquard should always be open when the crank-shaft of the loom reaches its top center, this being the point at which the loom commences to pick, and the shed should remain open until the shuttle has passed through. A good rule for setting this part of the jacquard machine is to have the shed closed when the crank-shaft is between its bottom and front centers, and opened to nearly its fullest extent when the crank-shaft reaches its top center.

Another method of setting the griff is to bring the lay up until it is about 1 inch from the fell of the cloth and then set the griff in such a manner that it will be at its lowest position, if the jacquard is a single-lift machine. This setting is for general work; if it is desired to produce cover on the cloth, the griff should be down when the lay is about $1\frac{1}{2}$ inches from the fell of the cloth. Whatever setting of the griff is made, the pick should be so regulated that the shed will be well opened by the time the shuttle enters it. The griff may be placed in any desired position by changing the position of the eccentric operating the lever that raises and lowers it, or if this lever is operated by cranks, these may be turned on the shaft until the desired position of the griff is obtained. In setting the griffs of a double-lift jacquard the lay of the loom should first be placed in the desired position, as previously explained, and the knives of the griffs then adjusted so that they are level with, or just passing, each other.

When the knives of the griff are in their lowest positions, the upper curved parts of the hooks should be about $\frac{1}{4}$ inch above the knives. Those hooks that are to be lifted should have their upper curved parts directly over the griff knives, to insure their being caught by the knives when rising, while the hooks that are not to rise should be pressed back by the needles until they are about $\frac{3}{16}$ or $\frac{1}{4}$ inch away from the knives, and should be kept in this position until the latter have risen above the heads of the hooks. This last point—namely, keeping the hooks pressed back until the griff knives have risen above them—depends on the dwell given to the cylinder while against the needle board and, consequently, is more closely connected with the action of the cylinder.

TIMING AND SETTING THE CYLINDER

40. In timing the cylinder, two points should receive careful attention: (1) The cylinder should not be brought against the needle board until the griff knives in descending have passed below the heads of the hooks; otherwise, the needles controlling those hooks that are on the descending knives but are not required to be lifted on the next pick are liable to puncture the cards, since there are no holes punched at the points where they strike the cards. (2) The cylinder should have sufficient dwell when against the needle board to insure the knives of the griff being lifted above the heads of the hooks before the pressure of the card against the needles is removed. If the cylinder should start to leave the needle board before the knives were above the heads of the hooks, some of the hooks that should remain down might be caught and lifted by the griff.

The tops of the hooks of the row nearest the needle board are not pushed back by the cylinder as far as those hooks farther from it, and therefore the former are much more liable to be caught by the blades of the griff when they should remain down. The reason for this is illustrated in Fig. 29, which shows one row of needles and the hooks to which they are connected. The top needle d_1 controls the front hook a_5, while the bottom needle d_2 controls the back hook a_6. The distance x from the top of the hook a_5 to the point where the needle d_1 is connected to it is less than the distance y from the top of the hook a_6 to the point where the needle d_2 is connected; consequently, as the cylinder presses both d_1 and d_2 back equally, the top of the hook a_6 will be moved a greater distance than the top of the hook a_5, and thus will not be so apt to catch on the griff when it should remain down.

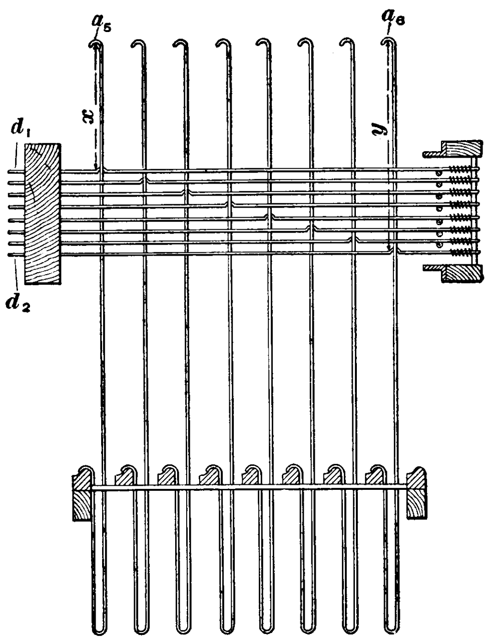

FIG. 29

With an independent cylinder motion, the cylinder can be timed with reference to the griff independent of the movement of the latter, so as to bring the cylinder against the needles at the exact time desired. This is accomplished by altering the position of the eccentric, or crank, that actuates the cylinder.

With self-acting motions, in which the cylinder is actuated by the rise and fall of the griff, the position of the cylinder will of course be directly dependent on the position of the griff. The relative position, however, of the cylinder when brought against the needle board may be regulated by means of the adjustable rod j_1, Fig. 15. With self-acting motions, such as that shown in Fig. 14, this position of the cylinder may be regulated by adjusting the swanneck j on the rod j_1. If the cylinder is brought against the needle board in time for the card to make the proper selection of the hooks, and remains in this position until the knives of the griff have risen slightly above the heads of the hooks, there should be no difficulty with these different parts.

41. When setting the different parts of the cylinder motion, the pawl that turns the cylinder should be in a correct position to give to it a full quarter-turn; otherwise, the cylinder is liable to be brought against the needle board cornerwise, which is sure to result in a mispick, and possible bending of the needles. This is also liable to cause the hooks to be bent, since if the cylinder comes in cornerwise, it reaches the needles sooner and thus moves some of the hooks before the griff reaches its lowest position; the griff is therefore liable to come down on top of these hooks and bend them. The timing of the rotary motion of the cylinder may be regulated by changing the position of the pawl. If the pawl is so set that the cylinder will start to turn too soon, the cards are liable to catch on the needles and be torn by them as the corner of the cylinder passes; if the pawl is set too far from the frame of the machine, the cylinder is liable to be given only a partial movement. The cylinder may be made to move farther from the needle board as it travels out, thus insuring a complete movement being given it by the pawl, but the farther the cylinder is made to travel from the needle board, the faster it must move, and this is a disadvantage. To further insure a complete movement of the cylinder so that it will be brought squarely against the needle board, a safety pawl g_7, Fig. 2, is added to most jacquard machines. This safety pawl is so set that in case the cylinder is only partly moved it will strike against the pawl and, since the pawl cannot move inwards, the cylinder must be pushed over, thus preventing the corner of the cylinder striking the needles.

The cylinder must also be adjusted in such a manner that the needles will pass directly through the centers of the holes in the cylinder when it is brought against the needle board. For this purpose provision is made for raising the whole cylinder gate if a vertical adjustment is required, but horizontal adjustments are made by moving the cylinder itself, either to the right or left, as required.

42. Jacquard machines are made with a widely varying number of hooks and needles. Table I shows the standard sizes of these machines.

TABLE I

Size of Machine	Hooks in Short Row	Hooks in Long Row
200	8	26
300	8	39
400	8	51
400	8	52
800	8	104
500	10	52
1,000	10	104
300	12	26
600	12	52
900	12	78
1,200	12	104
1,800	12	156

In each of the above machines it will be noticed that the total number of hooks obtained by multiplying the number of hooks in the short row by the number of hooks in the long row is larger than the number given under the size of the machine. These additional hooks are found on all jacquard machines and are usually employed in weaving borders and selvages or left idle.

JACQUARDS

(PART 2)

Serial 498B Edition

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JACQUARDS

(PART 2)

Serial 498B

Edition 1

HARNESS TYING

INTRODUCTION

1. The jacquard machine is placed at a considerable height (usually about 5 or 6 feet) above the warp in the loom, the connections between its hooks and the ends of the warp being made by means of the *jacquard harness.* Each eye through which an end of warp passes is connected, in the case of a single-lift jacquard, to one hook of the machine, or, in a double-lift jacquard, to two hooks; this does not mean, however, that each hook, in the case of a single-lift machine (or each pair of hooks, in a double-lift machine), operates only one end of warp, for the harness lines controlling either one or several ends may be attached to each neck cord.

The name **harness tying** is usually applied not merely to the actual operation of tying the various threads that form the harness, but to the subject generally, which involves, in addition to the actual making of the connections, everything relating thereto, including, principally: (1) the position of the jacquard machine over the loom; (2) the method of numbering the hooks in the machine; (3) the order in which the individual harness lines from the various hooks or groups of hooks should be connected to the warp threads; (4) the various plans and calculations that must be made in preparation for tying up, and a number of minor details as to the methods of making various connections, building and preparing the harness, etc.

Although jacquard machines in themselves do not differ greatly, the methods of harness tying vary considerably, and it is essential that a thorough understanding of the fundamental principles should be obtained, after which it is comparatively easy to understand the different methods that are found, in practice, to provide the best means for manufacturing various kinds of jacquard fabrics.

In considering these various points it should be remembered that a jacquard machine is used to produce fabrics with relatively extensive patterns, involving a large number of ends that interlace differently. There may be only one repeat of the pattern in the width of the fabric; in other words, every end may be controlled by a separate hook and interweave differently from every other end. Since in a double-lift jacquard two hooks are used to operate one neck cord and the harness lines attached to it, and thus have the same function as one hook in a single-lift machine, when it is stated that harness lines are connected to one hook this will be understood to mean that they are connected to one hook in the case of a single-lift machine, but in a double-lift machine to the two hooks operating one neck cord.

In case there is only one repeat of the pattern in the width of the fabric, the number of ends in the warp cannot exceed the number of hooks in the machine, since the number of different interlacings cannot exceed the number of hooks. Patterns of this kind are usually found only in narrow fabrics; it is much more common to have several repeats of the pattern in the width of the fabric. If, for example, the body of the warp contains 3,200 ends, the cloth is 40 inches wide inside selvages, and each repeat occupies 5 inches, there will be 8 repeats of the pattern in the width of the cloth. If only 1 end were controlled by each hook, a 400-hook jacquard would operate only 400 ends, and would therefore weave a piece of this cloth only 5 inches wide; but by tying 8 harness lines to the neck cord attached to each hook, selecting those harness lines that control corresponding ends in each repeat of the pattern, i. e., that interlace in a similar manner with the filling, a 400-hook machine will weave a piece of cloth 40 inches wide containing 3,200 ends and 8 repeats of the pattern in the width of the cloth. This provides for an imaginary division of the harness, each division being complete on 400 ends or harness lines; such an arrangement of the harness is spoken of as an *eight-division harness*.

If the same machine is used to weave cloth 40 inches wide with a warp of 2,000 ends, a pattern 8 inches in width with 5 repeats in the width of the cloth will result, and 5 harness lines will be controlled by each hook; this arrangement is spoken of as a *five-division harness*. Thus are obtained the names *five-division*, *six-division*, *eight-division* harnesses, etc.

2. Methods of Supporting Jacquards.—Jacquard machines are usually supported above the loom by two wooden beams placed parallel to each other and far enough apart to support each side frame of the jacquard. In Fig. 1, one of these beams l_6 and a portion l_7 of the frame of the

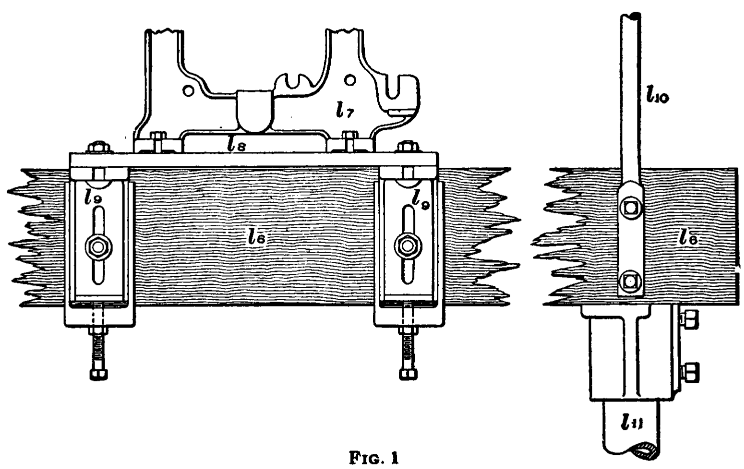


FIG. 1

jacquard are shown. A cross-piece l_8 to which the jacquard is bolted is secured to brackets l_9, which are adjustably supported on the beam l_6. By raising or lowering the brackets l_9 the jacquard may be leveled, which is very essential to its proper working, or it may be adjusted so as to raise or lower the warp line. The beams l_8 may be supported either by the loom itself or by columns or pillars l_{11}, usually made of iron pipe, that fit into sockets secured to the floor of the room and carry brackets, on which the beams rest. Braces l_{10} are also attached to the beams and to the ceiling of the room, thus reducing the vibration to a minimum, and giving a firm support for the jacquard machine entirely independent of the loom. This is preferable to supporting the machine from the loom itself, as in the latter case the vibration of the loom is communicated to the jacquard. Sometimes when a large number of jacquards are used in one room, a framework of iron girders is built, supported from the columns that support the roof or floor timbers; this makes an excellent foundation for the jacquard machines.

A jacquard machine should be placed in a position directly above the center of the *comber board* (see Art. **4**) through which the harness lines are passed. This position can be determined by tying a plumb-line to a hook as near the center of the jacquard as possible, and so placing the machine that this line will fall directly to a corresponding point at the center of the comber board. In case the comber board is not in the loom, the plumb-line should fall to a point on the center line of the loom and about 1 inch plus half the width of the comber board back from the reed cap when the crankshaft of the loom is on its back center. The object of bringing the center of the jacquard machine so near the front of the loom is to reduce, as much as possible, the lift necessary to produce the size of shed required for the shuttle, since any extra lift is detrimental to the good weaving of the warp. The object of having the center of the machine above the central holes of the comber board is to prevent an unequal lift of warp at the sides of the loom.

3. The Harness.—One portion of the harness of a jacquard is shown in Fig. 2; a_3 is the neck cord, which is attached to the hook a of the jacquard. Fastened to the lower end of the neck cord are the harness lines a_7, there

FIG. 2

being as many of these lines attached to each neck cord as there are repeats of the weave in the width of the cloth. In this figure 8 harness lines are shown attached to the neck cord; this is a suitable arrangement, if a repeat of the weave occupies 400 ends, and there are 3,200 ends in the entire width of the body of the warp; it gives 8 repeats of the pattern in the width of the cloth. Each hook of the jacquard will therefore control 8 harness lines, one from each division of the harness, and 8 corresponding warp threads, each in a corresponding position in each pattern of the cloth. The zigzag lines a_4, shown in the portion of the harness marked a_7, indicate where the 8 harness lines are stitched together. This stitching is for the purpose of uniting the harness lines into one bunch, so that as they are raised and lowered the separate lines will not catch and ride on the knots made by tying the other harness lines to their respective neck cords.

The harness lines are threaded through the comber board and support the couplings, which consist of the top loop, or sleeper, a_8, Fig. 2, the mail a_9, the bottom loop, or hanger, a_{10}, and the lingoe a_{11}.

4. The Comber Board.—The **comber board** is a long, narrow, perforated board extending from one side of the loom to the other a few inches above the lay and about 1 inch back from the reed cap when the crank-shaft is on its back center. The object of the comber board is to spread the harness lines, one harness line passing through each hole of the board. It also determines the ends per inch in the cloth, since the number of warp ends to each inch of the reed must correspond to the number of holes to the inch in the comber board. There are the same number of holes in the width of the board as there are hooks in the short row of the jacquard being used, while the number per inch in the length of the board depends on the ends per inch in the cloth being woven. For example, if the jacquard machine contains 8 hooks in its short row, there will be 8 holes in the short row of holes in the comber board, while if the reed contains 80 ends to the inch, there will be 10 holes in each inch of the long row, thus giving 80 holes in the comber board for each inch lengthwise.

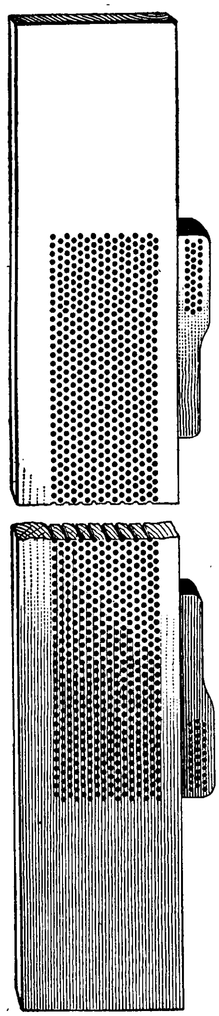


Fig. 3

Comber boards are made in various ways, but for ordinary classes of goods there are two principal varieties—the *solid* and *slips*. A **solid comber board** is shown in Fig. 3. It is usually about $\frac{3}{4}$ inch thick and long enough to rest on brackets screwed to the side frames of the loom. The small pieces shown screwed to the front of the comber board in Fig. 3 carry the harness lines controlling the selvage ends and may be moved to various positions along the board, so that different-width goods may be woven by leaving a portion of the harness at each side without any ends drawn through it. Comber boards should be made of some hard wood, such as beech, maple, or sycamore, and should be well seasoned in order to prevent their splitting.

Fig. 4 shows the style of comber board termed **slips**, the name being derived from the fact that it is built up of small pieces w_2, w_3, w_4, from 2 to 3 inches long, which are set in grooved back and front pieces w, w_1. The principal advantage of this comber board over that shown in Fig. 3 is that the ends per inch in the cloth can be reduced without altering the number of hooks to be used in weaving the design; whereas, with the solid comber board, if the ends per inch in the cloth is reduced, the number of hooks on which to build the pattern must also be reduced. With slips, the ends per inch in the cloth is reduced by placing small pieces of wood between the slips, so as to spread them. This applies to only very slight changes in the ends per inch of the goods, since if the slips are separated to

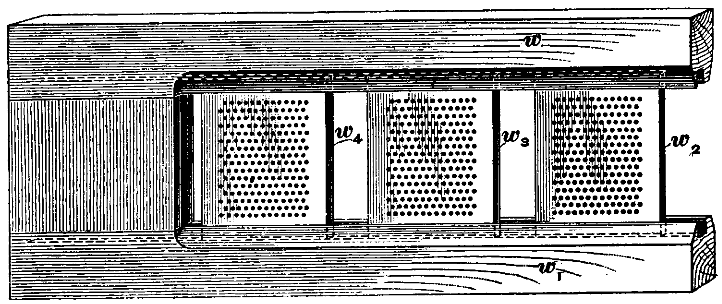


FIG. 4

any great extent, the angle of the harness lines will be altered and an uneven shed produced. It will be noted that this alters the width of the goods in the same proportion as the ends per inch of the cloth is changed.

STYLES OF HARNESS TIES

5. Straight, or Norwich, Tie.—Although there are a number of methods of connecting the harness lines to the hooks of the jacquard machine, all may be divided into two general classes: the *straight*, or *Norwich*, tie and the *cross*, or *London*, tie. When the jacquard machine is placed over the loom in such a position that the cylinder is directly over either the warp or the cloth being woven, that is, when it faces the front or back of the loom, the harnesses are said to have a **straight tie,** since in this case the long rows of hooks in the machine are parallel with the long rows of holes in the comber board. Fig. 5 shows the jacquard machine so placed, a complete short row of hooks being shown, but only a few in one of the long rows. The comber board, together with the harness lines from the first short row of hooks, is also shown in this figure, in order to illustrate the manner of passing the

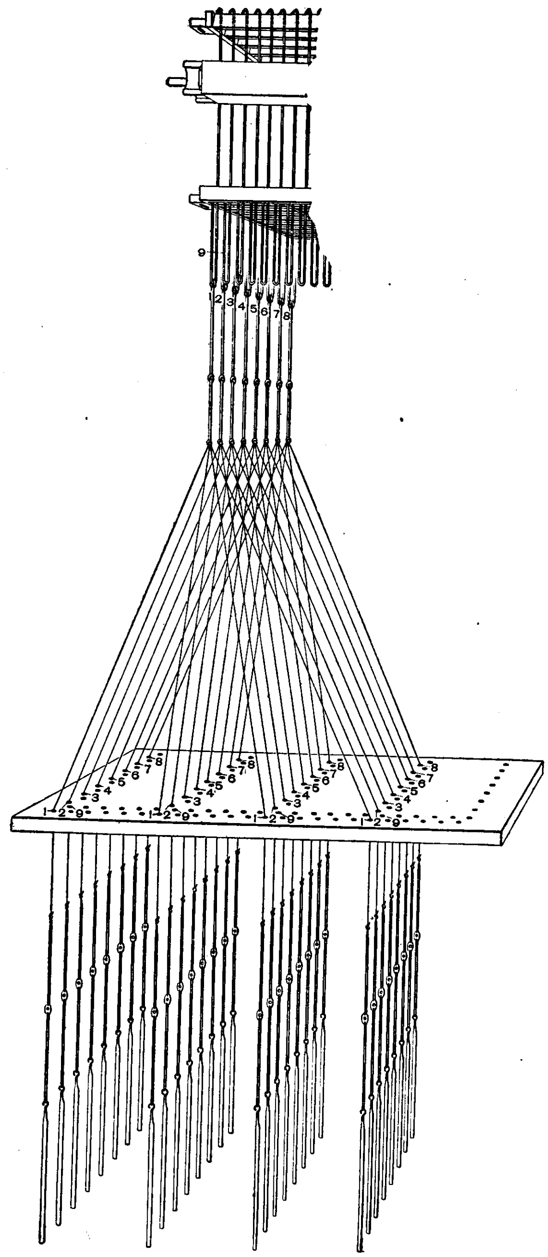


Fig. 5

harness lines from the hooks to the comber board in a straight tie. This figure shows 4 harness lines connected to each hook, thus indicating that there are 4 repeats of the pattern in the width of the cloth. The comber board is divided into four imaginary sections, and the harness lines from any one hook pass through corresponding holes in each section. Thus, the harness lines from number *1* hook pass through number *1* holes in the comber board, each of these holes being the first in its respective section; the harness lines from number *2* hook pass through number *2* holes in the comber board; the harness lines from number *3* hook pass through number *3* holes in the comber board, and so on.

When a straight tie is used, the cards on the machine hang either over the front or over the back of the loom. From the fact that the straight tie is used more commonly in England than in America, it is sometimes called the *English tie.*

6. Cross, or London, Tie.—When the jacquard machine is so placed above the loom that the cylinder is either at its right- or left-hand side, as shown in Fig. 6, the harness tie is said to be a **cross,** or **London, tie,** since in this case the long rows of hooks in the machine are at right angles to the long rows of holes in the comber board, thus producing a partial crossing of the harness lines. In this figure, as in Fig. 5, the harness lines connected to the short row of hooks in the machine pass, respectively, to the short row of holes in the comber board, the harness lines from number *1* hook passing through number *1* holes in the comber board, the lines from number *2* hook passing through number *2* holes in the comber board, and so on, the only difference between the methods adopted in the two ties being that in the case of the cross tie the jacquard machine is turned one-quarter way around with relation to the loom. When the cross tie is used, the cards of the jacquard machine hang either over the right- or the left-hand side of the loom. The cross tie is used in America more commonly than the straight tie.

In Figs. 5 and 6, only sufficient harness lines are shown to indicate the manner in which they are passed from the

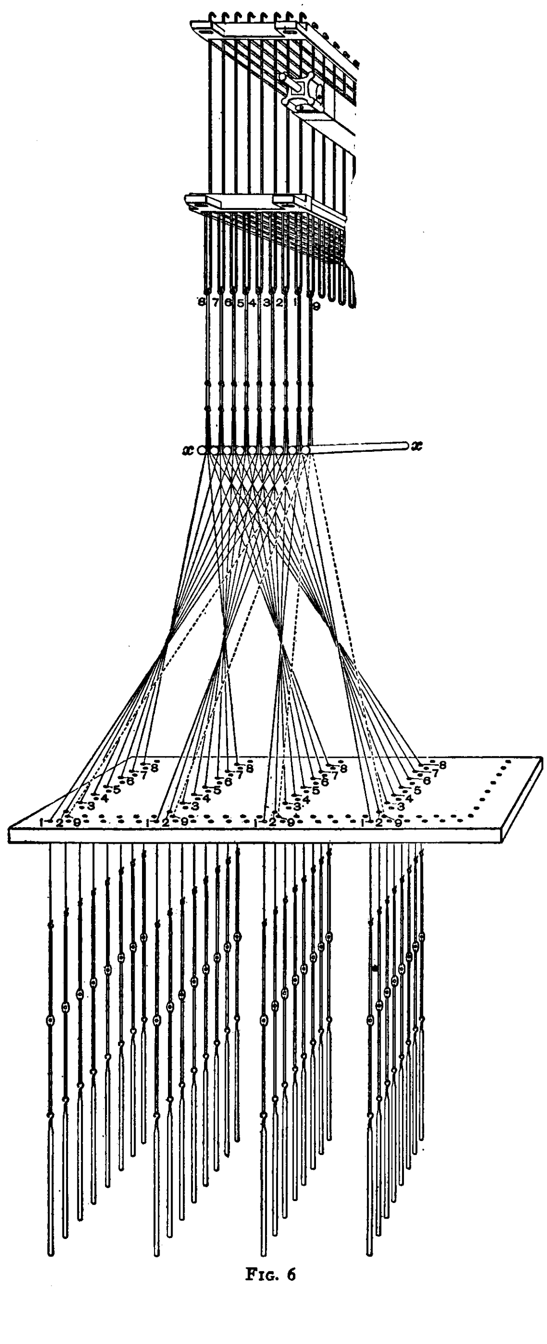


Fig. 6

hooks to the comber board, in which only a few holes are shown, but in practice there are lines connected to all, or almost all, the hooks, and there are hundreds, sometimes thousands, of holes in the comber board, each of which has a line passing through it.

7. With a jacquard placed as shown in Fig. 6, it is necessary to separate the harness lines connected to each long row of hooks by glass rods x, in order to equalize the length of the lift on the harness lines. These rods are supported by a frame at each end, which contains holes suitably spaced for the rods to pass through. Thin pieces of wood are secured to the outside of the frames to cover the holes and prevent the rods sliding out.

The object of these glass rods may be more fully understood from the following description. Referring to Fig. 7, suppose that the base $z_1 z_2$ of the triangle $z_1 z_2 z_3$ is 50 inches and represents the distance from the center of the comber board to the outermost hole, while the side $z_1 z_3$ is 72 inches and represents the vertical distance from the comber board to the neck cords. With these two dimensions known, the length of the side $z_2 z_3$, which represents the length of the harness lines extending to the outermost holes of the comber board, will be found to be 87.6 inches, by applying the rule for finding the hypotenuse of a right-angled triangle: Extract the square

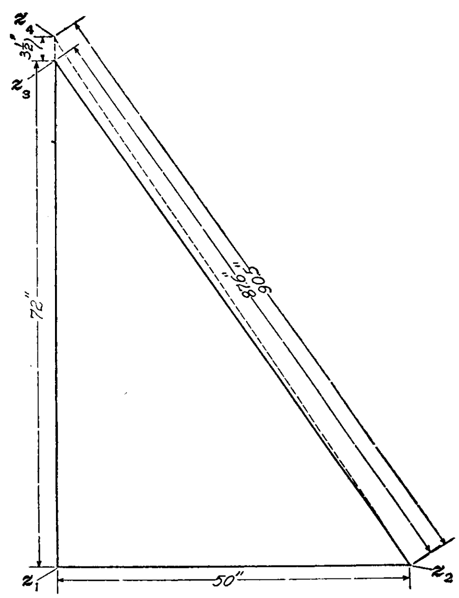


FIG. 7

root of the sum of the squares of the length of each short side $\left(\sqrt{50^2 + 72^2} = 87.6 \text{ inches}\right)$.

Suppose that the hook to which these harness lines are connected is raised $3\frac{1}{2}$ inches. Then the distance from the comber board to the neck cords will be represented by $z_1 z_4$, which will be $72 + 3\frac{1}{2} = 75\frac{1}{2}$ inches in length. The length of the side $z_2 z_4$ will be 90.5 inches $\left(\sqrt{50^2 + 75\frac{1}{2}^2} = 90.5\right)$. The difference in the lengths of the sides $z_2 z_3$, $z_2 z_4$ (90.5 – 87.6 = 2.9 inches) will represent the distance through which the outermost end is raised. Subtracting this result from the distance through which the center thread is raised, it is found that the outer thread loses .6 inch (3.5 – 2.9 = .6).

By inserting glass rods x, Fig. 6, the angle made by the harness lines at this place is prevented from changing, thus insuring the same amount of lift being given to the harness lines throughout the width of the comber board.

BUILDING THE HARNESSES

8. Before commencing to prepare any part of the harness for the jacquard machine, two important points should be taken into consideration: (1) As considerable expense is incurred in preparing the harness and connecting it to the hooks of the jacquard machine, it is undesirable to change the tie when a fabric of a different construction is desired; consequently, the arrangement of the tie and the ends per inch in the cloth should be determined before preparing the harness lines. The class of tie employed is governed largely by the class of goods to be manufactured, while the number of ends per inch adopted is generally the highest that is used in any class of jacquard goods manufactured by the mill, since it is impossible to increase the ends per inch to any extent after the harnesses have been tied up, although they may be decreased within certain limits. (2) The number of hooks to be used should be carefully determined. That number should be selected that will give the best variety of ground weaves. To illustrate this point, suppose that a 400-hook machine is to be used and it is desired to determine a number that may be employed to the best advantage. The total number of hooks in a 400-hook machine is 416, and, consequently, it is possible to employ any number of hooks not greater than this. At first it would seem natural to use every hook in the machine, in order to obtain the largest possible pattern. This, however, would be a disadvantage and would seriously handicap the person making out the designs, since he would be limited to a certain class of weaves for the ground; consequently, in selecting the number of hooks to be used it is better to take the number that will give the best variety of small numbers as factors.

If 416 hooks are employed, it will be found that for ground weaves complete on 16 ends or less, weaves must be used that are complete on either 2, 4, 8, 13, or 16 ends, since these numbers are the only ones under 16 that are factors of 416; if 400 hooks are used, weaves complete on 2, 4, 5, 8, 10, or 16 ends may be employed for the ground weave. Thus, with 416 hooks, weaves complete on only five different numbers of ends may be employed for the ground weaves, while with 400 hooks, weaves complete on six different numbers of ends may be used. With such a machine, it is preferable in most cases to employ 400 hooks, since with this number complete rows of hooks are obtained in the machine, and an added reason is that 5 is a factor of 400, and weaves complete on this number of ends are very largely used for ground weaves in jacquard designs, the 5-end satin being a very popular weave.

When the total number of hooks in a jacquard machine is not employed for working the regular harness, some or all of the additional hooks may be used, if desired, for selvage or a narrow border; in this case the 16 additional hooks could be utilized in this manner. Usually only two of the extra hooks are employed for the selvages.

THE COUPLINGS

9. After the number of hooks to be employed in tying up the harnesses and the style of tie have been determined, it is necessary to prepare the different parts of the harness. These parts are generally prepared separately and away from the jacquard machine itself, after which they are taken to the machine and connected to the hooks. The couplings of the jacquard harness, which consist of all the parts below the harness lines, that is, the top loop, the mail, the bottom loop, and the lingoe, are in some cases prepared by the machine builder, since the difference in the cost of buying them ready-made and preparing them at the mill is very slight, especially if the mill does not have men experienced in this line of work. It is necessary in every case to buy the mails and the lingoes.

The mail a_4, Fig. 2, is made of either brass, steel, or glass, and contains three holes. The warp end passes through the center hole, which is the largest and is either round or elliptic in shape. The lingoe is a piece of heavy wire, the weight of which depends chiefly on the width of the harness in the comber board and the counts, or the number, of the yarn being woven; the coarser the yarn, the heavier should be the lingoe. Lingoes should be perfectly straight. The top and bottom loops of the couplings are connected, respectively, to the top and bottom holes of the mail; these are short loops of linen twine, usually a little finer and of a better quality than the cord used for the harness lines.

10. Fig. 8 (*a*) shows a good method of attaching the top and bottom loops to the mail. A number of mails are threaded on a wire v that is made the same shape as the center hole, so that the top and bottom holes in the mail eye will be exactly in line. This wire, which should be only about 12 inches long, is supported by two stands v_1, v_2. At one side are placed the stands v_3 that support the spool v_4, on which is wound the twine that is to form the top and bottom loops. When the different parts are in position, the end of the twine from the spool v_4 is stiffened slightly with wax and passed through the eyes at one end of the mails; it is then made fast to the peg v_5, which is placed a sufficient distance from the wire v to give the desired length of loop. The hook, Fig. 8 (*b*), is then passed between the two mails at the left and the twine drawn from between them and looped over the peg v_5. This operation is repeated until the

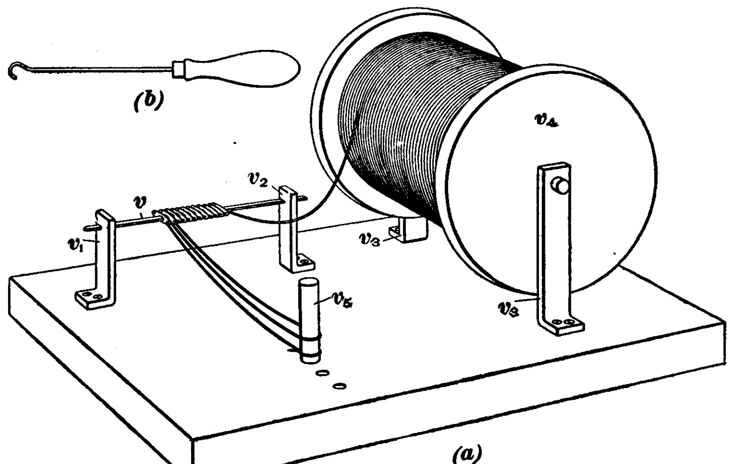


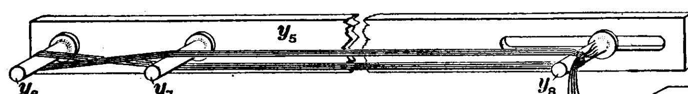
Fig. 8

twine is taken from between each two mails, after which they are reversed and the twine passed through the holes in the other ends in the same way, to form the other loops. The threads are all cut at the end that passes around the peg and, if they are to form the top loops, the ends from each mail are tied together, while if for the bottom loops, the twine is tied to the lingoe.

In preparing the loops in this manner, care should be taken not to employ too many mails at one time, since in this case the angle formed by passing the twine from the mails at the outer edges of the wire v will cause the loops to be longer than those in the center, thus giving a different length of loop for certain of the mails. To avoid this, a horizontal peg mounted on a stand so as to be parallel to v is sometimes used instead of the vertical peg v_4. After the couplings have been prepared in this manner, they should be twisted; this is accomplished by hanging them from a rod, giving them a coat of flour paste, and then rolling the lingoes over the knee, taking three or four at a time, after which the couplings are varnished. In some cases they are not varnished at this stage, as it is sometimes done after they are placed in the loom.

PREPARING HARNESS LINES

11. The size of the harness lines a_7, Fig. 2, is optional with the manufacturers, some using a light-weight and others a heavy line. A twine of about 5-ply 20s or 5-ply 30s linen makes a satisfactory line for use on such fabrics as dress goods, where the number of ends per inch ranges from 64 to 120. In many cases, however, a fine linen cable cord is used for this class of goods, while on wide looms, such as



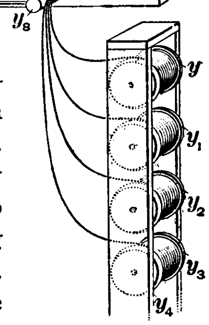
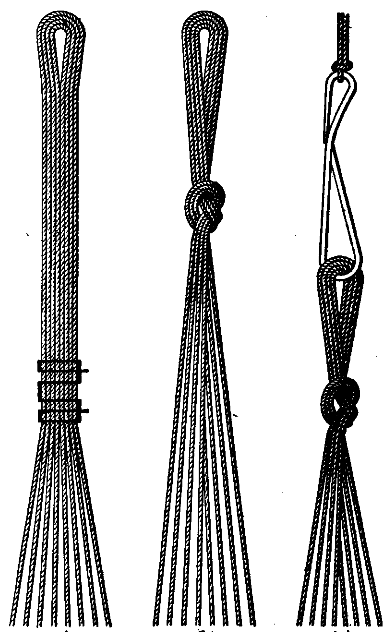


FIG. 9

for bedspreads, and on goods of comparatively few ends per inch, such as carpets, a good linen cable cord is almost always used. For heavier harness lines, correspondingly heavy lingoes must be used, in order to overcome the tendency of the lines to sag between the hooks and the comber board.

Before preparing the harness lines, the necessary number must be ascertained. To illustrate this point, suppose that 400 hooks are being used, that the pattern repeats on 400 ends, and that there are 8 repeats of the pattern in the width of the goods, which would necessitate 8 harness lines being connected to each hook; the number of harness lines would consequently be 3,200 ($400 \times 8 = 3,200$). To prepare these harness lines four spools of twine, as shown at y, y_1, y_2, y_3, Fig. 9, are placed in the stand y_4, from which the ends may be readily unwound. In close proximity to the stand is placed a board y_5 containing three pegs y_6, y_7, y_8; the peg y_8 is adjustable and is placed in such a position that the distance between it and the peg y_6 will be equal to the distance from the top loop of the coupling to the neck cord plus about 6 inches for tying purposes. The ends from the spools are first passed under the peg y_8, then under y_7, around y_6, over y_7, and back again to y_8; this will give with each operation 8 harness lines, the number required to be tied to each hook of the machine. This operation is repeated 400 times in order to obtain the required number of harness lines.

By passing the twines around the pegs y_6, y_7 in the manner described, a lease is formed, and before taking the twines from the pegs a string is passed through this lease so that when the harness lines are being connected to the hooks the different bunches may be readily separated; the twines are cut at the point where they pass around the peg y_8. The loop at the other end of the harness lines, that is, the part that passes around the peg y_6, is the part that is connected to the neck cord, which is attached to the hook of the jacquard. Each of the eight loose ends is of course attached to the upper loop of its respective coupling.



(a) (b) (c)

FIG. 10

12. Methods of Fastening Harness Lines.—In order to prevent the lines being caught, during the weaving process, on the knot formed by tying them with the neck cord, it is necessary to closely fasten each bunch of harness the arm s_9 tends to force the upper end of the arm s_8 to the right, thus keeping the projection s_3 in the slot of the segment casting s_2. By this means, although the casting s_4 is loose on the shaft s_1, it will communicate to the latter any motion received when the projection s_3 is engaged with s_2, as the latter is fast to the shaft. Connected to the casting s_4 is a rod t that is operated by an eccentric t_1 on the crank-shaft of the loom. The action of this motion is as follows: As the eccentric t_1 revolves with the crank-shaft, the rod t is alternately forced up and down, imparting motion to the casting s_4 and consequently, by means of the connection that s_3 makes with s_2, giving an oscillating motion to the shaft s_1. This motion of the shaft being communicated to the rod h_4, Fig. 12, through the arm s, moves the cylinder g in and out.

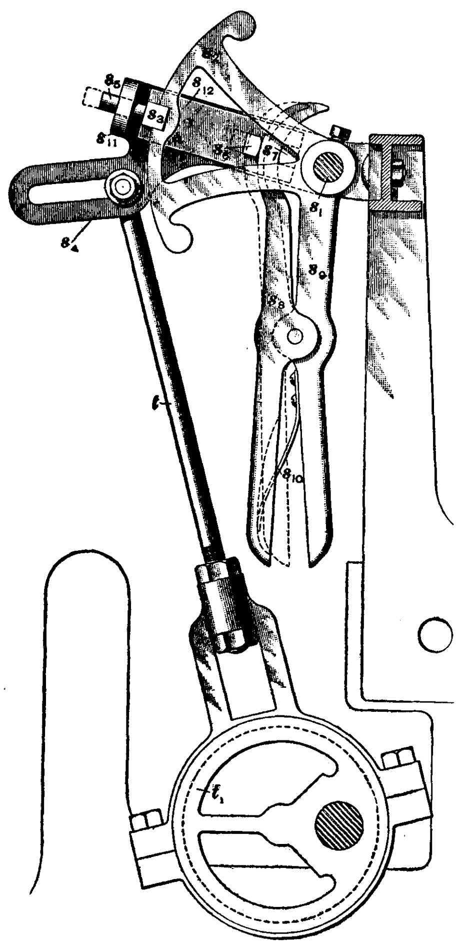


FIG. 13

On its outward movement, the lantern g_3 of the cylinder engages a pawl, or latch, g_2, thus turning the cylinder one-quarter of a revolution.

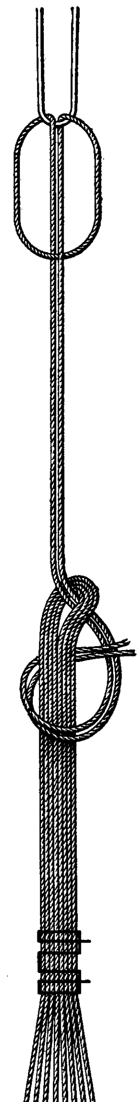


FIG. 11

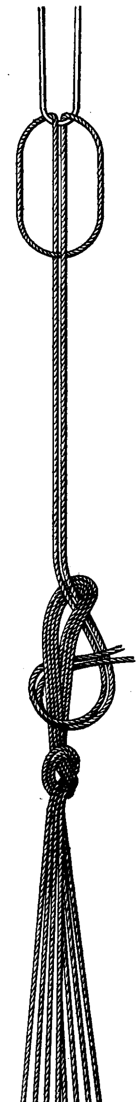


FIG. 12

in some suitable place, as on a bench, while for a measure a stick is used that is equal in length to the distance that there should be between the bottom board of the machine and the knot formed by the harness lines and the neck cord. With the leased harness lines in a convenient position, each bunch is taken in its regular order and tied to the neck cords, care being taken that the knot is in its correct position before it is tied tightly, so that when the operation is completed all the knots will be the same distance from the bottom board of the machine. The knot employed when tying the harness lines to the neck cord is shown in Figs. 11 and 12, Fig. 11 showing harness lines that are stitched, while Fig. 12 shows harness lines that are knotted.

After all the harness lines are attached to the neck cords, the machine is placed above the loom and a framework of wooden rods inserted near the point where the neck cords are attached to the harness lines, one rod passing between each two rows of the cords lengthwise of the jacquard machine. These rods must be securely fastened so that they cannot be pulled to one side or the other during the tying process; they prevent the harness lines being pulled out of a straight line when they are being attached to the coupling. The rods are removed when the tying is completed and the harness is ready for operation, but in the case of a cross tie, glass rods are inserted at this point.

Wire hooks similar to that shown in Fig. 10 (*c*) are sometimes employed in both the straight and cross tie, for attaching the harness lines to the neck cords, and are especially suited for use in those mills where the tie is frequently changed and where the harness is to be removed from the loom and laid aside for a time, its place being taken by another harness. Each hook is connected by the machine makers to a special form of neck cord that is made endless, a half knot keeping the hook in position. The loop of the harness lines is fastened to the other end, and the lines are also knotted directly below the hook. The hooks may be readily taken from the neck cord or from the harness lines, as desired.

When taking a harness from a jacquard machine it is necessary to make a lease of all the groups of harness lines near the top. This is usually accomplished by commencing with the first hook and taking the harness lines in regular order to the last. By this means the harness may be connected to the jacquard machine without great inconvenience in case it is desired to again employ the same harness. Sometimes, instead of this method, a cord is passed through the loops at the top of the harness lines in each long row, commencing at the front.

TYING HARNESS LINES TO COUPLINGS

14. Harness Lines Tied Above the Comber Board. The harness lines may be tied either above or below the comber board. When the harness lines are tied to the couplings above the comber board, the couplings are usually threaded through the comber board in some convenient place away from the loom, after which they are taken to the loom and the comber board leveled and securely fastened in position. To level the comber board, boards about $\frac{1}{2}$ inch in thickness are passed under it, one end of these boards resting on the whip roll and the other on the breast beam of the loom. Beveled pieces of wood are then wedged between these boards and the comber board until the latter assumes its correct position. All parts are then securely tied, so that there will be no chance of their slipping. Rods r_1, r_2, Fig. 13, are now passed through the upper and lower loops of the couplings and fastened to some convenient portion of the loom. The position of the rod r_2 is not of much importance so long as it passes through the loops properly, its object simply being to support the couplings before they are tied up; it is held by cords from the comber board. The rod r_1, however, should be so placed that when the mail is drawn up close to its lower edge the harness will be in its correct working position. The position of the rod r_1 is found by passing a string over the whip roll and breast beam of the loom and having the lower edge of the rod about half the depth of the shed below this line. It is held rigidly in the correct position by placing pieces of wood, cut to the proper size, every 12 inches between it and the comber board. The upper edges of these pieces are beveled off thin, so as to fit between two rows of holes of the comber board.

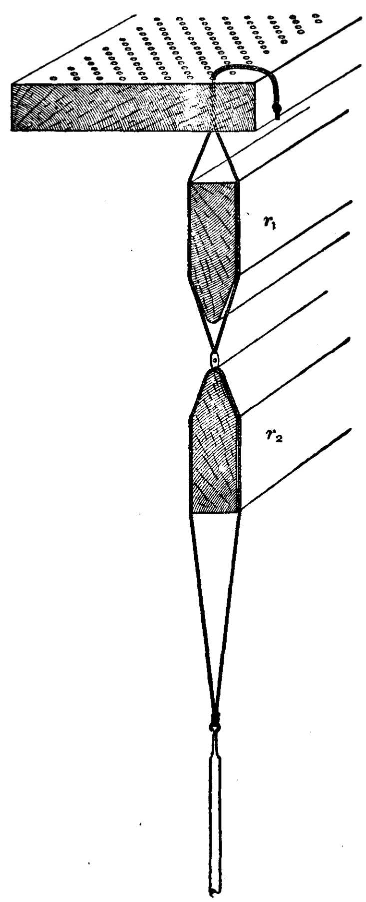


FIG. 13

After these different parts are in position, the operator commences to tie the harness lines to the couplings. When this is finished, the rods r_1, r_2 and the supports for the comber board are removed, after which the couplings are sized and twisted and afterwards varnished; this is one of the cases where it is necessary to perform these operations in the loom.

15. Harness Lines Tied Below Comber Board. When the harness lines are tied below the comber board, the empty comber board is first placed in position in the loom, after which the harness lines are threaded through it according to the plan of the tie adopted. The couplings, which should have previously been sized, twisted, and varnished, are then tied loosely to the harness lines and left for about a day, in order that the harness lines may stretch, after which the couplings may be leveled. To accomplish this, a long board about $\frac{1}{2}$ inch thick is placed edge uppermost across the loom under the comber board in such a position that its center is directly under the center of the comber board, while its top edge corresponds to the position of the mails when in their working position. The couplings are then leveled by this board and firmly tied.

In leveling the couplings, the front row should be a trifle above and the back row a trifle below the level of the board, in order to allow for the inclination of the yarn in the bottom shed between these two rows. The knots, together with the harness lines at the point where they pass through the comber board, are then varnished.

Tying the harness lines below the comber board has certain advantages over tying the harness lines above the comber board, especially when a cross tie is used, since, if the latter method is adopted, the knots come at a place where the harness lines lie close together, and thus produce more friction on the lines, while with the former method these knots are separated to better advantage, and there is not so much danger of their catching other harness lines and thus raising ends that are not required to be up.

VARNISHING HARNESSES

16. Varnishing the harnesses of a jacquard makes the harness lines smoother and causes them to wear much better. Harnesses that are to be taken from the loom for a time and then used again are usually varnished only where there is friction caused by the lines rubbing together, but in case the harness is to remain in the loom for some time it is all varnished. In every case care should be taken to use good varnish, since some qualities destroy the twine, while others peel off a short time after being used.

The common varnishes are principally made from shellac, beeswax, turpentine, and boiled linseed oil, the best varnish probably being boiled linseed oil alone. This, when well dried, becomes very smooth after working for some time and keeps the twines soft and pliable. Its principal disadvantage is that it takes some time to dry, and consequently cannot very well be used if the harness is tied up in the loom, where dust is apt to collect on it; but if tied up in a room for that purpose, this varnish will be found to be very satisfactory. In some cases a small quantity of beeswax is added to the oil to give it more firmness. Driers are sometimes used to make a varnish dry more quickly, but their use is not to be recommended, as they harden the twine and are very liable to be detrimental to its good working. The varnished lines should not be disturbed until they are sufficiently dry, since if the harness lines are made to rub against each other while the varnish is soft, the surface will be injured and make a rough harness. French chalk is sometimes dusted between the harness lines when the loom is being started; this assists in smoothing them and prevents too much friction when they are new.

METHODS OF PASSING HARNESS LINES THROUGH COMBER BOARD

CONSIDERATION OF FIRST HOOK

17. Although the methods of tying up a jacquard harness may be divided into two general divisions, known as cross and straight ties, there are numerous methods of passing the harness lines through the comber board, depending on the character of the designs that are to be woven in the loom. Before dealing with these different forms of ties, however, it is necessary to determine which is to be considered the first hook of the jacquard machine. There is no absolute rule of universal application regarding the position of this hook, different systems being in use in different mills, districts, or countries; but in all systems the first hook, regardless of its position in the jacquard, governs the first end of the design. In this Course, the first end is always considered to be on the extreme left, both of the design as represented on design paper and, consequently, of the warp as drawn through the harness. The hook considered as the first may be in one of four positions—it may be on the left nearest the cylinder, on the left farthest from the cylinder, on the right nearest the cylinder, or on the right farthest from the cylinder. There are, consequently, four possible positions for the needle governing the first hook—it may be the top needle on the left of the cylinder, the bottom needle on the left of the cylinder, the top needle on the right of the cylinder, or the bottom needle on the right of the cylinder. Figs. 5 and 6 show the hook here considered as the first, which in both cases is controlled by the top needle on the left of the cylinder.

The harness lines from this hook pass through the holes marked *1* in the comber board, these holes being at the front of the board. The next hook in the short row of the machine is number *2*, and the harness lines from this hook pass through number *2* holes in the comber board. The next hook to number *1* in the long row of hooks is number *9*, and the harness lines from this hook pass through number *9* holes in the comber board. The hooks are numbered in this manner throughout the machine, commencing with the first hook in the first short row at the left of the cylinder and running consecutively to the back hook and then from front to back in the same way through each succeeding short row of hooks; thus, number 400 hook, if the machine is a 400-hook machine, will in each case be the last hook in the short row at the right of the cylinder.

18. In drawing in a warp, for this system, with a straight draft, as is ordinarily used in jacquard work, the ends are drawn through the harness in regular order, from back to front and right to left; that is, the operator drawing in the warp commences at the right-hand side and draws the first end on that side through the back harness, which is the harness controlled by number 400 hook if the machine is a 400-hook machine, with 400 hooks tied up. The next end is drawn through the second harness from the back, the third through the harness in front of that, etc. When the drawing in is completed, it will be found that the first end of the warp is drawn through the mail of the harness line attached to the front hook in the short row on the left of the cylinder, Figs. 5 and 6, the second end through the mail of the harness line attached to the second hook in this row, and so on. Thus, the first 9 ends will pass through the mails of harness lines passing through holes numbered from *1* to *9*, and in the same order as these holes are numbered, and so on to the four-hundredth end.

As previously explained, the actual operation of drawing in the ends is to commence on the right-hand side, this being more convenient and more nearly in keeping with the ordinary practice on fancy looms.

19. It is very important that a thorough knowledge should be obtained of the method of connecting the needles, the hooks, the harness lines, and the ends of yarn, and the exact relation between the hole in the card and the end in the warp, not only for one end but for all the ends in a warp.

If this is thoroughly studied in one system, it is an easy matter to apply the knowledge to other systems that are found in practice where a different hook is considered to be the first, or where a different order of passing the harness lines through the comber board, or the ends through the mails of the harness lines, is adopted.

In general, it may be stated that for looms employed on the same kind of work and not differing structurally in any important point, all connections from the cards to the ends of warp are substantially the same, the difference being in determining which shall be considered the first end and which the last, or which shall be considered the first hook and which the last. As long as the design, cards, harness, and jacquard correspond, satisfactory results in the fabric can be obtained without necessarily following the system here described.

STRAIGHT-THROUGH TIE

20. The **straight-through tie** is the foundation of all other ties used on jacquard machines. With this tie each neck cord has only 1 harness line attached to it, so that each warp end is controlled independently of the others, and is therefore free to work differently. The harness lines are passed through the comber board in regular order, and as only 1 harness line is controlled by each hook, only as many holes will be required in the comber board as there are hooks. This style of tie is usually used to produce a fabric containing but one repeat of the pattern in its width, which is complete on the same number of ends as hooks on which the harness is tied. Therefore, if only one jacquard machine is used, the pattern and the cloth must be comparatively narrow, since in a machine tied up on 400 hooks only 400 ends will be operated, and in a machine tied on 800 hooks only 800, etc. When a pattern occupies the full width of the cloth and a large number of ends interlace differently, several jacquard machines are employed to weave it; they are supported above the loom as closely together as possible and tied up on the straight-through system. For instance, if a pattern were to contain 2,400 ends and occupy the full width of the cloth, two 1,200-hook machines or four 600-hook machines, etc. with a straight-through tie might be used.

LAY-OVER, OR REPEATING, TIE

21. In case one repeat of the design to be produced in the cloth occupies only a small number of inches, and it is necessary to produce a number of repeats in order to obtain

FIG. 14

the required width of the cloth, the harness lines may be connected to the hooks of the jacquard machine with what is known as a **lay-over,** or **repeating.** tie.

Suppose, for example, that the design shown in Fig. 14 is to be reproduced in the cloth. It will be assumed that 1 repeat of this design in the ends, indicated by the dotted lines, is to occupy only 2 inches widthwise of the cloth, while the complete width of the cloth is to be 28 inches. It will also be assumed that the harnesses are to be tied on 400 hooks and that there are to be 100 ends to the inch. Then if only a single harness line were tied to each hook, two patterns would be reproduced, since 2 inches, or, in other words, 200 ends (100 ends to the inch), is occupied by each repeat of the pattern. Since, however, it is desired to weave cloth 28 inches wide, there must be 14 repeats of the weave, and since the 400 hooks, if each hook controlled only a single harness line, would give but 2 repeats, 7 harness lines must be tied to each hook of the machine. This design could be woven on a 200-hook machine, if desired, as 1 repeat occupies only 200 ends. In this case 14 harness lines would be attached to each hook of the machine.

It is next necessary to draw up a plan of the comber board that will show the one tying up the harness lines through which hole each harness line from the different hooks is to be passed. Such a plan is shown in Fig. 15, which repre-

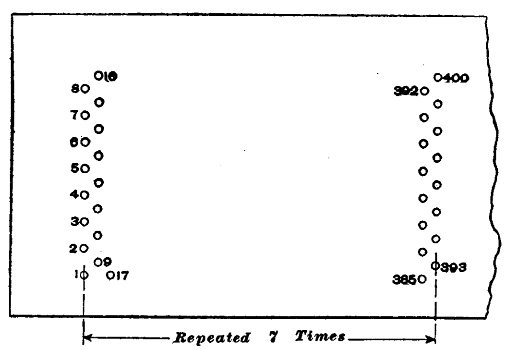


FIG. 15

sents the comber board divided into seven divisions, each representing one repeat of the tie. The 7 harness lines from number *1* hook pass through the number *1* holes in the comber board, while the 7 harness lines from number *2* hook pass through the number *2* holes of the comber board, and this is continued in regular order until all the harness lines from all the hooks have been threaded through their respective holes in the comber board.

In threading the harness lines through the comber board, the lines from number *1* hook are first passed through their respective holes and then usually the harness lines from number *9* hook, instead of those from number *2* hook, after which the harness lines from number *17* hook are passed through their holes in the comber board, and so on to hook *393*. In this manner the harness lines that pass to the front holes of the comber board are tied up before any of the harness lines are passed through the rear holes. If this method were not followed, it would be somewhat difficult to pass the harness lines through the last few holes when the tie was nearly complete, since the other harness lines would tend to cover the holes and prevent easy access. In some ties it is more convenient to tie the first short row of hooks first instead of the first long row.

It will be understood that in practice the design is usually made in accordance with the way the machine is already tied up, and in very few cases is the harness tied to weave one particular design, although this is occasionally done where special designs are required.

CENTERED TIE

22. In case a design in which one half is like the other when working from a central point outwards is to be woven, a tie known as a **centered** tie may be used, in order to reduce the number of hooks necessary to reproduce the design. Such a design is shown in Fig. 16, in which the central line u_1-u_2 divides the design into two parts that are alike when working from the line u_1-u_2 outwards; that is, if the design were folded over on the line u_1-u_2 the figure on one side would fall on the figure on the other side. The repeat of the design is indicated by the dotted lines. In weaving such a design as this, it is possible to reproduce it by considering only one-half of the repeat, if the harnesses are tied up on the centered plan.

To illustrate the method of tying the harnesses for this weave, it will be assumed that the cloth to be woven is to contain 100 ends per inch and that one-half of the pattern, as shown in Fig. 16, will measure 2 inches widthwise of the cloth when woven, thus making a full repeat 4 inches; the total width of the cloth is to be 28 inches. To weave this, it will be preferable to adopt a 200-hook machine, since the full-sized pattern can be produced by tying half the harness lines straight and then centering the tie, which produces the other half and gives a design 4 inches wide. A plan of this tie is shown in Fig. 17.

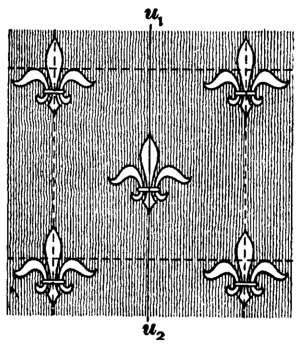


FIG. 16

The comber board is divided into seven divisions, each of which represents 1 repeat of the tie. The neck cord attached to each hook carries 14 harness lines, and therefore

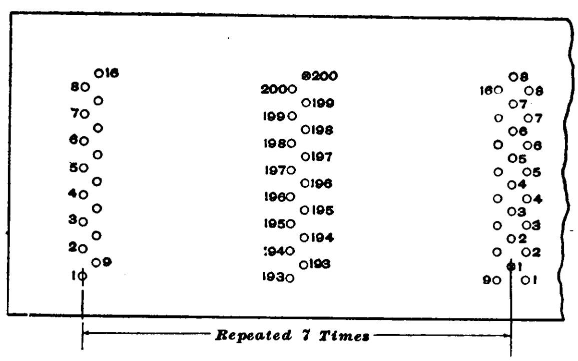


FIG. 17

2 harness lines from each hook will pass to each division of the comber board, as follows: One line from number *1* hook, through number *1* hole in the first half of the repeat of the tie: one line from number *2* hook, through number *2* hole;

and so on in regular order for the 200 hooks. This completes the first half of the repeat, and at this point the tie is centered; that is, a harness line from number *200* hook in the second half of the repeat of the tie passes through the corresponding hole numbered *200* in the comber board; a harness line from hook *199* passes through the hole numbered *199*; and so on in regular order, until hole number *1* in the last half of the repeat is reached. One point to be noted in connection with a centered tie is that the design should center on 1 end and not 2 ends; that is, there should not be 2 ends working exactly alike side by side at the center and edges of the pattern. This would happen if warp ends were drawn through all the harness lines passing through the holes numbered *200* and the holes numbered *1*. To avoid this, therefore, no warp ends are drawn through the harness lines passing through the holes numbered *200* and *1* that are marked with crosses in Fig. 17. It will also be noted that if these harness lines are allowed to remain empty, the texture of the cloth is reduced slightly; that is, instead of being 100 ends per inch it is now 99½ ends per inch, because 2 warp ends have been thrown out of every 400.

COMBINATION TIES

23. In some cases, the harness for the same jacquard machine may be tied up according to two systems; such an arrangement is known as a **combination tie.** For example, Fig. 18 shows a design that is to be woven on a jacquard machine, the central portion of the cloth consisting of the design (*b*), while on each side of the cloth there is to be a border with the design (*a*); these borders are to be exactly alike, working from the center of the cloth toward the selvages. It will be assumed that the border occupies 9 inches in width and that 1 repeat in the ends, as indicated by the dotted lines of the design for the body of the cloth, is 3 inches. It will also be assumed that the machines on which the design is to be woven contains 1,200 hooks, and that there are to be 100 ends to the inch in the cloth.

The border will, consequently, require 900 hooks of the machine, and the body of the cloth, 300. Since the design forming the center of the cloth must be repeated a sufficient number of times to make up the complete width, a number of harness lines equal to the number of repeats of this pattern will be tied to each of the 300 hooks weaving the center design Fig. 18 (*b*). For instance, if the cloth is to be 48 inches wide, 18 inches of this width will be occupied by the border, leaving 30 inches for the center of the cloth. Since 1 repeat of the weave for the center occupies 3 inches in width, there must be 10 repeats of this weave, and as

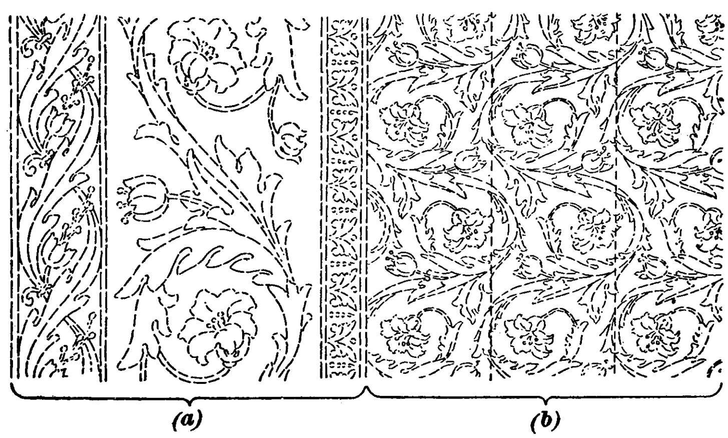


FIG. 18

300 hooks of the machine would weave only 1 repeat of the weave if there were only 1 harness line attached to each hook, 10 harness lines must be attached to each of the 300 hooks weaving the design in the center of the cloth.

Considering next the 900 hooks that are to be utilized for weaving the border, since the border on each side is to be the same from the body design to the selvages, the centered tie may be adopted, and since the 900 hooks with 1 harness line from each will give 9 inches in the cloth, it is only necessary to tie 2 harness lines to each of the 900 hooks weaving the border.

The plan of comber board for this tie should be marked off in sections, showing distinctly which holes are to be used for the border and which for the center of the design, as in Fig. 19. Referring to this figure, the manner of passing the harness lines through the holes in the comber board is straight from number *1* to *900*. This gives the border on

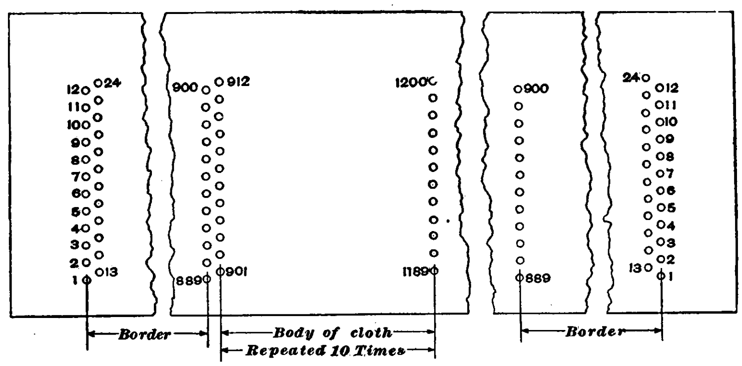


FIG. 19

the left side of the cloth. From number *901* to *1200* the draft is a lay-over, repeated 10 times. After this follows the border for the right-hand side. This border draft is the reverse of the one at the left commencing on number *900* hook and running to number *1*.

CASTING OUT

24. In constructing weaves for jacquard machines, it is often customary to make the design complete on either the same number of ends as there are hooks on which the harness is tied, or on a number of ends that is exactly divisible into the number of hooks on which the tie is made. Thus, if a weave is to be constructed for a machine having the harness tied on 400 hooks, it may be complete on this number of ends, or it may be complete on a number that is exactly divisible into 400, such as 200, 100, 80, or 40. If in any case it is desired to weave a design that is complete on a number of ends not exactly divisible into the number at present; this arrangement is shown in Fig. 26. With this motion, the vibration of the long hooks was so great that in many cases they were caught up by the knives when they were intended to remain down and, consequently, they were discarded for the shorter hooks, which are much more certain in their action.

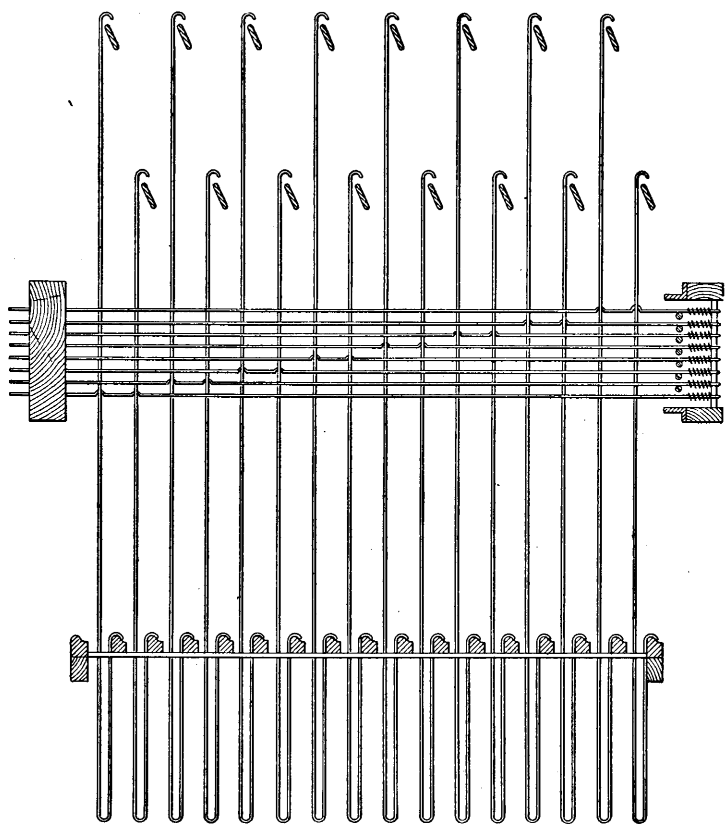


FIG. 26

31. Since in a double-lift single-cylinder jacquard one needle operates two hooks, when the needle is pushed back by the cylinder one of these hooks is liable to be held by the griff blade while the other is perfectly free to move. For therefore, the design must be made, and the warp reeded, according to the number of hooks that are to be used and the texture of the cloth that is wanted.

In all jacquard machines, there are certain reserve hooks that are tied up especially for the selvage. Thus, in a 400-hook machine, which in reality contains either 408 or 416 hooks, 400 hooks are usually tied up for the body of the cloth, while such of the additional hooks as are required are tied up for the selvage. The hooks operating the selvages are usually situated at the right-hand side of the machine as the observer faces the cylinder, although this is not necessary. The harness lines from these hooks pass to the right and also to the left end of the comber board; they are sometimes threaded through slips attached to the front of the comber board, as shown in Fig. 3, while at other times they are passed through the regular holes of the comber board immediately outside of the holes occupied by the harness lines carrying the body of the warp yarn. Usually only two of the extra hooks are used for the selvages, while part or all of the other extra hooks are added to and used the same as the other hooks of the machine, thus increasing its capacity; or they may be used to produce a small border, or left idle.

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JACQUARDS

(PART 3)

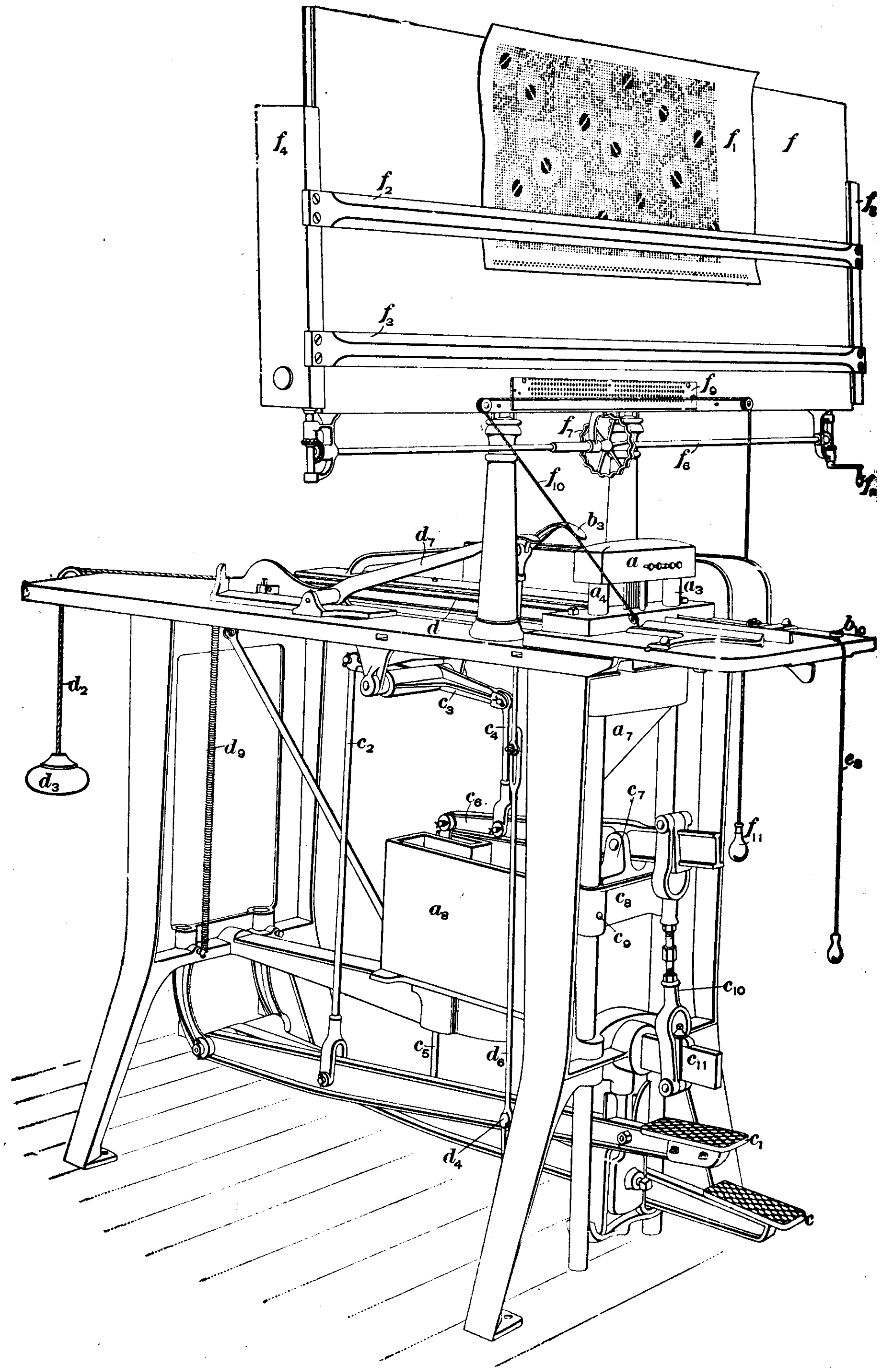
Serial 498C — Edition 1

CARD CUTTING, LACING, AND REPEATING

INTRODUCTION

1. The preparation of the pattern cards that are used to weave any given design on a jacquard loom is an important branch of jacquard work, and the subject should receive careful study. The designs for cloth to be woven in these looms are prepared on design paper and are much larger than the designs for dobby looms. They are usually painted in such a way that the squares that are painted over indicate where the warp ends are to be raised, while those squares that are not painted represent the warp ends down. On account of the large extent of paper to be covered by the design, this custom, however, is not always followed; for instance, the space occupied by a large figure formed in the design by warp flushes may be entirely painted over with one color, and then the binding with the filling indicated in another color, the latter not having to be cut. However, if the design contains a large figure with warp largely predominating, sometimes the system is adopted of marking only those squares where the warp is down, and instructing the card cutter to this effect. This saves much time in preparing the design.

For each pick in the repeat of the design, one card must be cut; for instance, if there are 384 picks in the repeat, this



f
f1
f2
f3
f4
f7
f8
f9
f10
f11
a
a3
a4
a7
a8
b3
b10
c
c1
c2
c3
c4
c5
c6
c7
c8
c9
c10
c11
d
d2
d3
d4
d6
d7
d9
e8

FIG. 1

requires the preparation of 384 pattern cards. Each card is cut by punching holes through it in the proper positions, one hole being punched for each small square in one horizontal row on the design paper that represents a warp end lifted.

The design paper used for jacquard designing should be selected so that the small squares are divided off by heavy vertical lines according to the number of hooks in each short row in the machine on which the design is to be woven; thus, if a machine with 400 hooks is to be used, with 8 hooks in a short row, the design paper should be 8 × 8, 8 × 10, or such other description as will provide for heavy vertical lines to divide off the small squares into sections of 8. This is for the reason that in reading the design for cutting the cards, the punching that is required is considered with regard to one short row at a time. If 3 hooks out of 8 in the short row are to be raised, all 3 holes are punched at one operation; or, if the entire 8 hooks are required to be raised, all 8 holes are punched at one operation, after which the card is moved a short distance and those holes required to be punched for the next short row are stamped out, and so on. Thus, in a 400-hook machine containing fifty short rows, fifty operations of punching might be required to produce one card of the pattern. In addition, more operations would be necessary to punch the peg holes and lace holes.

Owing to the different methods of indicating the ends that are to be raised or left down, the card cutter should in every case before commencing to cut a set of cards carefully note the instructions of the designer, who usually writes his directions either on the back of the design, or around the sides, stating the colors of the squares that represent ends raised, and consequently the holes to be cut in the card.

The cards are usually made of a tough quality of heavy cardboard that will, as far as possible, resist the strain and wear contingent on their contact with and pressure on the needles and their constant movement around the cylinder of the jacquard machine. Heavier cardboard is used for the larger machines, for machines running at high speeds, and for those designs that are frequently rewoven in different seasons. These cards are cut in strips, so that their length and width will be the right size for the cylinder, before the holes are stamped out. **Card cutting** properly is the punching of the holes, although this is sometimes called *card stamping*.

CARD CUTTING

PIANO MACHINE

2. Construction of the Head.—The machine commonly employed to transfer the design from the design paper to the pattern cards is known as a **piano machine**

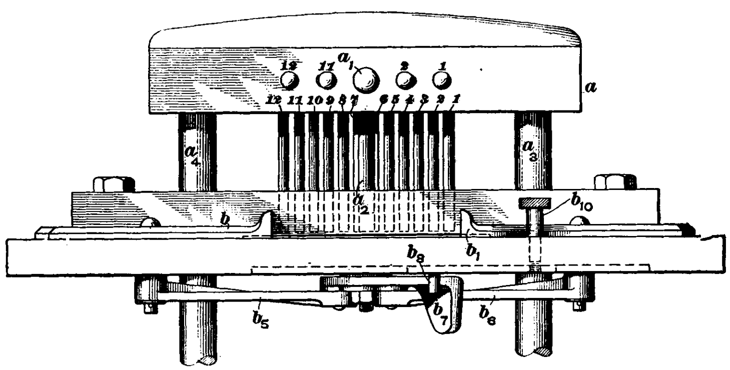


FIG. 2

and is shown in Fig. 1. Its principal part is the head a, Fig. 1; a front elevation of this mechanism alone is shown in Fig. 2, while a plan view of it, together with the card guides, is shown in Fig. 3. In order that the interior of the head may be studied, its top is shown removed in Fig. 3. Inserted in the head are twelve keys, numbered from *1* to *12* in Fig. 3; the inner end of each key, when pushed in, comes directly above a vertical punch also carried by the head. These punches are shown in Fig. 2 numbered from *1* to *12* to correspond to the keys that control them. In addition to these twelve keys there is also a key a_1, Fig. 3, that controls the punch a_2, Fig. 2, known as the *peg-hole punch.* The entire head is supported by two upright rods a_3, a_4, Figs. 1 and 2, that slide in bearings supported by the framework of the machine. These rods, together with the head, are lifted

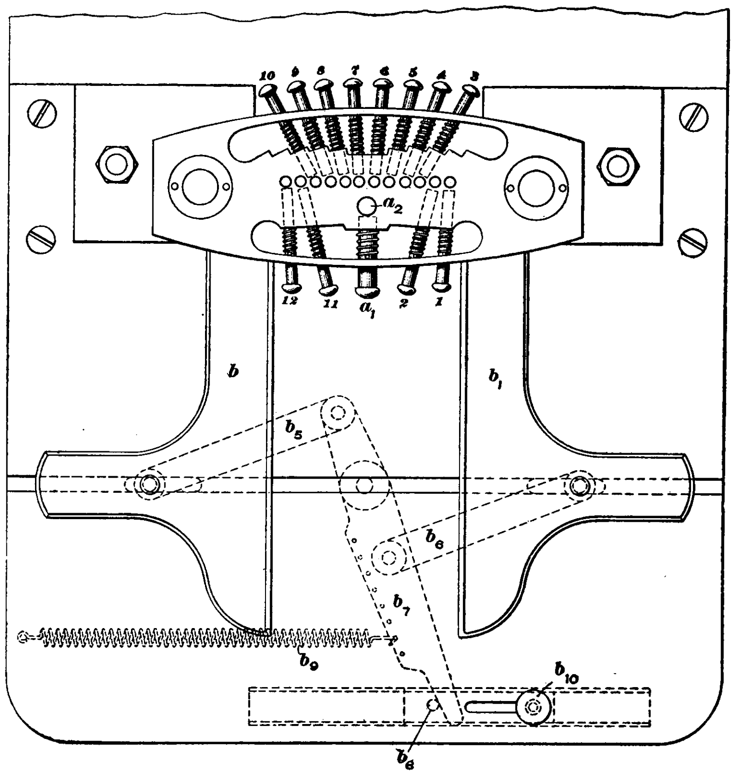


FIG. 3

and lowered by means of levers that are controlled by the feet of the operator.

3. Guides.—The card to be cut is inserted endwise between the guides b, b_1, Fig. 3, and held by a catch b_2, Fig. 4, that is raised to insert the card, shown at a_6, by pressing down on the lever b_3. The spring b_4 returns the catch b_2 to its working position when the pressure is removed from the lever b_3.

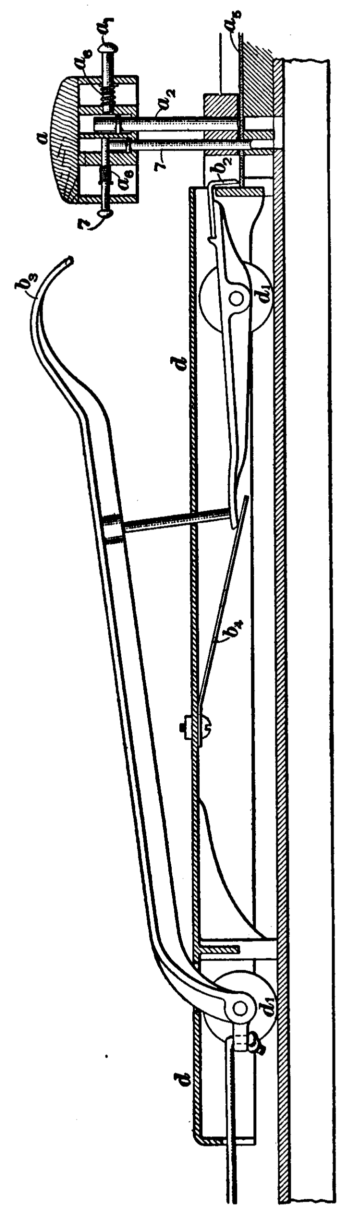


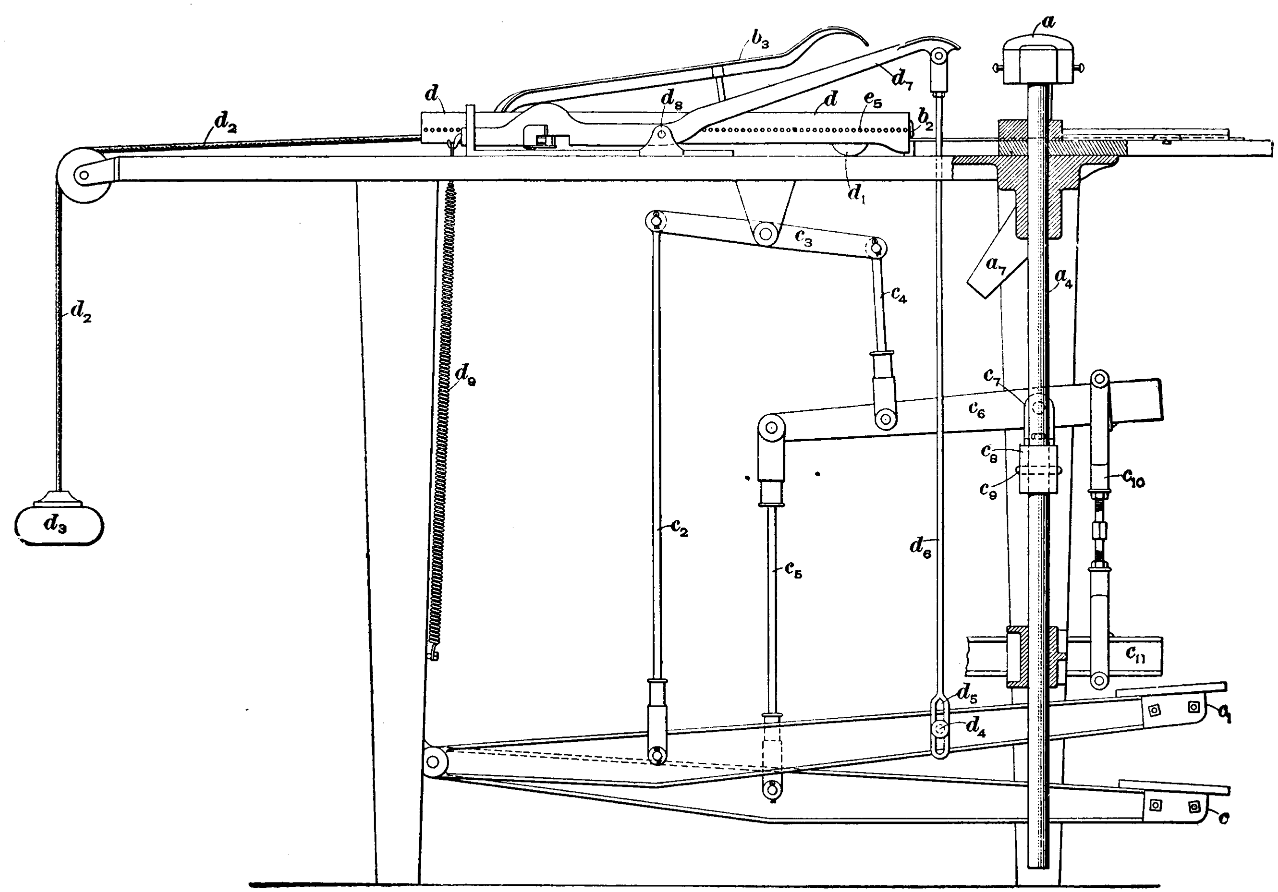
FIG. 4

All jacquards do not have the same number of hooks in their short row, there being either 8, 10, or 12 hooks. The guides b, b_1, Fig. 3, are shown in the position in which they are placed when a card is being cut for a jacquard with 12 hooks in its short row, which necessitates the use of all twelve punches of the piano machine. If, however, cards are to be cut for a machine with 10 hooks in its short row, both guides are moved in toward the center of the machine until the distance between them equals the width of the card; in this case, the two outside punches, or numbers *1* and *12*, would not be used. In the case of a card for a jacquard with only 8 hooks in its short row, the guides would be brought still closer together, and the punches *1*, *2*, *11*, and *12* would not be used.

The card guides b, b_1, Fig. 3, are controlled by connecting rods b_5, b_6 that are attached to a lever b_7, one end of which is held against a pin b_8 by a spring b_9. The pin b_8 is inserted in a slide that may be moved to any desired position and then securely locked by means of the thumbscrew b_{10}. Suppose, for illustration, that the guides are in the position shown in Fig. 3 and that it is desired to change them so that they will accommodate a card requiring the use of only ten punches. The thumbscrew b_{10} is loosened and the slide, together with the pin b_8, moved to the left. This allows the spring b_9 to draw the forward end of the lever b_7 to the left, which, acting through the connections b_5, b_6, draws the guides b, b_1 toward the center. When the guides are in the correct position for the card to be cut, the thumbscrew b_{10} is tightened and no further alterations are required until cards of a different width are used.

4. Mechanism for Raising and Lowering the Head. The mechanism for raising and lowering the rods a_3, a_4, together with the head that carries the keys and punches, is shown in Figs. 1 and 5. Two foot-levers c, c_1 are placed in such a position that they may be readily controlled by the feet of the operator when seated in front of the machine. Connected to the foot-lever c_1 is a rod c_2 that is connected to the lever c_3 attached to the rod c_4, which in turn is connected to the lever c_6. A connection is also formed between the lever c_6 and the foot-lever c by means of the rod c_5. The lever c_6 extends to the front of the machine and has attached to it a casting c_7 bolted to a crosspiece c_8 that connects the rods a_3, a_4. This crosspiece is firmly secured at one end to the rod a_4 by means of a pin c_9 that passes through the two parts, while at the other end it is similarly connected to the rod a_3. At its extreme forward end, the lever c_6 is attached to an adjustable connection c_{10}, which at its other end is connected to the girt c_{11}.

The arrangement of these parts is such that by pressing down on the foot-lever c the crosspiece c_8, together with the rods a_3, a_4 and head a, is lowered, the downward motion of the foot-lever c being communicated to the lever c_6 through the rod c_5. Simultaneously with the lowering of lever c the lever c_1 is raised by means of rods c_4, c_2 and lever c_3. On the other hand, when the foot-lever c_1 is pressed down, the inner end of the lever c_6 will be raised, through the action of



a
b_3
d_7
d
d_8
d
e_5
b_2
d_2
d_1
c_3
a_7
a_4
d_2
c_4
d_9
c_7
c_6
c_8
c_9
c_{10}
d_3
c_2
c_5
d_6
c_{11}
d_5
d_4
c_1
c

FIG. 5

the lever c_3 and rods c_2, c_4, thus raising the crosspiece c_9, together with the head a; this also raises c through the rod c_5. Pressing down on one lever necessarily raises the other into position to be pressed down. The part c_{10} instead of being rigidly connected to the lever c_6 and girt c_{11}, is attached to swinging collars, and since the rods c_2, c_4, c_5 are set loosely on studs, the rods a_3, a_4 are allowed a true vertical movement, thus preventing their binding in the bearings through which they pass.

5. Operation of Punching Cards.—The operation of punching a card is as follows: The operator, seated in front of the machine, presses down the foot-lever c_1, Fig. 5, thus raising the head a together with the punches. The card is then inserted between the card guides and pushed along until it comes in contact with the catch b_2, Fig. 4. Pressing down on the lever b_3 lifts this catch, and the card is then moved into place, when the pressure on the lever is released, which allows the catch to securely hold the card in its proper position. The operator determines from the design, which is placed before him, what holes are to be cut on each row of the card, and with his fingers presses in the keys that lock the punches for the holes to be cut. Suppose, for example, that twelve punches are being operated and that on a certain row every other punch is to cut a hole in the card; then keys *2*, *4*, *6*, *8*, *10*, and *12*, Fig. 3, will be pushed in, which will lock the corresponding punches. The operator then presses down on the foot-lever c, Fig. 5, which brings down the head, together with the punches, so that those punches that are locked by their keys will penetrate the card.

The key a_1 and punch a_2, Fig. 4, show the relative position of a key and punch when the key is out and the head of the machine down. In this case the card a_8 pushes up the punch, which simply rests on the card, without puncturing it. The key *7* and punch *7* in the same figure show the relative positions of these parts when the key is pushed in. In this case the punch is locked by the key, so that when the head is brought down the punch is pushed through the card a_8. When the operator removes his fingers from the keys, the springs a_6 return them to their original positions. If a punch is not locked by its key, the card, coming in contact with it as the head is forced down, pushes it up, as shown in the case of the punch a_2, Fig. 4, and when the head is again raised, the punch drops by its own weight into position. Referring to Fig. 3, keys *1* and *2* are controlled by the thumb of the right hand; keys *3*, *4*, *5*, and *6*, by the fingers of the right hand; keys *7*, *8*, *9*, and *10*, by the fingers of the left hand; while keys *11* and *12* are controlled by the thumb of the left hand; key a_1, Fig. 3, is generally controlled by the thumb of the right hand.

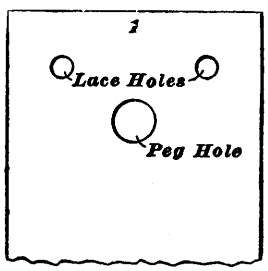


FIG. 6

The first holes to be cut are generally the lace and peg holes at the end of the card first inserted in the machine; they are shown cut in the card illustrated in Fig. 6. These holes are cut at one operation by the operator pushing in the keys controlling the two punches next to the outside punch on each side of the machine, and also the key for the peg-hole punch. Thus, if a card that requires twelve punches is being cut, keys *2*, *11*, and a_1, Fig. 3, are pressed in by the operator and the head forced down. The card is then ready to have the first row of holes for the design punched. The round pieces of card that are cut out by the punches drop into a chute a_7, Fig. 5, and are deposited in a box a_8, Fig. 1.

6. Skip Motion.—An arrangement is provided on this machine by means of which, after one row of holes is cut, the card is automatically moved the exact distance required to bring it in position to have the next row of holes punched. Referring to Figs. 4, 5, and 7, the catch b_2 that holds the card, and the lever b_3 and spring b_4 that control this catch form a part of the carriage d that runs on rollers d_1. Attached to the rear of this carriage is a string d_2 that passes over a pulley at the rear of the machine and supports the weight d_3. This weight exerts a constant pull on the carriage and, if not prevented by some catch, will draw the carriage to the limit of its backward movement. Attached to the foot-lever c is a stud d_4 working in the slot d_5 in the lower end of the rod d_6, which at its upper end is attached to a lever d_7 pivoted at d_8. The rear end of this lever carries a rod e controlled by a spring e_1, Fig. 7, and is held down by a spring d_9, one end of which is attached to the lever, while the other end is connected to the frame of the machine. Connected to the front end of the rod e is a block e_2 that slides on a plate e_3 attached to d_7, while screwed to this block is a skip plate e_4, one end of which projects beyond the block and works in pins e_5 attached to the side of the carriage. Another skip plate e_6, which is screwed to the lever d_7, has a projecting end that works between the pins e_5.

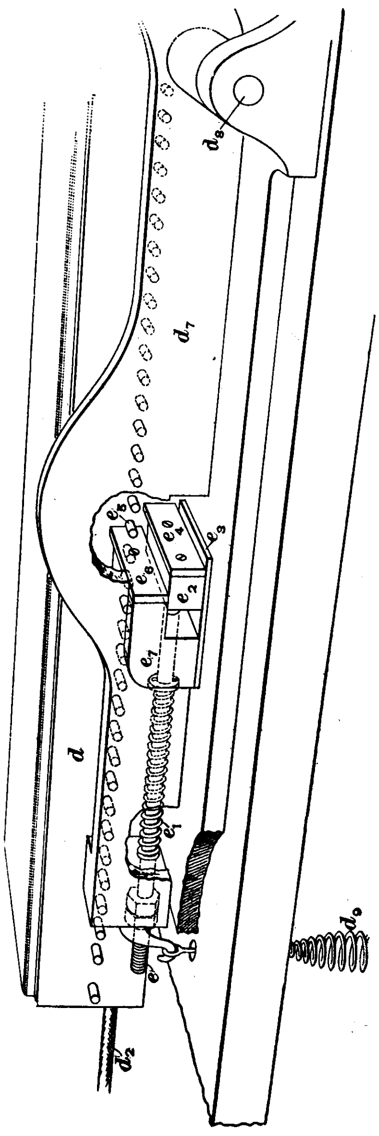


FIG. 7

The operation of this mechanism is as follows: When the rear end of the lever d_7 is held down by the spring d_9, the plate e_6, by coming in contact with one of the pins e_5, prevents the weight d_3, Fig. 5, from moving the carriage d.

When, however, the head a is lifted by the operator pressing down the foot-lever c_1, Fig. 5, the stud d_4 comes in contact with the lower end of the slot d_5, which pulls down the rod d_6, together with the forward end of the lever d_7, and raises the rear end of this lever. Referring now to Fig. 7, as the rear end of the lever d_7 is raised by this action, the skip plate e_6 is brought out of contact with the pin with which it has been in contact, and at the same time the skip plate e_4 is brought in contact with the next pin in front of the one with which e_6 was engaged. The weight d_3, Fig. 5, then draws the carriage back, compressing the spring e_1, Fig. 7, until the block e_2 comes in contact with the part of the lever d_7 shown at e_7, when the plate e_4 will be directly under the plate e_6. As the lever c, Fig. 5, is now depressed to cut another row of holes in the card, the lever c_1 rises, allowing the spring d_9 to depress the rear end of the lever d_7; this will move the plate e_4, Fig. 7, out of contact with the pin, but will at the same time cause the plate e_6 to occupy a position immediately behind, and in contact with, the pin that was previously resting against e_4 and thus hold the carriage in position. As the plate e_4 is brought out of contact with the pin, the spring e_1 pushes the rod e, together with the block e_2 and plate e_4, forwards, thus bringing it in position to engage with the next pin when the lever c_1, Fig. 5, is again depressed. As the catch b_2, Figs. 4 and 5, that holds the card is attached to the carriage d, any backward movement of the carriage will give a corresponding movement to the card. The pins e_5 are accurately spaced, so that the distance between them exactly corresponds to the distance between two consecutive rows of holes in the card.

A cord e_8, Fig. 1, that is attached to the carriage is used to draw it forward again preparatory to cutting the next card. To accomplish this, the lever c_1, Fig. 5, is pressed down, thus raising the head and bringing the punches out of contact with the card. The forward end of the lever d_7 is then still further depressed by hand until both skip plates e_4, e_6 are entirely free of the pins e_5, when the carriage may be pulled forwards by the cord e_8.

7. Reading Board.—The design f_1, Fig. 1, that is to be cut is tacked to the reading board f. The guide rules f_2, f_3 that aid the operator in following the squares on the design paper with his eye are attached to movable side pieces f_4, f_5, each of which engages a vertical screw carrying at its lower end a bevel gear working in a bevel gear on the horizontal rod f_6. After one row of squares on the design paper has been cut, which completes one card, the operator, by turning the hand wheel f_7 or the crank f_8, moves the guide rule into its correct position to show the next row to be cut. Two guide rules are used simply for convenience in reading small designs, and also because the range of adjustment of the side pieces f_4, f_5 is not sufficient to cause one guide rule to move over the entire surface of the reading board. They also serve to stiffen the side pieces and render the whole arrangement rigid.

Attached to the reading board is a card or a portion of a card f_9 that is an exact duplicate of the cards being cut. All the holes in this card are cut, and the vertical rows of holes are numbered consecutively, commencing at the right-hand side. A cord f_{10} that passes over pulleys attached to the reading board is connected at one end to the carriage, while its other end carries a weight f_{11}. An ordinary pin is passed through this cord, or a knot made in it, in such a position that when the carriage is in its correct position for cutting the first row of holes in the card, the pin or knot will be opposite the first row of holes on the card f_9. The operator is thus enabled to tell at any time which row of holes he is cutting on the card by simply observing the position of the pin or knot on the guide card.

METHODS OF READING DESIGNS

8. In cutting cards for a jacquard design, a clear understanding should be had of the relation between the holes in the card and the hooks of the machine; also, of the system adopted for numbering the hooks (that is, which is to be considered the first hook) and in what order and direction the design must be read and the cards cut. In order to illustrate these points, it will be supposed that a machine with 8 hooks in the short row is being used and that the design shown in Fig. 8 (*a*) is to be cut, this design being complete on 16 ends. Jacquard designs are of course complete on a very much larger number of ends than this, but a design complete on 16 ends is taken as an example because this illustrates the principle as well as a design complete on a greater number of ends.

Each card represents only 1 pick, and the cards are numbered in the order in which they are presented to the needles of the machine, the first card selecting the hooks for the first pick, the second card those for the second pick, etc.

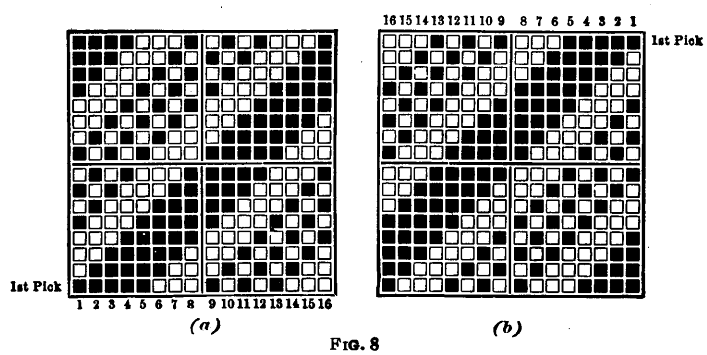


FIG. 8

When cards are being cut, it is the rule for the operator to have the numbered side of the card up, and the numbered end is passed into the card-cutting machine first. When the card is placed on the jacquard machine, the numbered side comes next to the needles, with the numbered end in such a position as to operate the first needle correctly; that is, if the first hook is considered to be the one on the extreme left nearest the cylinder, operated by the top needle in the left-hand short row, the numbered end of the card is placed at the left. All that is necessary when cutting cards for a design is to know the position of the needle operating the first hook; for instance, in the case just given, if the first end of the design is to be raised over the first pick, the hole cut for this will be at the extreme left of the first row at the numbered end of the card.

9. Suppose that it is desired to cut cards, to give the design shown in Fig. 8 (*a*), for a jacquard in which the first hook is considered to be the one that is on the extreme left nearest the cylinder and operated by the top needle in the left-hand short row. The first end and first pick of the design, situated at the lower left-hand corner, are marked in Fig. 8 (*a*). The design may be placed on the reading board of the card-cutting machine either right side up or upside down. When it is desired to read it right side up, it is tacked to the reading board and the guide rules are moved so that the lower edge of one of them will come just above the first pick, thus enabling that pick to be easily read. In this case the card cutter will read from left to right. If a machine similar to that illustrated in Fig. 1, with 12 punches, is used, it must be adjusted so that 8 punches only will be used, as the cards must be cut with 8 holes in each short row. In such a case, punches numbered from *3* to *10*, Fig. 3, would be used. As the card is inserted in the machine with the numbered side up and the numbered end first, and as it must be so placed on the jacquard machine that when it comes against the needles the numbered end will be at the left when facing the cylinder and the numbered side against the needles, holes that are cut by the punch operated by key number *10*, Fig. 3, will come against the needle that operates the first hook, and holes cut by the punch operated by key number *3* will come against needles that control the eighth hook.

Fig. 9 shows the ends of two cards, (*a*) representing how the first two rows of holes would be cut for the first pick of the design shown in Fig. 8 (*a*), while (*b*) represents how the first two rows of holes would be cut for the second pick. As the design in Fig. 8 (*a*) is read by the card cutter, he observes that the first, second, third, fourth, and fifth ends must be raised in the first section of 8 ends. By pressing the tenth, ninth, eighth, seventh, and sixth keys, Fig. 3, holes are cut in the card as shown in the first row in Fig. 9 (*a*). The card is then moved along to bring it into position for cutting the holes for the second section of 8 ends of the design, namely, the ninth to the sixteenth ends of the first pick. In this case it is required that the machine shall raise the hooks operating the first, third, and fifth ends in this section of 8 ends, and the card cutter consequently presses the keys numbered *10*, *8*, and *6*, Fig. 3, thus cutting holes as shown in the second row in Fig. 9 (*a*). Fig. 9 (*b*) represents the end of a card for the second pick of Fig. 8 (*a*); the object in punching the holes in the order and position

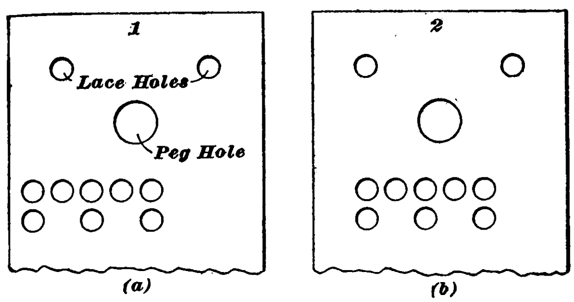


FIG. 9

shown in Fig. 9 (*b*) can be seen by observing which ends are to be raised on the second pick of the design. In case a design is complete on a smaller number of ends than there are hooks in the machine, the card cutter repeats the first pick as shown on the design paper until the entire card has been cut.

For convenience, it is frequently the custom to place the design upside down on the reading board, thus bringing the first end and first pick in the upper right-hand corner, as shown in Fig. 8 (*b*), which is the same design as Fig. 8 (*a*), excepting that its position is changed. In this case, the card cutter moves the guide rules so that the upper edge of one of them, usually the top one, will come just below the first pick, thus enabling him to read it readily. With the design in this position, the card cutter commences at the right of the design to determine the holes that are to be cut, and reads from right to left. In this case the punches are selected exactly as in the previous instances, and as reading the design from right to left after it has been turned upside down also gives the same result as reading it from left to right when in a normal position, the cards will be perforated in the same manner in either case.

METHOD OF CUTTING A SET OF CARDS

10. In order to understand more fully the operation of cutting the cards from a design worked out on design paper, it will be assumed that it is desired to cut a set of cards that will give the design shown in Fig. 10. It will further be assumed that the machine to be used to weave this design is a 400-hook jacquard with 8 hooks in a short row and 51 hooks in a long row, the harnesses being tied up on 400 hooks. As shown in Fig. 10, the design occupies 96 ends, and since 96 is not a factor of 400—the number of hooks to which the harness lines are attached—it is necessary to have some of the hooks, together with the harness lines that are attached to them, inoperative. Dividing 400 by 96, it is found that this number of hooks will give four full repeats of the pattern with 16 hooks left over. This number of hooks must consequently be cast out.

It should be understood that casting out some of the hooks in this manner reduces the ends per inch proportionally. For example, if the comber board gives 100 ends per inch when the full number of hooks in a machine is being used, casting out 16 hooks, as in this case, will reduce the ends per inch from 100 to 96. (400 : 384 = 100 : 96.) The fact that casting out hooks in a jacquard machine reduces the ends per inch in the goods is often taken advantage of for this purpose alone.

In casting out hooks, those to be left idle should be distributed at regular intervals so that the yarn will not pass to the reed at an angle that will cause it to be chafed and broken. In the case of the design shown in Fig. 10, since this machine is a 400-hook machine, having 8 hooks in each short row, and since there are 16 hooks to be cast out, there will be two rows of 8 hooks each that will not be required. These two rows of hooks may be omitted at the end of the machine, or one row may be left out at the center—the twenty-fifth—and another at the end—the fiftieth. The latter case will be taken for illustration.

Having determined which hooks are to be left idle, it is next necessary to mark off, on a narrow strip of paper, squares exactly equal in size to the squares on the design paper enclosed by the heavy lines. There should be as many of these squares in a horizontal row as there are large squares in one horizontal row occupied by the design, in this case twelve; while each vertical row should contain as many squares as there are repeats of the weave in one card, in this case four. The squares are numbered consecutively, as shown in Fig. 11, which illustrates one of these slips marked off for the design shown in Fig. 10.

38	39	40	41	42	43	44	45	46	47	48	49	50
26	27	28	29	30	31	32	33	34	35	36	37	
13	14	15	16	17	18	19	20	21	22	23	24	25
1	2	3	4	5	6	7	8	9	10	11	12	

FIG. 11

Referring to Fig. 11, it will be noticed that there are no squares marked *25* or *50*, but that these numbers are set down in a different manner from the other numbers; the object of this is to indicate to the card cutter that after cutting the twenty-fourth and also the forty-ninth row of holes on the card, the next rows, or the twenty-fifth and fiftieth, are to be skipped. After making out the slip of paper as described, it is attached to the guide rule on the reading board in such a manner that the vertical lines of the squares will exactly correspond to the heavy vertical lines on the design paper. By this means the operator can readily determine for which large square of the design paper he is cutting.

Each operation of the piano machine cuts the holes to operate the hooks in one short row of the jacquard machine; or in other words, if the machine contains 8 hooks in a short row, the piano machine will cut holes to correspond to the needles operating these hooks as the pattern calls for. For this reason, and in order to enable the card cutter to follow the design more readily, it is customary to use design paper divided into sections of eight squares when cutting cards for a jacquard machine having 8 hooks in its short row. If the machine has 10 hooks in its short row, design paper divided into sections of 10 is preferable; while if the machine has 12 hooks in its short row, design paper divided into sections of 12 should be used.

11. To further illustrate the method of casting out hooks and marking off slips of paper that are attached to the guide rule, suppose that it is desired to weave on a 400-hook machine a design that is complete on 160 ends. Dividing 400 by 160, it is seen that there will be two repeats of the pattern and 80 hooks that will be left idle. As there are 8 hooks in a row, 10 rows of hooks must be thrown out. In order to prevent too many hooks being omitted at any one place, it is preferable in this case to throw out two rows of hooks at two separate points of the machine and three rows at each of two other points, thus giving 10 idle rows. Since the design will be made out on 8 × 8 design paper, and since the pattern repeats on 160 ends, there will be 20 large squares across the design paper in one repeat of the pattern, or in other words, there will be 20 squares in each horizontal row on the strip of paper that is marked out to be placed on the guide rule. When numbering the squares on the slip of paper, they will be numbered consecutively up to *10*; then the numbers *11* and *12* will be set down in such a manner as to indicate that these two rows of hooks are to be omitted. Commencing again at *13*, the squares will be numbered consecutively up to *22*, when the numbers *23*, *24*, and *25* will be set down in such a manner as to indicate that these rows of hooks are to be omitted. This will complete one reading of the design, that is, it will give 160 ends, but since this is to be repeated in order to occupy the full card, there will be another horizontal row of squares directly above the first. These will be numbered

consecutively commencing with *26* and running up to *35*, when the numbers *36* and *37* will be marked in such a manner as to indicate that these rows of hooks are to be omitted; the squares will then commence with *38* and be numbered consecutively up to *47*, when the numbers *48*, *49*, and *50* will be set down in such a manner as to indicate that these rows also are to be omitted. A slip of paper marked off in this manner is shown in Fig. 12.

12. After the slip has been attached to the guide rule, the design paper is fastened to the reading board and the guide rule set in such a manner that it will come directly above or below the first pick to be read. Suppose that the design shown in Fig. 10 has been attached to the reading board right side up, bringing the first end and first pick in the lower left-hand corner. The operator moves the guide

26	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35* [36-37]	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47* [48]	49-50
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10* [11-12]	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22* [23]	24-25

Fig. 12

rule until it is in the correct position and then commences to punch the holes called for by the design. As one card serves for only 1 pick of the design, the reading of 1 pick determines the manner of cutting one complete card, and after this card has been cut the guide rule is moved until it is in the correct position for reading the next pick. It should be borne in mind that one operation of the piano machine punches the holes called for by that portion of the pick between two heavy vertical lines, or in the case of the design shown in Fig. 10, one operation of the machine punches the holes to operate 8 ends on 1 pick; consequently, with this design, the machine must operate twelve times in order to produce one repeat. Since, however, this determines the operation of only 96 hooks, and since there is a total of 384 hooks, each pick as shown on the design paper must be repeated on the card four times in order to complete the punching of the card; consequently, after the operator has

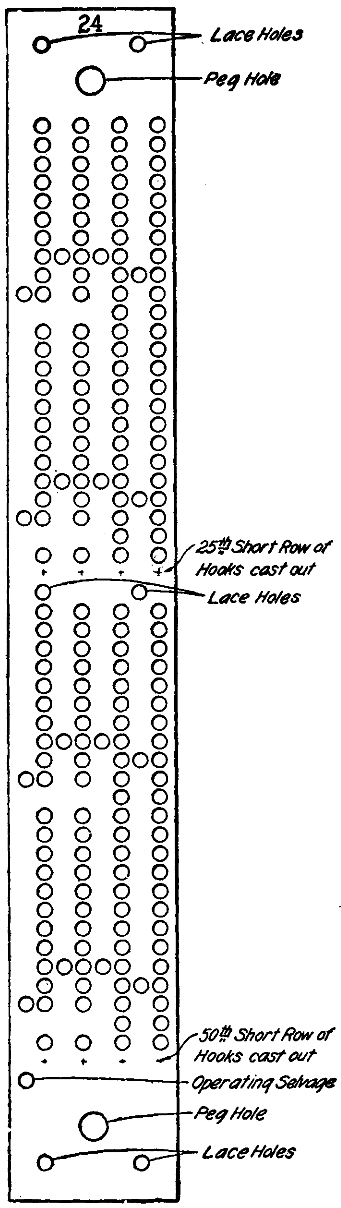


FIG. 13

read the pick once, he commences again with the first end and repeats the operation.

Fig. 13 shows a card cut for the twenty-fourth pick of Fig. 10 to operate the hooks in a machine in which the hook on the extreme left nearest the cylinder is considered the first hook. This card would be placed on the cylinder with the numbered side next the needles and the numbered end at the left.

It is assumed that 2 hooks of the extra short row are to be used to operate the selvages; therefore, in Fig. 13 a hole is punched to raise one of these hooks, while on the next card, the other hook would be raised, so that a plain selvage would be produced.

LACING

LACING BY HAND

13. After the cards have been cut, it is necessary to lace them together in such a manner that they may be placed on the cylinder of the jacquard machine. This operation was formerly performed by hand, but as this process is necessarily a slow one, automatic card-lacing machines have been invented and are largely used at the present time. When cards are laced by hand, they are placed on a hand-lacing frame, which consists principally of two long supports for the cards. Metal or wooden pegs are inserted at regular intervals in each support, the distance between the two supports being such that when the cards rest on them the two rows of pegs will be at a distance apart corresponding to that of the peg holes in one card, while the pegs in each support are so spaced as to give the exact distance between the cards that is required in order to have them pass around the cylinder of the jacquard machine. These frames usually hold from thirty to fifty cards, while the pegs are capable of being moved nearer together or farther apart, in order to regulate the space between them for different-sized cards. After a number of cards have been placed on the frame in the order in which they are to come on the machine, the operator laces them together with a heavy twine threaded through a needle. The needle is passed up through the first lace hole of the first card, down through the second hole of the same card, up between the first and second cards, down through the first hole of the second card, up through the second hole of this card, down between the second and third cards, and so on with all the cards. The operator then starts again with the first card, but this time reverses the order of passing the needle through the cards; that is, the needle in this case is passed down through the first hole of the first card and up through the second hole, instead of up through the first hole and down through the second, as in the former case. The two ends are also crossed between each two consecutive holes and also between each two consecutive cards, giving the result shown in Fig. 14, which shows the cards laced in this manner.

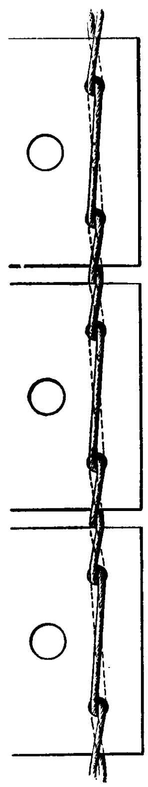


FIG. 14

AUTOMATIC LACING

14. General Construction of Automatic Lacer. The stitch formed when the cards are laced by hand differs from that formed by the automatic lacer and is considered preferable by some, although the greater rapidity with which cards can be laced on the automatic machine has caused hand lacing to be superseded. It is also possible with the automatic lacer to regulate the tension of the lacing cords and keep them at a uniform tension throughout the lacing of a set of cards. This is somewhat difficult in the case of hand lacing, since the operator may draw the cords tighter at one point than at another.

Fig. 15 shows a view of an automatic lacing machine, while Fig. 16 shows a view, partly in section, of the same machine. Referring to these figures, the cards g are placed in the correct order in a stack between two uprights g_1, g_2, and rest on a steel plate g_4, Fig. 16, that is screwed to a rack g_3; this rack is capable of being moved back and forth in a table that supports these different parts. When the rack g_3 is moved to the right, in Fig. 16, the plate g_4 is withdrawn from under the cards g and the bottom card rests on the rack, just in front of g_4. As the rack is moved to the left, the plate g_4, which is slightly thinner than one card, pushes the bottom card forwards until it is in position below the lace-hole punches h_2, h_3 and the peg-hole punch h_1. There are two sets of these punches, one at each end of the head, while in the center are placed two punches similar to h_2, h_3. When the next card in the bottom of the stack is brought into position to be punched, the card previously punched is pushed forwards until the peg holes in the card are engaged by pegs on the sprocket carrier chain i. This chain carries the cards forwards until they are brought into position below the needles j. There are three of these needles in the width of the machine, one for each set of lace holes, and as the first set of lace holes of the card is brought into position, the needles descend, pass through them, and form, below the card, a loop of the cord that is threaded

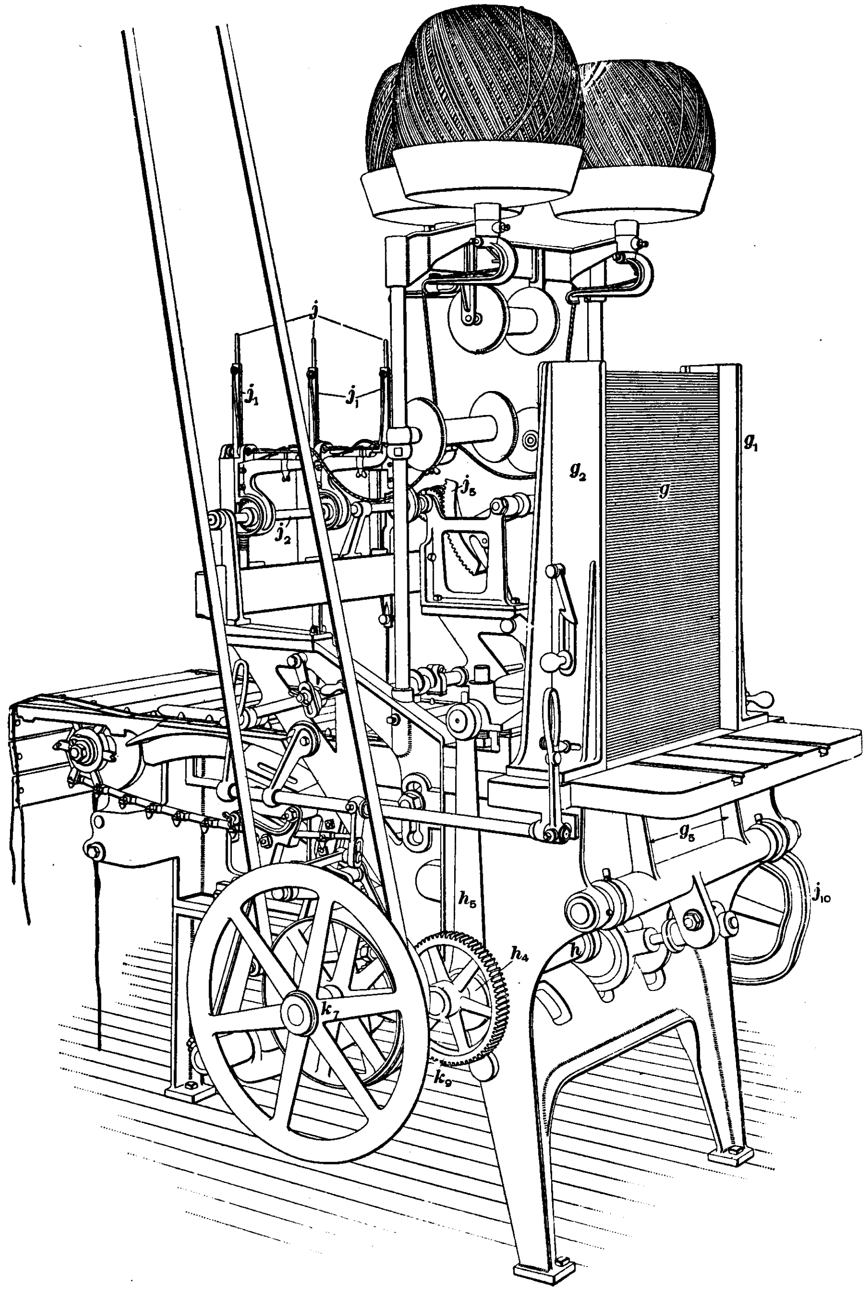


FIG. 15

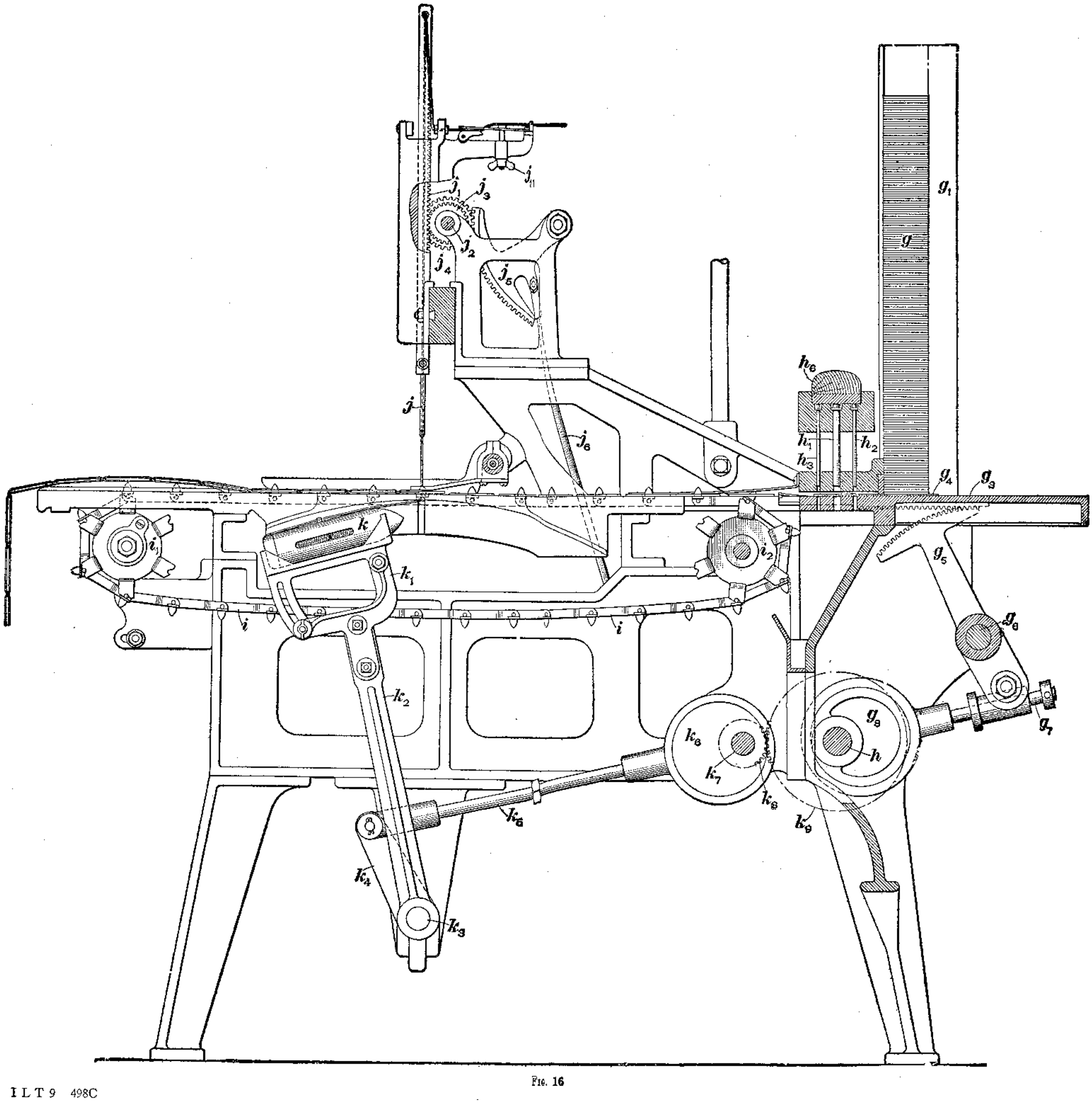


FIG. 16

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through the needle. A shuttle k that carries a specially wound cop of cord passes through the loop formed by the cord in the needle, thus securely locking this cord and lacing the cards together. The twine for the needles may be taken from balls placed in a stand above the machine that is supported by two upright rods, as shown in Fig. 15, or it may be taken from the spools directly below this stand, as shown in the same figure.

15. Feed-Mechanism.—Referring to Fig. 16 and also to Fig. 17, which shows an enlarged view of the feed-motion of the machine, the manner in which the rack g_3 is pushed

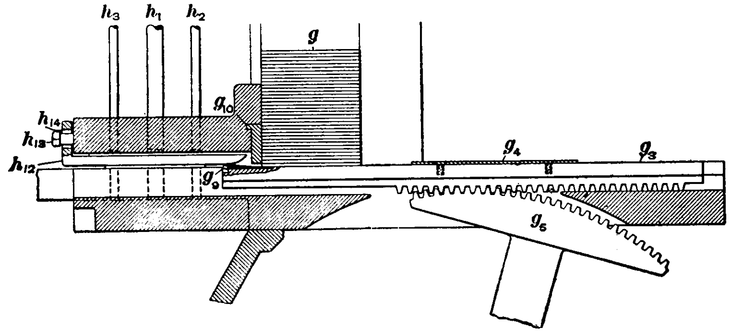

Fig. 17

forwards in order to bring a new card into position is as follows: On the under side of the rack g_3 are teeth that are engaged by a segment g_5 cast with a sleeve carried by the shaft g_6; this sleeve supports two segments similar to g_5, as shown in Fig. 15. Also cast with the sleeve is an arm connected at its lower end to a sleeve on the eccentric rod g_7, which is worked by the eccentric g_8 on the shaft h. As the shaft h revolves, the eccentric g_8 works the eccentric rod g_7 back and forth, so that the collar setscrewed to the end of this rod comes in contact with the sleeve and draws it to the left when the rod is moving in this direction, while a hub on this same rod forces the sleeve to the right when the rod g_7 is moving in the opposite direction. By this means, the arm g_5 is given a backward-and-forward motion, and as its teeth engage with the teeth on the lower side of the rack g_3, this rack is also carried backwards and forwards. As a new card is brought into position, a spring g_9 carried by the forward end of the rack g_3 engages with the card that has just been punched and pushes this card forwards into position for the pegs on the sprocket chain i to engage with the peg holes in the card. As the rack is next moved back, a weight h_{12} drops on the card just brought forwards to be punched and holds it in position. This weight is attached to the framework of the machine by a screw h_{13} that works in a slot h_{14} of the weight, this slot being sufficiently large to allow the weight h_{12} a slight vertical movement. A piece g_{10} situated directly in front of the cards is capable of being adjusted to allow only sufficient space between its lower edge and the top of the rack g_3 for one card to be pushed forwards at a time, thus lessening the liability of two cards being pushed forwards at once by the plate g_4.

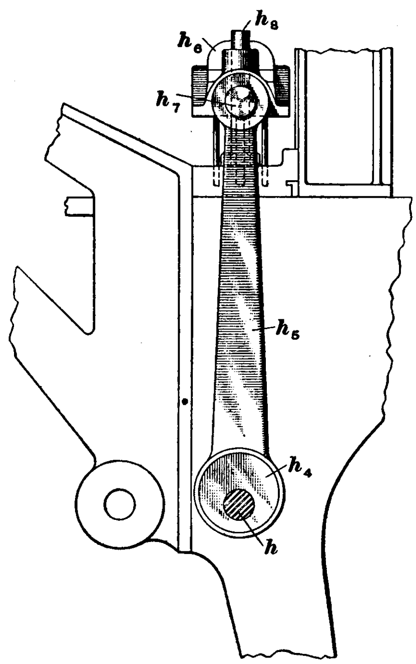

FIG. 18

16. Construction of Head.—The head h_6 that carries the punches is raised and lowered by means of an eccentric h_4, Figs. 15 and 18, on the shaft h; this eccentric carries an eccentric arm h_5 connected to a stud h_7 on the head h_6. One of these connections is at each end of the head, while two guide rods, one of which is shown at h_8, Fig. 18, are provided in order to insure the head receiving a true vertical rise and fall.

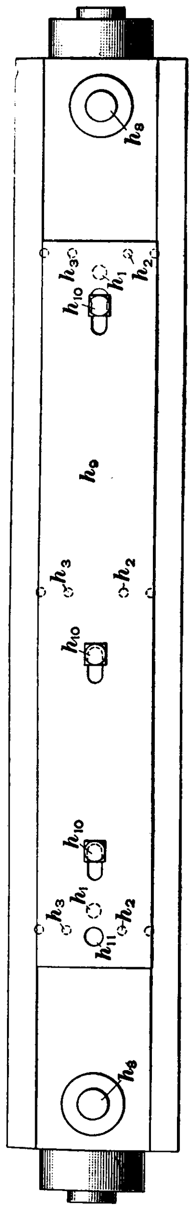

Fig. 19

It is in some cases necessary to lace cards that have been punched in the piano machine, while in other cases it is necessary to lace a set of blank cards. For instance, after the pattern has been punched in the cards by the piano machine, since this machine does not lace the cards together, it is necessary to pass them through the lacing machine, in order that they may be in suitable form to be attached to the jacquard machine; while if it is desired to lace cards together that are afterwards to have the pattern punched in them, as described later, it is necessary to pass blank cards through the lacing machine.

In case it is desired to lace cards that have the pattern punched in them, the peg holes and the lace holes will also have been punched; therefore, in case the peg-hole punches on this machine are now made to operate, there is some liability of their enlarging the peg holes previously punched, which would be detrimental to the good work of the cards when placed on the cylinder of the jacquard machine. This is provided for as follows, reference being made to Fig. 19, which is a plan view of the head: A plate h_9 that is bolted to the head rests directly over the punches, as shown in the figure; consequently, when the head is forced down, the punches, coming against this plate, are brought down with the head and puncture the cards. When, however, it is not desired to use the peg punches, the bolts h_{10} are loosened and the plate h_9 moved to the right. This brings the hole h_{11} directly over the peg punch h_1 at this end

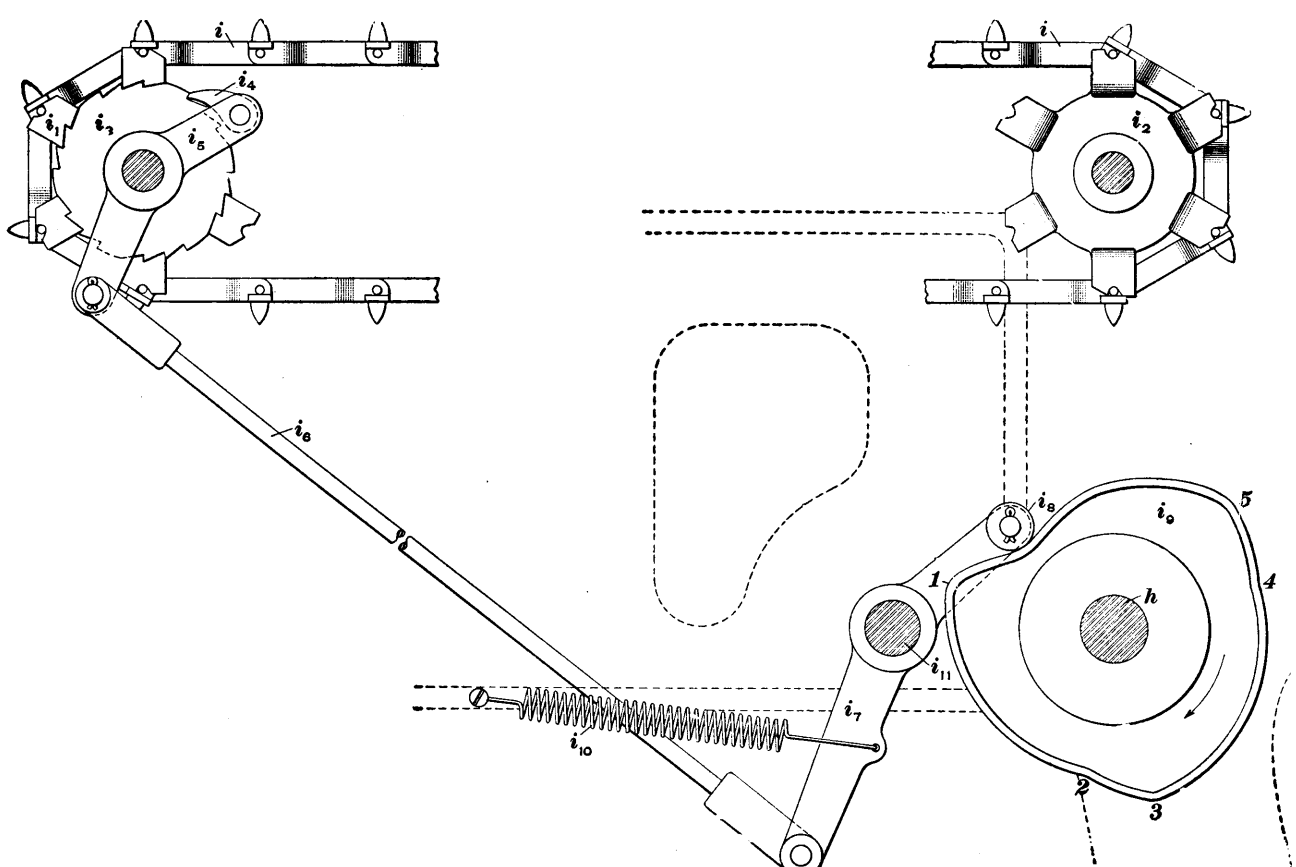

Fig. 2

of the head, while the slot in the plate h_9 through which the bolt h_{10} at the extreme right of the plate passes is enlarged sufficiently at its right-hand end to allow the peg punch at this end of the plate to pass through the slot. When the plate is in this position and the head is brought down, if the lower end of the peg punch does not exactly fit the peg hole previously cut in the card, the punch will be pushed up through the holes in the plate h_9, and consequently will not enlarge the peg holes previously cut.

By properly constructing the plate h_9, the lace-hole punches may be rendered inoperative by the same movement of the plate that renders the peg-hole punches inoperative. It is not an uncommon practice, however, to so arrange the holes in the plate h_9 as to keep the lace-hole punches in an operative condition, in order to cut the lace holes in the cards in the lacing machine. Lace holes can be cut in this machine much more quickly than in the piano machine and with sufficient accuracy for lacing purposes. It will be noticed that in Fig. 19 two additional punches are shown at each end of the head and also in the center. These punches are for the purpose of making small semicircular cut-outs at the edges of the card. These cut-outs, of course, are in direct line with the lace holes and form small spaces for the lacing cord to pass through, thus allowing the cards to come closer together than would otherwise be possible.

17. Carrier Chain.—The drive of the sprocket carrier chain i is shown in Fig. 20. The sprocket gear i_1 and ratchet gear i_3 are both fastened to the same shaft and the latter is revolved by means of the pawl i_4 on the lever i_5. The chain i imparts the motion of i_1 to i_2. Connected to the lever i_5 is a rod i_6 that, in turn, is connected at its lower end to a lever i_7 pivoted on the stud i_{11}. The lever i_7 carries at its other end a cam-bowl i_8 that by means of the spring i_{10} is kept constantly in contact with the face of the cam i_9 on the shaft h. As the cam i_9 revolves, the projections on the cam raise the cam-bowl i_8, while the depressions on the cam allow the spring i_{10} to lower the cam-bowl. This up-and-down motion of the cam-bowl being communicated to the pawl i_4, through levers i_7, i_6 and rod i_6, will cause the pawl to turn the ratchet gear i_3, which, as it is fast to the shaft carrying the sprocket gear i_1, will turn this gear, thus driving the chain i. The pegs in the chain i are so spaced that when they pass through the peg holes of the cards, the cards will be the correct distance apart for being placed on the jacquard cylinder.

In lacing the cards, the needle j, Fig. 16, is passed through each lace hole at one end of the cards and also between two consecutive cards. The distance between the two lace holes on one end of the card is greater than the distance between one of these lace holes and that edge of the card at which it is situated; consequently, when the needle is passed through the first lace hole of a card and it is necessary to move the card into position for the needle to pass through the other lace hole of the same card, the chain i must be given a greater motion than is necessary when moving the card forwards to bring it into position for the needle to pass down between this card and the next one after the needle has passed through the second lace hole. In order to give this varying motion to the chain i, the cam i_9, Fig. 20, has a deeper depression so as to allow the pawl i_4 to move back over the long tooth in the ratchet i_3, thus giving a greater movement when moving the card from one lace hole to the other than at any other time; the ratchet gear i_3 has its teeth spaced to agree with the face of the cam i_9.

To understand more fully this point, the position of the different parts will be followed, starting with the cam-bowl i_8 and the cam i_9 in the position shown in Fig. 20. When the parts are in this position, the needle has passed through the first lace hole of the card and had its thread locked by the shuttle. It is now necessary to move the card from the first to the second lace hole—a greater movement than is given to the card at any other time. As the point on the cam with which the cam-bowl is in contact in Fig. 20 is nearer the center of the cam than any other part, the cam-bowl when moving from its present position to the point *1*, will give the greatest throw to the pawl i_4 and bring the second lace hole of the card directly under the needle. As the cam is moving from *1* to *2*, the needle will pass through this lace hole, while the pawl i_4 will be brought back to engage with the next tooth of the gear i_3. The cam-bowl in moving from *2* to *3* moves the cards sufficiently to bring the space between the laced card and the next one directly below the needles. As the cam-bowl is moving from *3* to *4* the needle passes between the two cards, while the pawl i_4 is again brought back to engage with the next tooth of the ratchet i_3. From *4* to *5* is occupied in moving the

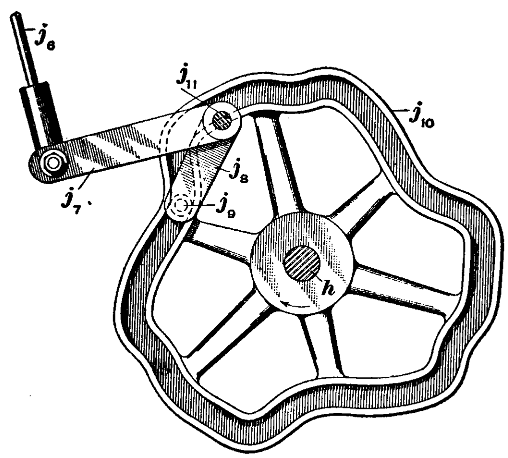

FIG 21

chain forwards until the first hole of the second card is brought below the needles, while from *5* to the point at which the cam-bowl is shown resting on the cam, is occupied in passing the needles through the first holes of this second card and bringing the pawl i_4 back for its greatest throw.

18. Lacing Mechanism.—The needles j, Fig. 16, are attached to a rack j_1 having teeth that engage with the gear j_3 situated on the shaft j_2. This shaft, as shown in Fig. 15, carries three gears similar to j_3, each of which drives a rack j_1 carrying a needle j. Fast to the shaft j_2, Fig. 16, is a gear j_4 engaged by a quadrant j_5 that is connected to a rod j_6. The lower connections of this rod are shown in Fig. 21. At one end of the shaft h is a cam j_{10}, also shown in Fig 15, that has working in its course a cam-bowl j_9 carried by an arm j_8 that is attached to j_{11}, which also carries an arm j_7 that is attached to the lower end of the rod j_6. The arms j_7, j_8 act as an elbow lever and serve to raise and lower the rod j_6 and, consequently, the quadrant j_5, Fig. 16, as the cam revolves. This up-and-down motion of the quadrant j_5, being transmitted to the shaft j_2 by the gear j_4, gives the desired motion, by means of the gears j_3, to the racks j_1 and

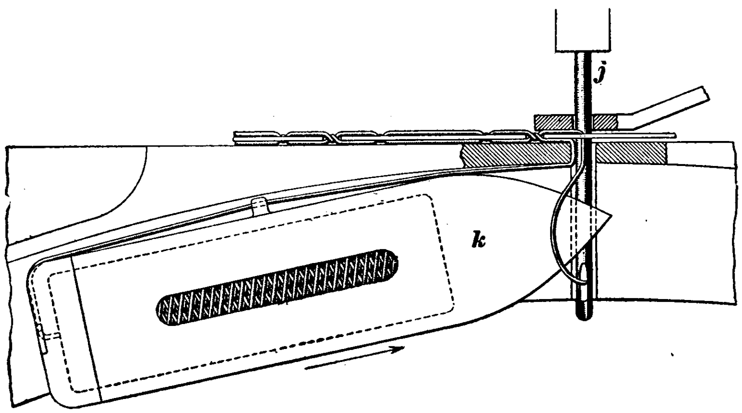

FIG. 22

needles j. The cam j_{10}, Fig. 21, is so constructed as to give three complete up-and-down motions to the racks for every revolution that it makes, while, in addition, there is also given to the racks when at their extreme downward position a slight upward motion, after which they are again brought to their extreme lowest position. This motion is provided in order to cause the cord drawn through the needle to form a slight loop below the cards, which is sufficiently large for the nose of the shuttle k to enter, as shown in Fig. 22.

For each set of lace holes there is a support similar to k_1, Fig. 16, that carries a shuttle k; the support is carried by an arm k_2 attached to a shaft k_3. An arm k_4 that is also attached to the shaft k_3 is connected to an eccentric rod k_5 operated by an eccentric k_6 on the shaft k_7; consequently, as the shaft k_7 revolves, the eccentric k_6, through the eccentric rod k_5 and arm k_4, gives an oscillating motion to the shaft k_3, which, being communicated to the shuttle through the arm k_2, gives it its desired motion. These parts are so timed that the shuttle moves to the right just as the loop is formed in the cord carried by the needle j. The shaft k_7 is the driving

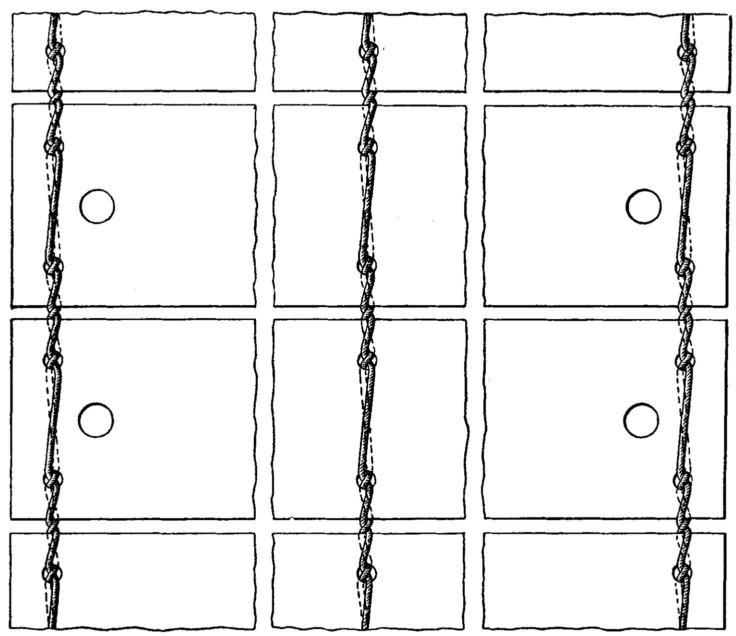

FIG. 23

shaft of the machine and carries a gear k_8 driving the gear k_9 on the shaft h. The gear k_8 contains 25 teeth, while the gear k_9 contains 75 teeth; consequently, the former makes three revolutions to one of the latter.

The position of the shuttle k and needle j, just as the point of the shuttle is entering the loop of the cord carried by the needle, is shown in Fig. 22, while the stitch formed by this operation is shown in Fig. 23, which illustrates cards laced

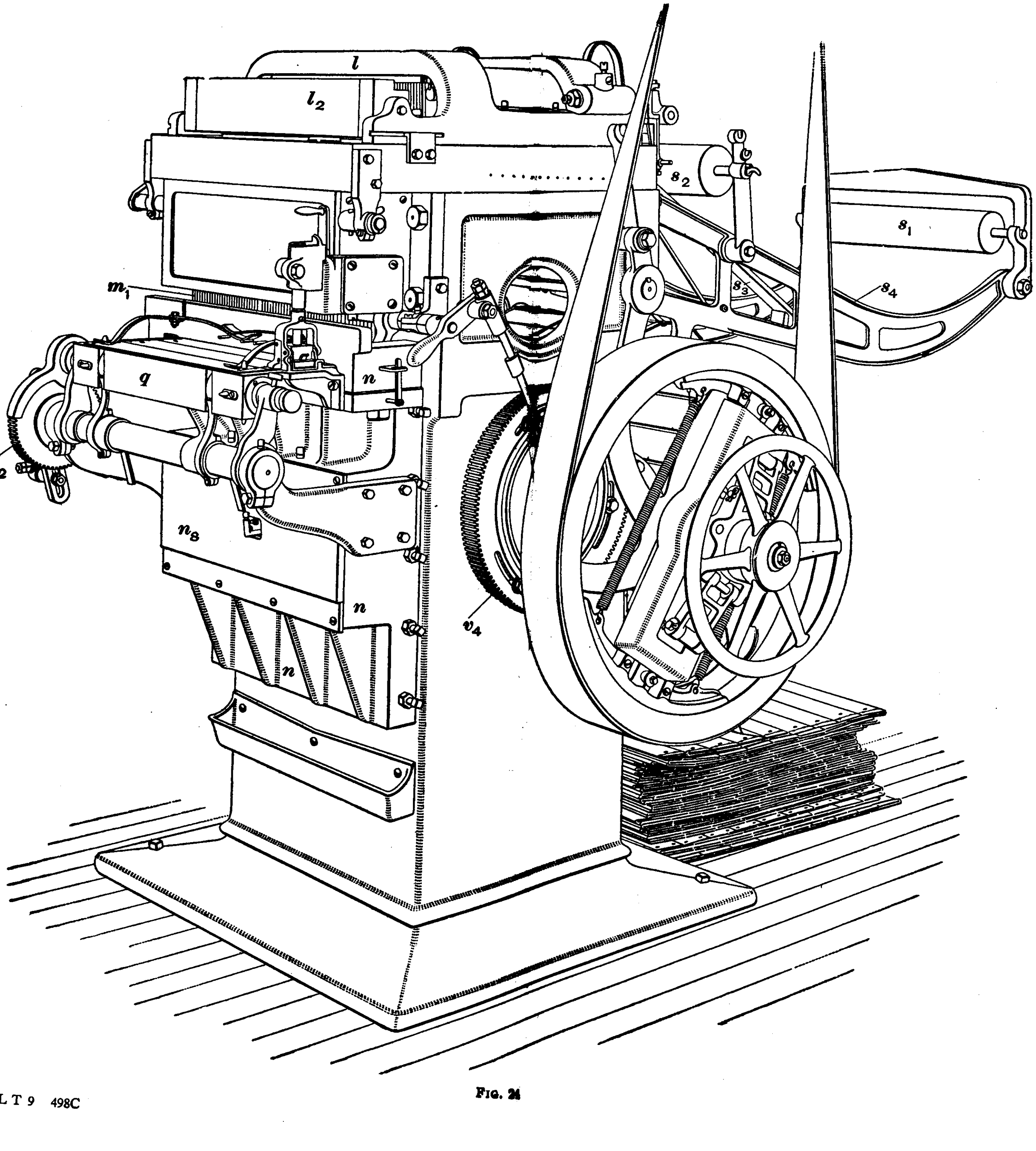

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FIG. 24

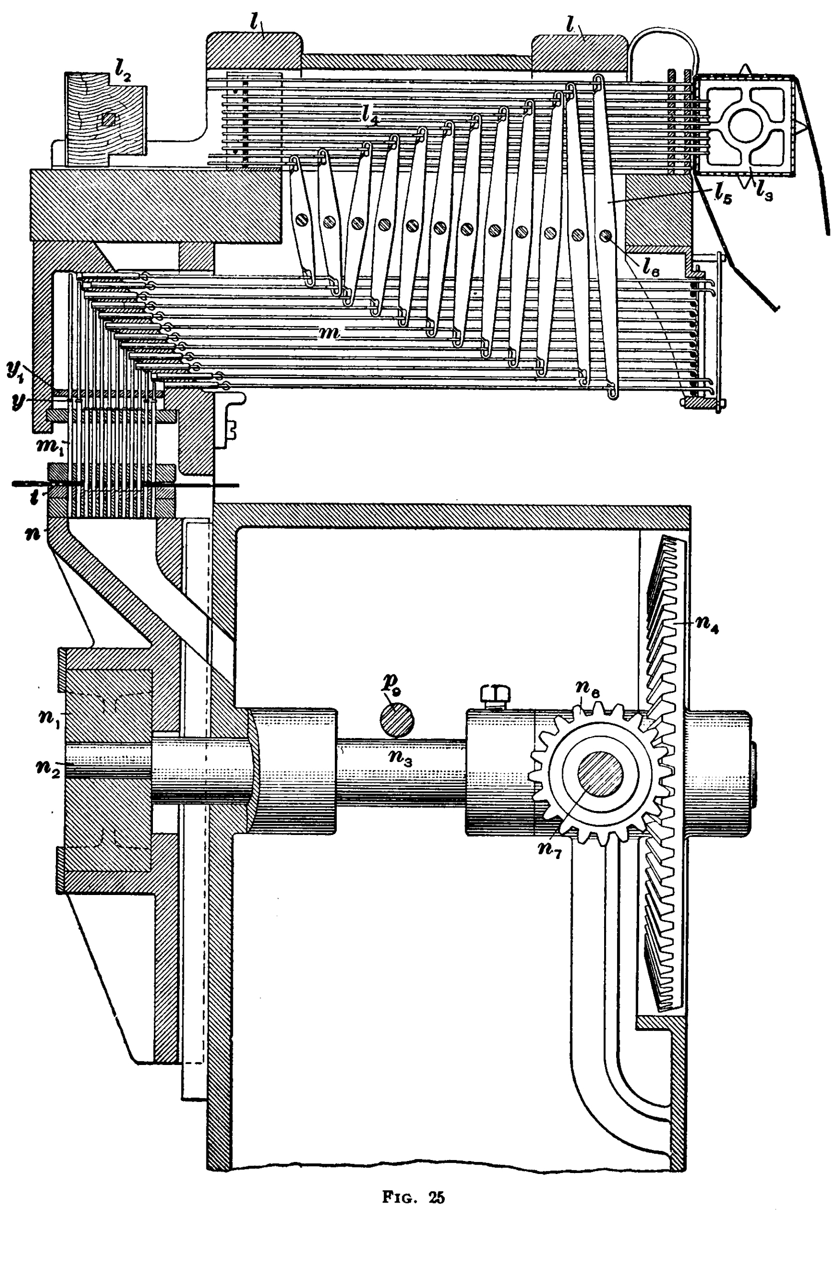

FIG. 25

together by this machine. It will be noticed that the cord carried by the needle is always above the cards, while the cord carried by the shuttle is always below the cards; these two cords, however, are crossed at each lace hole and also between consecutive cards.

REPEATING

AUTOMATIC REPEATING MACHINE

19. If a number of jacquard machines are to have the same design woven in them, after a set of cards for one jacquard has been cut on the piano machine, it may be duplicated as many times as desired by means of a machine known as a **repeater.** As this is done automatically and with certain accuracy, the repeating machine saves considerable time and expense as well as insures perfect results. Fig. 24 shows a view of this machine, of the Royle type, while Fig. 25 is a section through the same, showing the principal parts. Referring to these two figures, the carriage l is a hood covering certain portions of the machine. It is given a horizontal reciprocating motion and its sides l_1 rest on the top of the machine. At its forward end it supports a buffer l_2, while at its rear end it carries a cylinder l_3 similar to the cylinders on jacquard machines. Enclosed by the carriage are selecting needles l_4, Fig. 25, supported by the framework of the machine. Attached to these needles are levers l_5 pivoted on rods l_6 that extend from one side of the repeater to the other and are supported by the sides of the machine. Connected to the lower ends of the levers l_5 are rods m, known as *key wires*, controlling keys, the forward ends of which are situated directly above punches m_1. It will be noticed, by referring to Fig. 25, that the key wires vary in length, the upper ones being the longest; the punches also vary in length, the longest being situated in the outside row and the shortest in the inside row.

The operation of these parts is as follows: The cards of the set that has been cut by the piano machine are laced together and passed around the cylinder l_3, Fig. 25. As this cylinder is brought against the face of the selecting needles l_4, those needles that come in contact with the portion of the card that is not cut, are pushed to the left by the card, which gives a corresponding motion to the upper ends of the levers l_6 and results in the lower ends of these levers being moved to the right. This motion of the lower ends of the levers l_6 throws the key wires m and the keys to which they are connected to the right, moving them out of the path of the punches m_1. On the other hand, the selecting needles l_4 that come opposite holes in the card on the cylinder l_3, together with the levers attached to them, remain stationary; and the key wires m and keys, since they are as far to the left as they can go, will therefore lock their respective punches m_1. The cards that are to be punched are laced together as previously described and passed through the repeater; one of these cards is shown in position to be cut at t, Fig. 25. When in this position, the card rests on a carriage n that is situated directly under the punches m_1 and has a vertical reciprocating motion. As the card t is brought into position below the punches, the carriage n rises, carrying the card with it. Those punches that are not locked by the keys are pushed up by the card, and consequently do not puncture it, while those punches that are locked by the keys remain stationary and are pushed through the card as it is forced up by the carriage n. By this means, the holes punched in the cards that come under the punches m_1 are exact duplicates of the holes in the cards that pass around the cylinder l_3.

In order to clearly understand the action of the selecting needles, together with the keys of this machine, it should be remembered that the selecting needles l_4 receive no motion except that imparted to them by the card on the cylinder or by the buffer, while it is the carriage l carrying the buffer l_2 and cylinder l_3 that moves back and forth. When this carriage is moved to the left, the card on the cylinder is brought in contact with one end of the selecting needles, and when the carriage is moved to the right, the

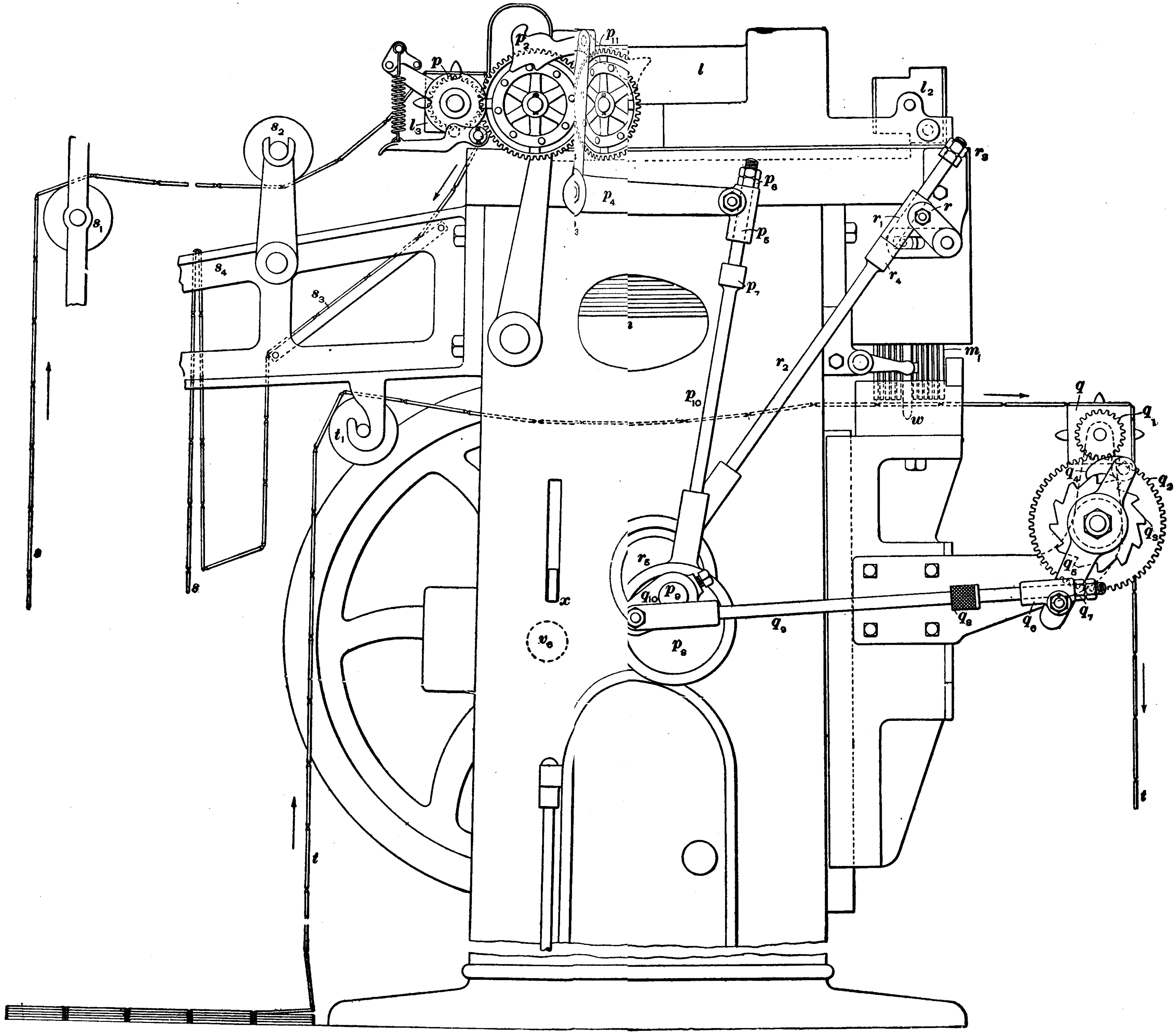

Fig. 26

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buffer l_8 is brought in contact with the other end of the needles and moves those previously pushed to the left by the card until all the levers l_5 are in their original positions. It will be noticed that the two faces of the buffer l_8, Fig. 25, are not of the same size. This buffer is capable of being turned over, so that its larger face may be used when cards are being cut for a jacquard machine with 12 hooks in its short row, while the smaller face is used for cutting cards for a machine with 8 hooks in its short row.

20. The manner in which the carriage n, Fig. 25, is given its vertical reciprocating motion is as follows: Keyed to the driving shaft n_7 is a bevel gear n_6 that drives a bevel gear n_4 on the shaft n_3. This shaft, at its forward end, carries an eccentric, or crank, n_2 working in a crosshead n_1 that rests in the carriage n. As the shaft n_3 revolves, any horizontal motion imparted by the crank n_2 is taken up by the crosshead n_1, while any vertical motion is imparted to the carriage n, thus raising and lowering it. The board n_8, Fig. 24, is directly over the crosshead n_1 and forms a casing for this part of the machine.

Fig. 26 shows the drive for certain parts of the machine, also the position that the two sets of cards occupy. The cards s are those that have been cut and that are to be duplicated. They pass over the guide roll s_1, under the roll s_2, and then to the cylinder l_3. From the cylinder l_3 they slide over guides s_3 and finally rest on the cradle s_4. The cylinder l_3 is turned primarily by the eccentric p_8 on the shaft p_9. Connected to this eccentric is an eccentric rod p_{10} that carries a sleeve p_6, attached to which is a lever p_4 pivoted at p_5. Attached to the lever p_4 is a pawl p_2 working a pin on the gear p_1. This gear drives a gear p on the end of the cylinder l_3. As the eccentric revolves on the shaft p_9, the rod p_{10} is forced up, bringing the projection p_7 in contact with the collar p_6 and forcing the pawl p_2 to the left, turning the gear p_1, which drives the gear p and thus turns the cylinder l_3. As the eccentric continues to revolve, the rod p_{10}

being lowered brings the set nuts p_6 in contact with the collar p_5, thus bringing the pawl back into such a position that it will engage with the next pin on the gear p_1. In order to understand fully the action of this pawl, it should be understood that the carriage l is continually being moved, first in one direction and then in the other. The fulcrum p_3 of the lever p_4 is also fixed to the carriage l, so that as the latter moves, the position of p_4 relative to the gears p_1 and p_{11} is maintained. It is as the carriage is being moved to the left that the pawl p_2 revolves the cylinder l_3. In this manner the cylinder is away from the needles when it turns, and consequently there is no liability of its injuring the points of the needles.

Sometimes the cards s are moved in the opposite direction to that shown by the arrows in Fig. 26; in such cases it is necessary to revolve the cylinder l_3 in the opposite direction. This is accomplished by swinging the pawl p_2 over until it occupies the position shown by the dotted lines, when it will engage with the gear p_{11} and, as it turns this gear, it will revolve the cylinder l_3 in the opposite direction.

The cards t, Fig. 26, that are to be cut, are moved in the direction shown by the arrows in this figure. They pass over the guide roller t_1 and thence directly through the machine and to the cylinder q, which is revolved by means of a crank q_{10} driven by the shaft p_9. Attached to this crank is a rod q_9 that passes through a sleeve q_6, to which is attached a lever q_5 carrying at its upper end a pawl q_4 that engages with the ratchet q_3 on the gear q_2. This gear engages with the gear q_1 on the end of the cylinder q. As the rod q_9 is moved forwards and backwards by the crank q_{10}, the casting q_8 and nut q_7 will alternately come in contact with the sleeve q_6, thus moving the pawl q_4 backwards and forwards, so that it will engage with and move the ratchet q_3.

21. In order that the keys that are to be moved to the left may be unobstructed, all punches must be level. To bring down those that were forced up by the card just cut, a plate y_1, Fig. 25, is forced into contact with collars y on the punches m_1. This plate is operated independently of any other part of the carriage n; its motion is derived from the eccentric r_5 on the shaft p_9, Fig. 26. This eccentric is connected to a rod r_2 that carries the projection r_4, set nuts r_3,

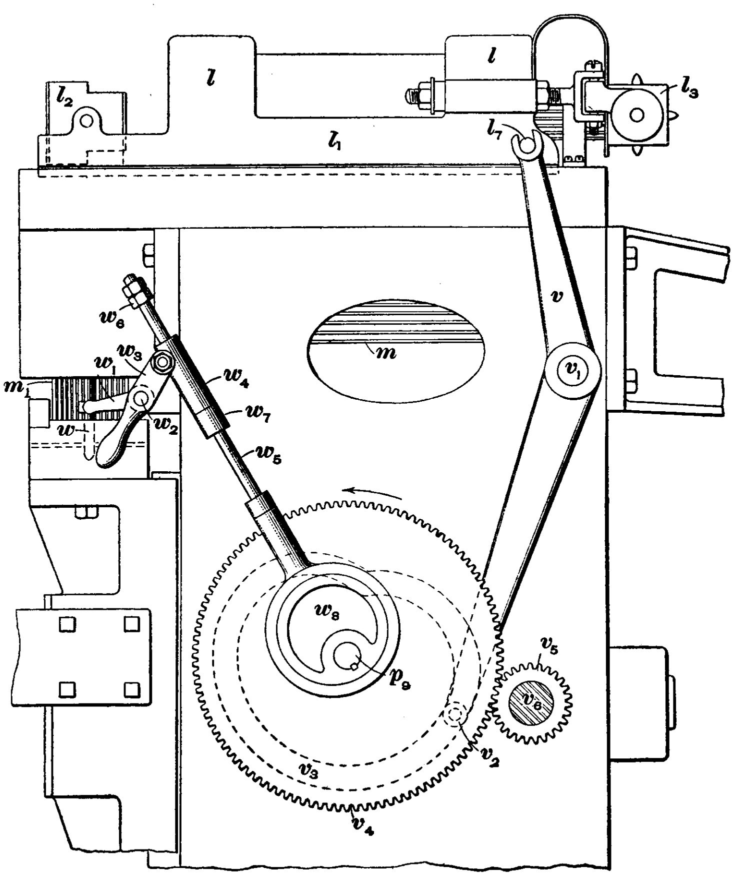

FIG. 27

and collar r_1, which is attached to the lever r. The lever r is secured to the outside end of a shaft that extends entirely through the forward portion of the key box. On the outside of the key box at each end of this shaft are secured forked levers that connect with sliding blocks, which in turn are connected by means of pivots to vertical slides that support the plate y_1 at its opposite ends.

22. The method of imparting motion to the carriage l, Fig. 24, is shown in Fig. 27. The carriage carries a stud l_7 that works in the upper end of the lever v pivoted at v_1; the lower end of this lever carries a cam-bowl v_2 working in the course of the cam v_3. As the cam revolves it forces the cam-bowl v_2, together with the lower end of the lever v, first to the right and then to the left, thus imparting a swinging motion to the upper end of the lever, which being conveyed to the carriage l by means of the stud l_7 gives to this carriage its horizontal reciprocating motion.

23. In order to make certain that the card to be punched is in its correct position below the punches, two pegs w, Fig. 27 (one at each side of the machine), are passed through the peg holes of the card to be punched and hold it securely in its correct position. These pegs are operated independently of the punches, as shown in this figure. Connected to the shaft p_8 is an eccentric w_8 operating an eccentric rod w_5 that passes through a sleeve w_4. The latter is attached to a lever w_3 pivoted on the shaft w_2. This shaft extends across the width of the machine and carries at each end an arm w_1 attached to a peg w. As the eccentric w_8 revolves, the rod w_5 is moved up and down, bringing the collar w_7 and set nuts w_6 alternately in contact with the sleeve w_4, thus imparting an oscillating motion to the shaft w_2, which being imparted to the arm w_1 lowers and raises the pegs w.