CHAPTER IX.

Cross Border Jacquard Mechanisms.

Cross border patterns are specially adapted to the manufacture of handkerchiefs, napkins, damasks, table covers, shawls, tapestries and carpets. The arrangement of the mechanism for producing the *side* borders and the body or centre for any of these types of woven figured fabrics presents few difficulties, one portion of the upright hooks being set apart for weaving the borders and another for producing the centre. When two or more Jacquard machines are used, one is frequently reserved for the border, and the rest for the centre. The harness cords are tied up to their respective sets of hooks or machine and passed through the comber board to suit the side borders and centre.

The difficulties begin, when, having woven one or more repeats of pattern, it is necessary to produce a change, or *cross* border, which shall balance the side borders and make one complete square or oblong pattern. The manufacture of bordered fabrics involves the adoption of one or other of the following mechanical methods.

(1) Whenever the centre and side border constitute only *one* repeat of pattern, it is usual to stamp two repeats of the cross border and one repeat of the centre but to lace the second set of border cards the reverse way, making one continuous chain, so that the loom can run without interruption for change of pattern. When only a small quantity is required to be woven the cross border cards are only stamped for one repeat; these are woven forwards, before weaving the centre, and backwards, after the centre has been woven. Where a large number of webs have to be produced, the former plan is sometimes adopted even when there are two or more repeats of pattern for the centre to be woven. With very long lengths of table covers, etc., this plan becomes most expensive involving the

use of many thousands of cards—a greater number than the loom is capable of accommodating.

(2) Two sets of cards are cut, one for the centre and sides and the other for the cross border—the latter consisting of two repeats laced in opposite directions. As many repeats of the centre as may be required are woven, then by hand, the cross border cards are substituted over the card cylinder and adjusted so as to start with No. 1 card, and the whole set is woven over once when the cards are again changed, by hand, to the first set; the operations are similarly repeated until the requisite quantity of material has been woven. The slowness and inconvenience of this method have led to the introduction of several semi or wholly automatic devices.

(3) A common method consists in employing two sets of cards with two card cylinders as on the double lift principle. One set of pattern cards and card cylinder controls the centre and the other set and cylinder the cross border. The cylinders are designed to strike on every pick but are only in action one at a time, according to whether the centre or cross border is being woven. Whenever either cylinder has to be put into action, the other must be simultaneously thrown out. Numerous inventions have been designed whereby this operation may be performed by hand or automatically. The mechanism which will perform these changes automatically is a desideratum and ideal, but such motions, of necessity, involve very many mechanical details and complications for which reasons they do not readily find favour. The following represent a few of the principal inventions designed to accomplish the foregoing object.

Devoge's Cross Border Jacquard.

This machine is a double-acting, double-cylinder Jacquard, but for cross borders, is worked as a single cylinder machine, with either cylinder, at will. Fig. 114 is a diagrammatic representation of the mechanical details employed for locking and detaching either card cylinder *by hand,* to suit the requisite length or number of repeats of pattern for either set of cards.

A is the reciprocating rod operated from an eccentric on the crank shaft of the loom; B is a stud connecting the rod A with a lever C screwed to the shaft D which extends across the length of the machine and near its base. E is a lever set screwed at right angles behind C to the same shaft D. An adjustable stud F combines the lever E with the link G which in turn is adjusted through the stud H to the lever I pivoted at J. K and K[1] are two studs set equidistant from the common fulcrum J. L is a connecting arm pivoted at K. Near the free end of the arm L a special socket M is

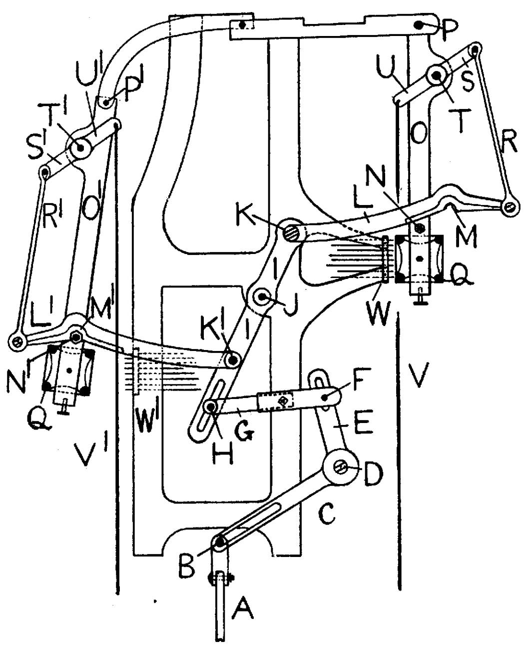


Fig. 114.

formed, which is free to lock as required with a suitably formed stud N, securely fixed near the base of the swing batten lever O, pivoted to a fixed bracket projecting from the top of the Jacquard framework at P. The position of the card cylinder is shown at Q. The extremity of the arm L is linked by the connection R to a small lever S, set screwed to the shaft T which extends and is fastened to the swing batten O and its duplicate for the same card cylinder. Immediately behind the lever S and set screwed diametrically opposite to it, is a second lever U to which a cord V is attached. This hangs down to within the control of the weaver. Corresponding details, from K to V inclusive, are indicated from K^1 to V^1 for controlling the card cylinder on the opposite side of the Jacquard machine. Portions of the needles and needle board for the right hand cylinder are given at W, and for the left hand at W^1.

Action of the Mechanism.

In the illustration, the socket M^1 of arm L^1 is in working contact with the stud N^1 in the swing batten lever O^1, so that the card cylinder Q^1 will strike against the needles W^1 on every shot whilst this arrangement lasts. But immediately the weaver stops the loom, pulls down and makes fast the cord V^1, he elevates through the medium of parts U^1 S^1 and R^1 the free arm of L^1 and detaches the socket M^1 from its connections N^1 and swing lever O^1. Simultaneously the cord V is released and the arm L falls, by gravity, on to the stud N, so that by turning the loom slowly 'over,' the notch M falls over the stud N and locks itself, by which means the cylinder Q is in working operation for as long as required.

Crossley's Cross Border Jacquard.

The cross border machine, commonly known as Crossley's was patented by Davenport and Crossley in the year 1883. An important feature in this invention is, that in addition to its use for cross borders it can be run as a double lift, *single* cylinder Jacquard.

The design and construction of the internal parts is ingenious, though somewhat complex, but the mechanism for producing the changes from one card cylinder to the other, which are usually performed by hand, is simple in arrangement. Fig. 115 is a line diagram which shows the internal arrangement of the needles and uprights. Fig. 116 is a plan of the special parts; corresponding numerals in each diagram and the subsequent Fig. 117 refer to similar parts. The ordinary details are:—griffe blades 1, uprights 2, guide board 3, resting rods 4, links 5, tug cords 6, needles 9, horse shoe loops 10, needle board 11, card cylinder 12, springs and spring box 13. The special details are the card cylinder 14 and a supplementary set of needles 15, supported and kept in their horizontal plane by the boards 16 and 17; a loop is formed in the terminal of each needle. Through the loops of each vertical row of needles a fixed pin 18 passes which limits the traverse of the needles 15 whenever they are under pressure by the non-perforated portion of the pattern cards. A second loop or ring 19 is formed in the needles 15, through *each* of which a separate small vertical rod 20 is suspended and also passed through a loop 21 formed in the corresponding needles of the lower and normal set. Adjusted and fixed immediately behind each set of suspended rods 20 is a horizontal rod 22, equidistant between loops 19 and 21, which serves as a pivot about which rods 20 can turn whenever pressure is applied to the upper set of needles 15.

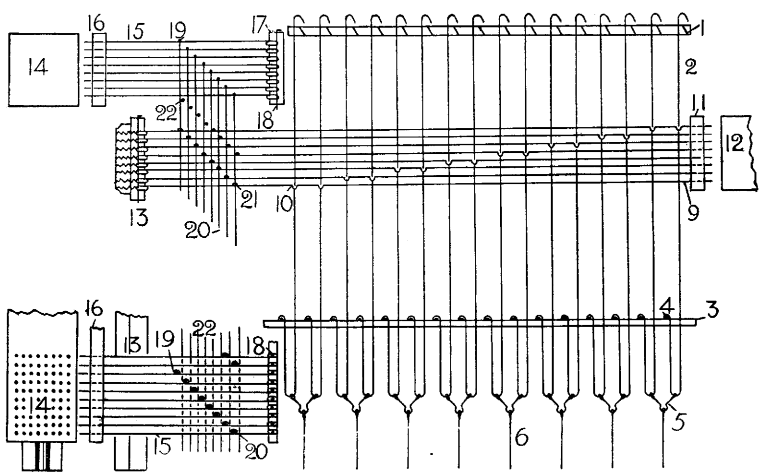


Fig. 116. Fig. 115.

Action of the Mechanism. The pattern cards on cylinder 12 produce the same results as obtains in an ordinary double lift single cylinder machine. The action of a non-perforated card on cylinder 14, when pressed against the needles 15, moves them to the right, together with the tops of the suspended rods 20, but the lower portion is moved to the left carrying with it the ordinary needles 9 and thus producing exactly the same result as a similar card operating on the cylinder 12.

Card Cylinder Changing Mechanism.

Fig. 117 shows a side elevation of the cross border changing mechanism. The reciprocating rod 23 receives its motion from an eccentric secured to the crank shaft; 24 is an adjustable stud connection between the rod 23 and a fixed lever 25 set screwed to a shaft 26 which extends across the Jacquard. Adjusted and fixed to the same shaft 26 is a lever 27 which combines through the stud and link 28 with a simple balk lever 29 pivoted at 30. The lower and upper arms of lever 29 carry projecting studs 31 and 32 respectively, which are free to oscillate in the slots 33 or 34 or be locked in the eccentric recesses 35 or 36. The slots 33 and 34 are compounded with the respective connecting arms 37 and 38. The arm 37 is attached to the lower cylinder 12, which is supported and free to rotate near the base of the swing lever 39, pivoted at 40 on a bracket compounded with the Jacquard machine. The arm 38 is similarly attached to the supplementary card cylinder 14 supported and free to rotate near the base of swing lever 41.

In the illustration supplied, the stud 31 is temporarily fixed in the recess 35 of connecting arm 37 while the stud 32 is clear of recess 36 and free to oscillate in the slot 34 of arm 38. Consequently whenever the rod 23 is reciprocated, the subsequent parts 25, 26, 27 and 28 correspondingly rock in sympathy with the balk lever 29 and since the stud 31 is locked and that of 32 is free, the former moves the card cylinder 12, from and to the face of the needles, but the latter simply moves to and fro in the slot 34, producing no action upon the card cylinder 14. The change, by hand, from cylinder 12 to 14 and *vice versa* is accomplished by the combination and action of the following added details. Pivoted to the fixed stud 43 is a simple lever 44 which the links 45 and 46 respectively join to the connecting slot arms 37 and 38 as shown.

A cord 47 links the free arm of lever 44 with a quadrant lever under the control of the weaver. The quadrant is secured to a bracket fixture. The quadrant lever can be fixed in different positions on the face of the quadrant. When the lever is depressed the left arm of lever 44, link 46 and cylinder arm 38 also descend, permitting the stud 32 and recess 36 to combine and place the cylinder 14 into operative action, but the right arm of lever 44 elevates the link 45 and cylinder arm 37 until the stud 31 is clear of the recess 35, and card cylinder 12 remains stationary. When the quadrant lever is released and lifted to the top, the action of all the parts just described is reversed and the cylinder 12 is brought into operative action, while 14 remains stationary.

Carpet Cross-border Jacquards.

For the designing and weaving of cross-border patterns for Pile and Ingrain Carpets, see *Carpet Manufacture*, pages 40 to 47, 150 to 157 inclusive, and 292 and 293.

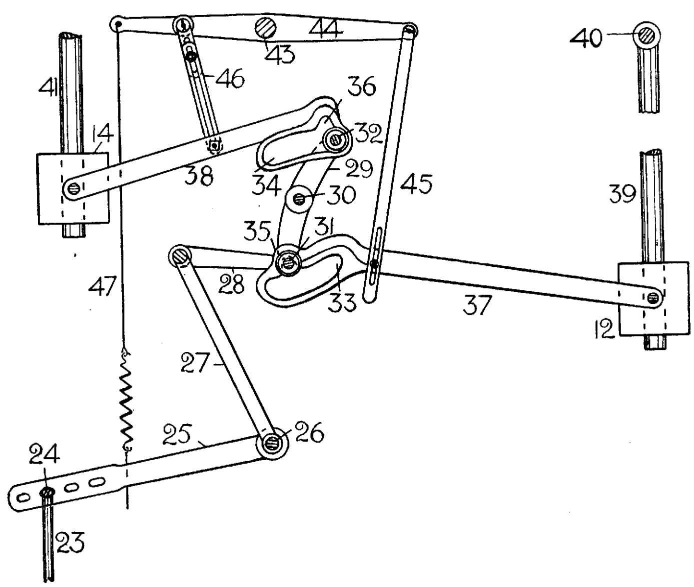


Fig. 117.

Automatic Cross Border Jacquard.

Rothwell's.

This mechanism is designed to produce the changes from one card cylinder to the other automatically, and also to reverse the pattern cards at will. Fig. 118 is a side elevation of the right hand motion, showing the various details which connect and operate the two card cylinders. 1 indicates a portion of the reciprocating rod which receives its motion from an eccentric rotating with the crank shaft of the loom; 2 is a supplementary rod adjusted near the top of rod 1, with which it moves in sympathy. The rod 1 is adjusted by a bolt and nut to the lever arm 3, the sleeve of which is free to oscillate on, but independently of shaft 4; compounded with the same sleeve is the lever arm 5. The rod 2 is similarly adjusted to the lever 3^1—the duplicate of lever 3. The shaft 4 runs across the back, and its duplicate 4^1 across the front of the Jacquard machine near the foot. Adjusted near the top of lever 5 is a stud combined with a flanged antifriction bowl 6, free to move forwards and backwards in the space 7, or to be locked in the notched recess of this space near the top of link 8.

The link 8 is combined through a stud 9 to a second link 10, in turn combined, by the adjustable stud 11, to a simple lever 12 set screwed to the shaft 4^1. The link 10 combines the lever 12 by the studs 11 and 13 to the swing batten lever 14, pivoted to the Jacquard frame supports; the free arm of this lever supports and reciprocates the card cylinder 16 after the usual manner. The top and bottom catches 17 and 18 are compounded and pivoted on the common stud 19. A cord may be attached to the straight and free arm 20 compounded with the double catch, for reversing the rotation of the card cylinder 16 by hand, in the usual way. Duplicates of all the details from 3 to 16 for connecting the card cylinder on the left hand are respectively illustrated by the numerals 3^1 to 16^1 inclusive. The second cylinder 16^1 is designed to turn in one direction only for which purpose the single catch 22, pivoted to the machine at the point 23, is employed. One of the gantry supports for the Jacquard machine is shown at 24. If the cross border mechanism is not increased beyond the details already illustrated the apparatus may be controlled by hand to effect the changes from either cylinder to the other.

The Automatic Mechanism.

The added details for this purpose consist chiefly of a set of tappets of two different heights linked together and free to rotate with a small chain cylinder, operated at will, through the medium of one Jacquard upright, a ratchet wheel and a drawing catch.

Fig. 119 shows a side elevation of the chain cylinder and tappets.

Fig. 120 is a front elevation of part of the same details.

Fig. 121 is a side view of the details for turning the ratchet wheel compounded with the tappet cylinder.

Fig. 122 is a front view of part of the same details.

Fig. 123 is an elevation of the mechanism for automatically reversing the card cylinder 16. Corresponding numerals refer to similar details. 25 is a square bracket secured to the ends of the Jacquard framing. A small chain cylinder 26 is supported, centred and free to rotate between the two sides of the bracket 25. Upon the cylinder 26 and free to rotate with it is a continuous chain of small tappets 27^1 of two different heights; resting in close contact with one or other of the tappets 27^1, is a small anti-friction bowl 28^1 supported and projecting from the underside of the simple lever 29^1, pivoted to the stud 30^1 in the upright bracket 31^1, in turn securely fixed to one of the ends of bracket 25. The free arm of the lever 29^1 is connected by a short stud 32^1 to a vertical rod 33^1 which is free to slide between two guide brackets 34^1, compounded with and on the remote side of lever arm 5^1. The head of the rod 33^1 supports the free end of the link lever 8^1. Duplicates of the parts for controlling and operating the card cylinder at the front of the machine are shown at 28 to 34 inclusive and respectively.

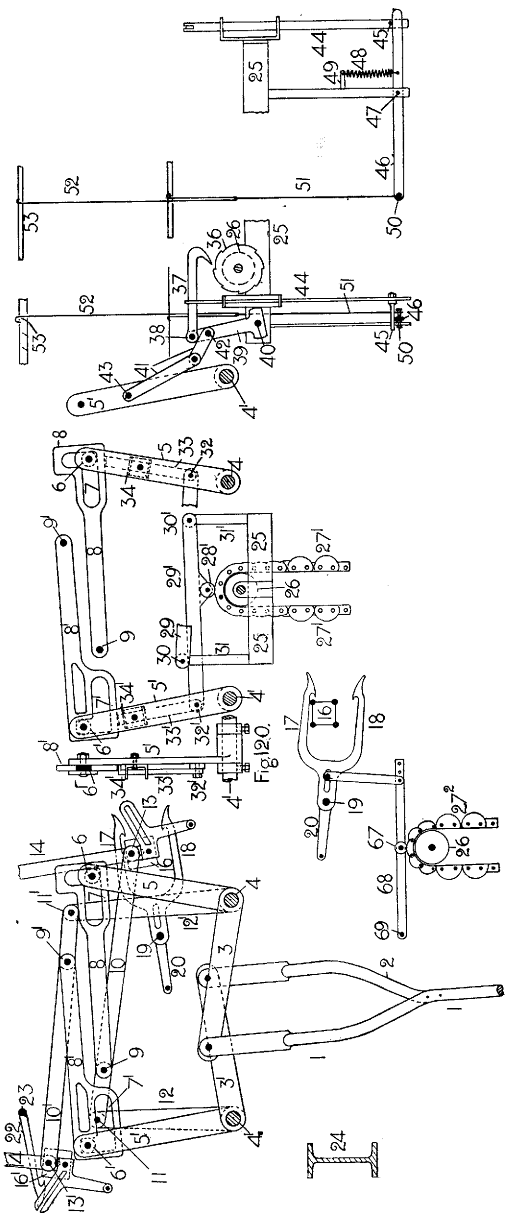
Combined action of the Locking and Vibratory Mechanism.

Whenever it is required to lock the bowl 6^1 in the recess 7^1 of link 8^1, one of the smaller tappets 27^1 is brought to the top of the chain cylinder 26, which permits the bowl 28^1, lever 29^1, rod 33^1 and link 8^1 to fall by gravity until the notched space 7^1 encloses the bowl 6^1 adjusted to lever 5^1. The unlocking of this lever is effected by rotating one of the larger tappets 27^1 into rolling contact with bowl 28^1 in lever 29^1 and lifting through these, the rod 33^1 and link 8^1 until the notched space 7^1 is clearly above the bowl 6^1, so that the last is free to reciprocate in the space 7^1. It will be observed that the stud and antifriction bowl 6^1 are enclosed in the notch of space 7^1 in the link 8^1. This combination compounds the lever 5^1 with the link 8^1, so that whenever the lever arm 5^1 reciprocates, the link 8^1 moves in sympathy. On the contrary the bowl 6 is shown to be clear of the notched recess in space 7 of link 8, so that whenever the lever arm 5 reciprocates, it exercises no influence on the link 8, but immediately the bowl 6^1 is released from the notch in the space 7^1, the bowl 6 is automatically pressed into the notched recess of space 7 in the link 8, and thus compounds it with the lever arm 5. When link 8 is locked, that of 8^1 is free and *vice versâ*.

The continuous reciprocation of the rod 1, with its complement 2, alternates in sympathy levers 3, 3^1, 5 and 5^1 freely and independently of their respective oscillating shafts 4 and 4^1. The bowl 6^1 being locked in the notched recess 7^1, reciprocates the link 8^1. This link, acting through the stud 9^1, reciprocates the link 10^1, stud 11^1 and lever 12^1, which last oscillates the shaft 4. Simultaneously the link 10^1 reciprocates through stud 13^1 the swing lever 14^1 which carries the card cylinder 16^1 outwards and inwards, from and to the needles. If necessary, both levers 5 and 5^1 may be permanently locked with the respective links 8 and 8^1, so that the machine or machines may be used as ordinary 'double lifts.'

Mechanism and Rotation of the Chain Cylinder and Tappets.

A ratchet wheel 36, Fig. 121, is secured to the same axis as the chain cylinder 26. 37 is a pulling catch resting immediately over the ratchet wheel, in contact at will, but normally clear; this catch is pivoted on the stud 38 fixed near the top of the simple lever 39, which is supported and free to rotate upon the stud 40 adjusted to bracket 25. A knuckle jointed link 41 combines through the studs 42 and 43 the lever 39 with that of lever 5^1. The pulling catch 37 is further supported and lifted out of contact or lowered into contact with the ratchet wheel 36, by a forked vertical rod 44, which is kept in the vertical plane by suitable guides, affixed in the cross rail of bracket 25. Near the base of this rod 44, a projecting stud 45 is adjusted at right angles and normally rests upon the right arm of the simple lever 46, pivoted on the stud 47. A spiral spring 48 links lever 46 to the bracket 49, and keeps the right arm of lever 46 in close contact with stud 45. The left arm of the lever 46 is combined through stud 50 and cord 51 with one of the upright hooks 52, the griffe blade for which is shown at 53.



Figs. 118, 119, 120, 121, 122

Fig. 123.

Action of the Mechanism.

Each vibratory movement of lever 5^1 reciprocates the pawl catch 37, but since this is normally clear of the ratchet wheel 36, through the energy in spiral spring 48 no rotation of the chain cylinder takes place. If, however, the left arm of lever 46 is lifted through the medium of cord 51, upright 52 and griffe blade 53, the right arm of lever 46 descends, permitting, through rod 44, the catch 37 to fall into acting contact with the ratchet wheel 36, and thereby turn it one eighth of a revolution, counterclockwise with each oscillation of lever 5^1. This brings forward the next successive tappet in chain 27^1 to either release link 8^1 or compound it with lever 5^1 through the connections described.

A perforation in the last or other card of either card cylinder, repeats this operation. Each *small* tappet 27 therefore represents *one* repeat of the set of pattern cards on the back cylinder 16, and each *large* tappet permits one repeat on the front cylinder 16^1. Conversely each small tappet 27^1 represents one repeat of the pattern cards on the front cylinder 16^1, and a large tappet permits one repeat on the back cylinder 16. The tappet chains 27^1 or 27 can be made any length to suit the required design.

Automatically Reversing the Card Cylinder.

The necessity for reversing the direction of the card cylinder occurs *only* when the figure design has to be woven the reverse way. Upon the chain cylinder 26, Fig. 123, a third chain of large and small tappets 27^2 is kept in rolling contact with an antifriction bowl 67 in the lever 68 pivoted at 69; the free end of this lever is adjusted to the double catch 17 and 18, so that whenever a large tappet lifts the lever 68, it also places the bottom catch 18 into operating contact with the back card cylinder 16. A small tappet rotated under the bowl 67, permits the lever 68 and top catch 17 to resume their normal positions when the card is turned in the usual direction.

Needles and Special Uprights for Cross Border Jacquards.

Fig. 124 shows in elevation one row of uprights and one row of each set of crosswires. The uprights 52 are constructed in two parts, but looped together as shown at 66; this special arrangement makes it possible for all the hooks to be placed the same way. The griffe blades are also all arranged the same way. When the uprights are back to back and the griffe blades opposed to each other, the difficulty of repairing is increased. The griffe blades are shown at 53, the guide and support board at 54, the links at 55, the tug cords

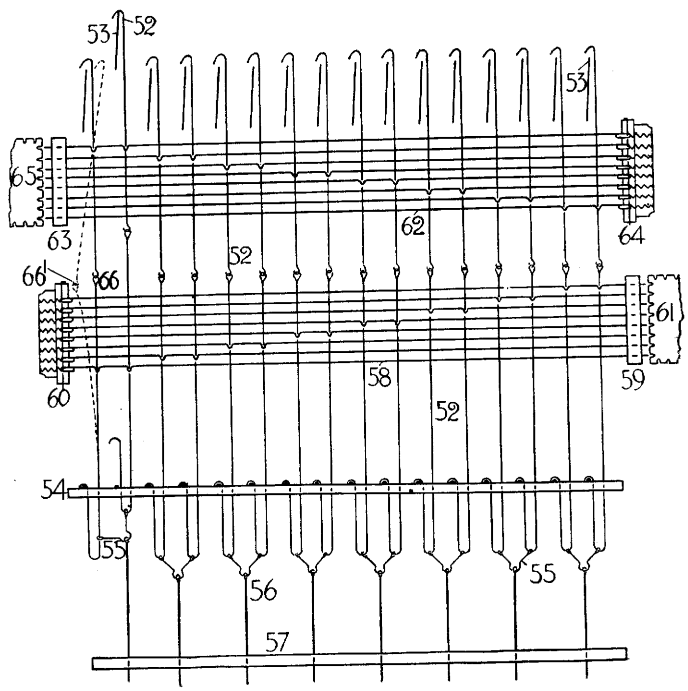


Fig. 124.

at 56, and a guide board at 57, which primarily ensures that the tugs and links rise or fall in a vertical plane. The crosswires for the bottom set are indicated at 58, the needle board at 59, the springs and spring box at 60, and the card cylinder at 61. The top set of corresponding details are indicated at 62, 63, 64 and 65 respectively.

Action of the Mechanism. Whenever a non-perforated card is presented by the card cylinder 65 to the face of the needles in the top set, it presses the upright *clear* of the rising griffe blades, but whenever a non-perforated card in cylinder 61 presses in contact with the face of the needles of the bottom set, the needles move the upright 52 near the loop joints 66 to the left—66^1, but the top portions of the uprights act as levers, and *pivot* about the point where they are in contact with the upper needles, thus causing the hooks at the top to move likewise to the right, *clear* of the rising griffe blades as indicated by the dotted lines.

Whenever a perforated card is presented to either cylinder, it exercises no influence on the needles nor through them on the uprights, consequently the latter rise with the griffe blades after the usual manner.

CHAPTER X.

Twilling Jacquards.

THE majority of woven, figured fabrics, such as damasks, napkins, dress goods, etc., belong to the class technically denominated *warp* and *weft* figures.

The figure effect on the surface of the fabric is usually produced by a combination of masses of weft predominating, contrasted with masses of warp predominating. The *weft* effect is usually denominated the 'figure' or 'flower' and the *warp* surface, the 'ground' of the pattern. The figure, in white or self colours, is visible because of the different reflecting properties which masses of warp and weft *floats* possess when viewed at right angles to each other, as they are naturally displayed on the surface of a cloth.

The balance of structure of the fabric necessitates that the *long* floats of either warp or weft must be tied down into the body of the cloth. This is commonly accomplished by employing some elementary weave, which repeats many times in each mass of figure and in the ground pattern.

It was always therefore a desideratum with the manufacturer to devise some simple shedding mechanism which would produce the binding or structural weave independently of the figuring or Jacquard apparatus and thus make it possible for each figuring unit to control two or more *adjacent* threads of warp constituting the figuring shed. It has been evident for hundreds of years that by the combination of two such shedding factors, the *normal* figuring capacity of the larger shedding apparatus would be materially and economically increased. It was the knowledge of this fundamental datum which evolved the simplex treadle and compound mounting, for weaving old diapers, Fig. 46, the pressure and split harness for producing the more elaborate figures in table covers, etc., in hand loom weaving, and finally the modern twilling Jacquard.

The twilling mechanism is designed to bind automatically, in sateen or twill order, each *group* of warp threads selected by the Jacquard machine to form the upper and lower lines of the figuring shed. The mechanism which produces the binding is combined with the Jacquard and requires no external apparatus as is the case with many inventions designed with the same object. The 'binder' weave is usually an 8 or 5 end sateen or *both*.

The chief feature of this mechanism is that each needle controls two or more uprights. Each Jacquard card has to serve for two or more shots of weft. The Jacquard machine lifts the uprights which are grouped to the needles, while the twilling motion depresses or elevates one out of every five or eight uprights, according to whether the binding must be in five or eight end sateen order.

The figuring capacity of 'single lift,' twilling Jacquards is always equal to the product of the number of needles and the average number of uprights per needle.

The number of shots in the complete repeat of the woven pattern is equivalent to the product of one repeat of the pattern cards and the average number of shots per card.

The Bessbrook or Irish Twilling Jacquard.

Generally speaking, all twilling Jacquards are called 'Bessbrooks.' There is, however, a slight difference in detail between the Irish and Scotch makes. The first series of illustrations have been drawn from the 'Brookfield' make of an Irish twilling Jacquard.

Arrangement of Needles and Hooks— 8 Leaf Twill.

Fig. 125 is a side elevation of one row of needles combined with one row of ordinary hooks of a 608 machine. Each needle is linked to and controls three hooks; these are combined with, and independently controlled by an 8 leaf twilling motion.
By this compound arrangement the figuring capacity of the machine = 8 needles × 76 rows × 3 hooks per needle = 1824 figuring hooks.

Fig. 126 is an elevation, from the same side of the machine, of the twilling hooks.

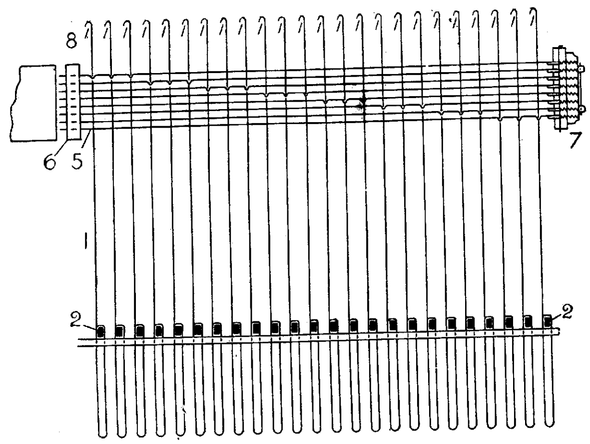


Fig. 125.

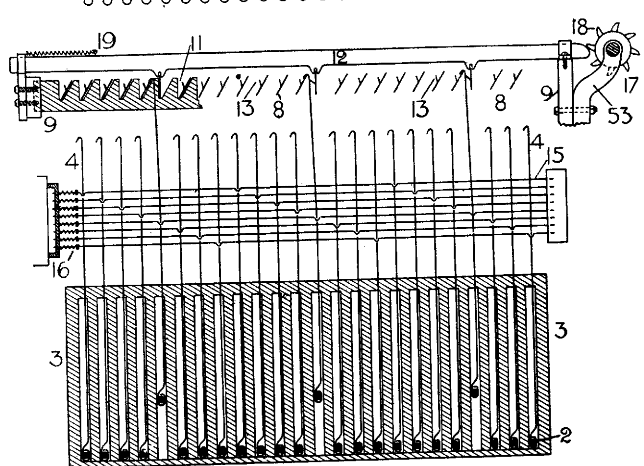


Fig. 126.

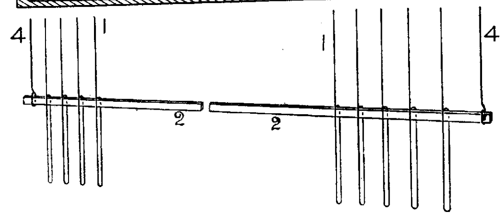


Fig. 127.

Fig. 127 shows a front elevation of the twilling hooks together with a few of the ordinary hooks. Similar numerals indicate corresponding details. The ordinary hooks 1 are doubled back from the base so as to form complete loops. The hook bars 2, made of iron, are passed severally through each row of loops. They are contained laterally, but free to reciprocate vertically, between divisions formed in two vertical 'grid' plates 3 and its duplicate. Their ends are combined with the twilling hooks 4 as shown, and they all normally rest at the bottom of the grid plates. The ordinary hooks 1 are normally at rest on the hook bars 2. The ordinary needles are shown at 5, the needle board at 6, and the spring box and springs at 7.

The griffe or lifting knives 8 are supported in the top of the head frame 9, and by a supplementary cross rail 10, Fig. 129. Portions of the supports are cut away as at 11, one side forming an incline, and the other a true vertical plane. This groove -V- permits the griffe blades 8 to be oscillated as required by means of a set of twilling bars 12. In this machine there are eight twilling bars and compounded with the underside of each are three double 'finger' projections at equal distances apart. The projections of each bar are connected in consecutive order with the griffe blades 8 for three repeats, so that each twilling bar can oscillate three griffe knives, see Fig. 129.

Normally each griffe blade lies parallel with the inclined plane of groove 11, and the ordinary hooks 1 remain stationary over the griffe blades 8, but the *twilling hooks* are then clear.

Formed near each end of the blades 8 are 'lip' projections 13, which rest in close contact with the back of the twilling hooks 4. These twilling hooks are kept in their normal position by a separate set of needles 15 and spiral springs 16. Each needle is joined to three *twilling* hooks in the same order as the twilling bars are connected with the griffe blades, Fig. 129. The twilling bars are operated by means of a small steel cylinder 17, denominated the twilling cylinder, studded with brass pegs 18, and arranged in any ordinary twill or sateen order, in this example—eight end sateen. Each peg is so arranged that as the cylinder rotates, it will be directly opposite the end of its respective twilling bar. A spiral spring 19 fastened to the head 9 and the twilling bar 12, keeps the last in contact with the pegs 18.

Mechanism of Card and Twilling Cylinders.

Card Cylinder.

Fig. 128 is a side view of a Bessbrook *eight* leaf twilling Jacquard, and Fig. 129 a part plan of the same side of the machine, and including the twilling mechanism. Similar numerals in Figs. 125 to 129 inclusive, refer to corresponding details.

21 is the gable on the left side of the machine, and 22 a short shaft, 2in. in diameter, which oscillates to the right and left *once* for every shot of weft, see Fig. 156. It is supported in a pedestal fixed to the front of the gable 21, and duplicated on the oppôsite side of the machine. Adjusted and secured to the shaft 22 is a lever 23, the arm of which supports an antifriction bowl 24, on which rests the *base* rail of the lifting head 9. Fitting closely to the side of the head 9 are two *slide* brackets 25 and 25^1; these are free to rise or fall in the respective grooves 26, 26^1 in the gable 21. The bracket 25 is provided with a fixed stud and a rotating antifriction roller 27, which is free to rise and fall with the head 9, and also fits into the groove of a bracket 28 denominated the swan neck. This is set screwed to the slide spindle 29, in turn supported in a horizontal plane by three 'lugs' **x**. A brass bush 'sleeve' is set screwed into the bore of each lug. The spindle 29 passes through and is free to move in these sleeves with the minimum of friction. Welded to the left hand side of the slide spindle 29 is a steel bracket 30, into which is cut a vertical slot. At the base of this slot, the gudgeon pin, in the end of the card cylinder 31 rests, and is free to rotate; a lock nut and set screw 32 are adjusted through the base of the bracket 30 for raising or lowering this end of the card cylinder. A second slide spindle 33, provided with a hammer head and a spiral spring 34, is supported between the brackets 35 and 35^1, the former being fixed to the Jacquard gable 21, and the latter to the slide spindle 29. The object of the spindle and hammer 33 and spring 34 is to keep the card cylinder 'square' during the period of striking the needles.

The spindle 29 is compounded with its duplicate on the opposite side of the machine through the medium of a cross rod and coupling 36; this arrangement ensures that both ends of the card cylinder 31 shall travel outwards or inwards in perfect unison. All parts from 21 to 35^1 inclusive are duplicated on the opposite side of the machine. A fixed stud 37 in the gable 21 supports and serves as a pivot for the cylinder catches 38 and 39. 40 is a supplementary arm or wing and 41 the straight arm to which a cord and spiral spring 42 are attached for the purpose of lifting the *top* catch 38 clear, and bringing the *bottom* catch 39 into contact with the cylinder 31.

Details of the Intermittent Mechanism.

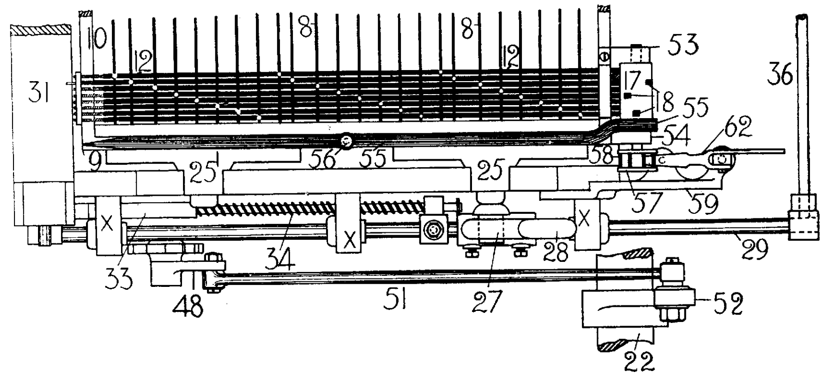
Mounted upon a stud 43, fixed in the gable 21, is a specially constructed cam or tappet 44, denominated the 'twilling tappet.' Normally, it is in rolling contact with the antifriction bowl 45, fixed into the shoulder of the bottom catch 39.

A similar bowl and stud 46 is bolted in the winged arm 40. The tappet 44 and bowl 46 are normally clear, but whenever the string 42 is held or fastened down, the catch arm 41 is also depressed in sympathy, but the top catch 38 is lifted clear and the bottom catch 39 is brought into working contact with the card cylinder. The bowl 45 is also lifted clear of the twilling tappet 44, but the bowl 46 on the winged arm 40, is moved into rolling contact with it, so that whether the card cylinder is rotating forwards or backwards, the twilling tappet operates on the catches to produce the same number of shots per card. Compounded with the tappet 44 and rotating on the same stud 43 is a ratchet wheel 47, having twelve teeth. A small lever 48 is bushed and free to oscillate about the stud 43. Pivoted and adjusted to this lever 48 is a pawl 49, the free end of which is kept in close contact with the ratchet wheel 47 through the medium of a steel spring as shown. The object of the lever 48 and pawl 49 is to rotate the ratchet wheel 47. A strong steel 'finger' spring 50 is also kept in close contact with the ratchet wheel 47, to obviate any tendency to recede when the pawl is also receding to lay hold of the next ratchet tooth. The lever 48 is linked by means of an adjustable rod 51 to the lever 52 secured to the shaft 22.

Twilling Cylinder.

The twilling cylinder 17, Figs. 126 and 129, is supported and free to rotate between two wings of a bracket casting 53 secured to the head 9. One or other of the brass pegs 18 is always in pressing contact with its corresponding twilling needle. Compounded with the twilling cylinder 17 is a small octagonal shaped pulley 54, upon the periphery

Fig. 129.



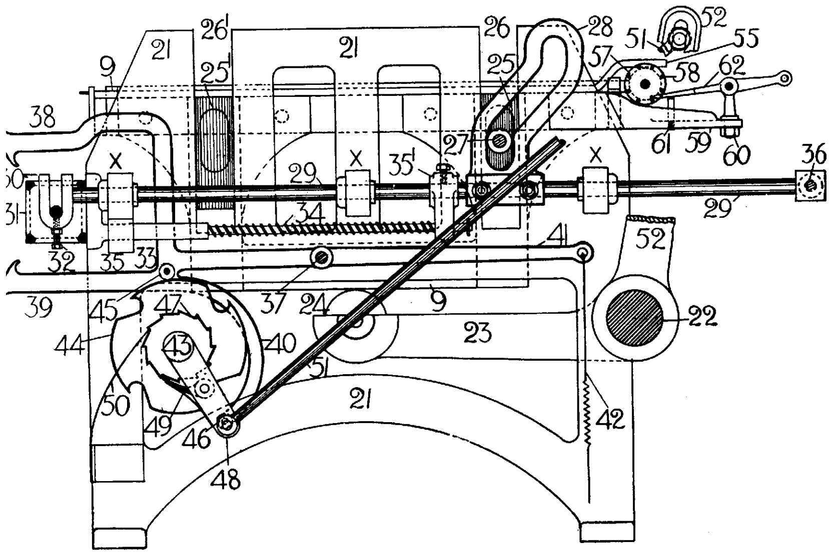


Fig. 128.

of which rests the free arm of a long flat steel spring 55, secured to the head 9 at 56. This spring is to prevent the twilling cylinder from rotating too far whenever motion is imparted to it.

Also compounded with the end of the twilling cylinder 17 is a small reel 57, the flanges of which are of brass and pierced with eight small holes at equal distances apart and near to the periphery; through the opposite holes of each flange, small steel pins 58 are inserted and welded. A bracket 59 is set screwed to the gable 21. Adjusted to this bracket are two vertical studs 60 and 61. Pivoted near the top of the former is a simple lever 62, the left arm of which normally rests upon the pins 58.

Action of the Card Cylinder Mechanism.

The head 9 rises and falls on every pick. With each *ascent* of the head, the stud and bowl 27 also rise in a vertical plane, but since they are contained in the inclined groove of the swan neck lever 28, they cause the latter together with the spindle 29, the steel bracket 30 and the card cylinder 31 to move *outwards* to the left, but *inwards* with each *descent* of the head.

Whenever the smaller radius of the twilling tappet 44 is in working contact with the bowl 45, the cylinder catches are normal and the card cylinder 31 is rotated the usual $\frac{1}{4}$ revolution, but immediately the greater radius is rotated into contact with the bowl 45 the top catch is lifted clear of the card cylinder, but not sufficiently high to bring the bottom catch into working position with the card cylinder 31. So long as these conditions prevail, the cylinder is reciprocated outwards and inwards, without *any* rotation. In a similar manner the twilling tappet operates upon the stud and bowl 46 attached to the wing lever 40, whenever the double catch lever 41 is held down by the string and spiral spring 42 for the purpose of lifting the bottom catch to reverse the card cylinder.

Action of the Twilling Mechanism.

With each ascent of the Jacquard head 9, the reel 57 rises above the left arm of lever 62, which is then free to fall until it rests upon the vertical stud 61. With each descent of the head one of the steel pins 58 is brought into forcible contact with the left arm of lever 62, which offers resistance sufficient to cause the reel pulley 57, compounded with the twilling cylinder 17, to rotate $\frac{1}{8}$ revolution and thus bring one of the brass pegs 18 into contact with its corresponding twilling bar 12 and move it so as to overcome the resistance of the spiral spring 19, Fig. 126, and simultaneously move the *three* griffe blades, with which it is linked from the incline to the vertical plane of groove 11. These three griffe blades are then clear of all the *ordinary* hooks in each corresponding row, irrespective of whether they have been left *on*, or pushed *off* the griffe blades by the ordinary pattern cards. Simultaneously with the movement of the griffe blades into the vertical plane, the projecting lips 13 near the ends of each blade press against the back of the *twilling* hook immediately in front of them, in such a manner as to push the hook over its respective griffe blade so that with the ascent of the head on the next pick, these blades lift three of the twilling hooks, to which they are attached as indicated, Figs. 126 and 129. These, in turn pull up their respective hook bars 2, which elevate all the ordinary hooks 1 in each respective row, irrespective of whether they have been selected by the pattern cards to be lifted or left down. It should be noted that there is no griffe blade and lip projections to operate the *first* twilling hook. The lifting of this hook is dependent upon its connections with the ninth and seventeenth twilling hooks, counting from the right.

The result of the foregoing twofold action is as follows :—*First*, when any of the twilling bars 12 press the griffe blades 8, clear of the ordinary hooks 1 this ensures, that *one* row of harness and warp threads, out of every *eight* is left *down* including the same proportion of warp threads selected by the pattern cards and hooks, to form the warp portion of the figure. *Second*, the three given griffe blades when moved into the vertical plane, *lift* the twilling hooks and bars and *one* out of every *eight* rows of ordinary uprights, harness and warp threads, so that this same proportion of warp is lifted from among the mass of warp threads selected by the pattern cards and left *down* to form the *weft* figure.

The same sequence of operations is repeated on the next and each successive pick of weft. A different twilling bar is pressed forward through the action of the next brass peg 18 rotated into position with each $\frac{1}{8}$ revolution of the twilling cylinder 17. The same pattern card may strike against the needles for one, two or more shots of weft, without in any way interfering with the twilling motion.

The twilling cylinder is usually studded with brass pegs in *sateen* order, because with this method of *binding* a greater quantity of warp and weft can be relatively crowded into a given space, and in addition a greater reflection of light is given from the solid smooth surface of a sateen, than from a twill or perhaps any other weave.

Construction of Twilling Tappets and Ratchet Wheels.

The twilling tappet is simply a steel disc, in the periphery of which notches are cut to permit the top catch to rest normally in contact with the card cylinder. The original and extreme periphery of the disc, lifts the top catch and leaves it, together with the bottom catch, *clear* of the card cylinder so that it can reciprocate, without being turned.

The twilling tappet is compounded with a ratchet wheel, in which each tooth cut corresponds to one shot of weft; the total number of teeth must be a convenient multiple of the *average* number of shots per card.

The disc must be divided into as many sections as there are teeth in the ratchet wheel. Each section also represents one shot of weft. Notches are then cut on those sections only, where the card cylinder must be rotated. In Fig. 128, the tappet 44 and ratchet wheel 47 have been designed to produce an average of *three* shots per card. The ratchet wheel contains 12 teeth, and the tappet has consequently been cut once in every three divisions, viz:—cut 1, miss 2, for four times.

The possible and standard variation of tappets and ratchet wheels for the usual number of shots per card are as follows:—

No.	Shots per card	Average	Teeth in Ratchet Wheel	Construction of Tappet.	
1	2	2	8 or 12	8 or 12 divisions	Cut 1, miss 1
2	2 3	$2\frac{1}{2}$	10	10 ,,	Cut 1, miss 1, Cut 1, miss 2
3	3	3	9 or 12	9 or 12 ,,	Cut 1, miss 2
4	3 4	$3\frac{1}{2}$	7 or 14	7 or 14 ,,	Cut 1, miss 2, Cut 1, miss 3
5	3 3 4	$3\frac{1}{3}$	10	10 ,,	Cut 1, miss 2, Cut 1, miss 2 Cut 1, miss 3
6	4	4	8 or 12	8 or 12 ,,	Cut 1, miss 3
7	4 5	$4\frac{1}{2}$	9	9 ,,	Cut 1, miss 3, Cut 1, miss 4
8	4 5 5	$4\frac{2}{3}$	14	14 ,,	Cut 1, miss 3, Cut 1, miss 4, Cut 1, miss 4

Lags and Pegs in lieu of Twilling Tappets.

Fig. 130 shows a front elevation and Fig. 131 a side elevation of a small card cylinder with lags and pegs after the dobby pattern, designed and applied by the writer, to replace the foregoing and somewhat expensive system of twilling tappets. A is the Jacquard card cylinder, B and C the top and bottom catches respectively, compounded and pivoted on the stud D. Part of the usual extended single arm is only shown, but in its complete form it is under control of the weaver, when it is necessary to rotate the card cylinder A backwards. In the lower shoulder of the double catch a stud E is fixed, on which a small antifriction roller F is placed and free to rotate; it normally rests in contact with the lags G on card cylinder H, with which is compounded a ratchet wheel I free to rotate on the fixed stud J. Free to oscillate on this same stud is a lever K, which carries a pawl lever L, kept in constant contact with the ratchet wheel which it rotates. A strong steel spring M keeps the ratchet wheel from receding after each partial rotation. The lever K is connected to the Jacquard head through the medium of stud N and rod O. Strong wood or steel pegs P are screwed or otherwise firmly fixed in the wood lags G, according to the required number of shots per card. A peg in the lag places both catches clear of the card cylinder A, and a 'blank' permits the top catch to rest on the card cylinder, *i.e.* the position shown in the diagram. The ratchet wheel I combined with the card cylinder H is rotated a distance equal to the pitch of the ratchet teeth and lag division, every time the Jacquard head descends as heretofore described.

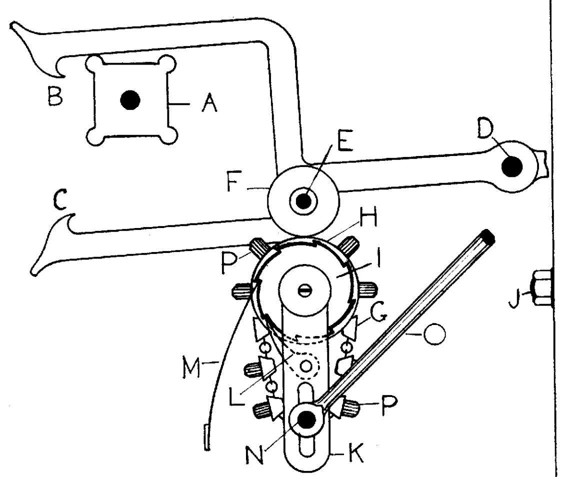


Fig. 130.

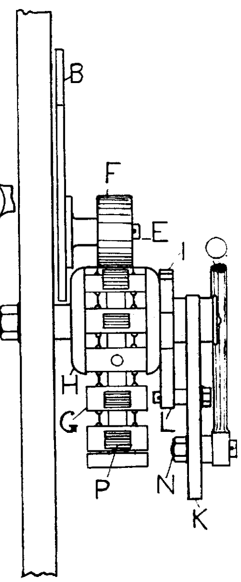


Fig. 131.

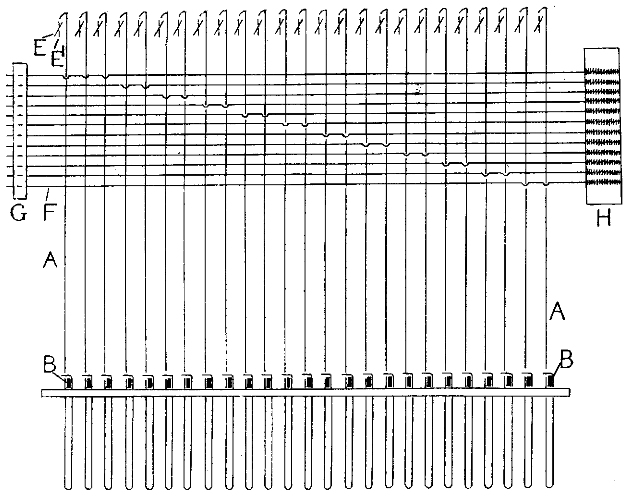
This arrangement involves no change of ratchet wheel and lag cylinder. It is only necessary to peg the lags, to suit the required number of shots per card.

The Scotch Twilling Jacquard.

The construction of this make of machine does not differ in essential principles from the Irish type already fully described.

There are, however, minor points of difference, and these are illustrated at Figs. 132 and 133, the former being an elevation of one row of ordinary figuring hooks and needles, and the latter the twilling hooks, hook bars and twilling bars, together with a transverse section of the twilling cylinder, as viewed from the left hand side of a right hand loom.

Fig. 132.



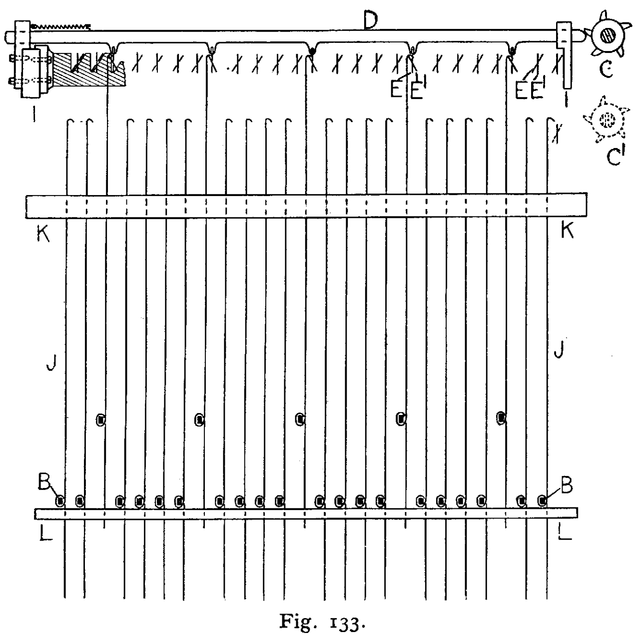


Fig. 133.

A indicates the ordinary hooks; B the hook bars; C the twilling cylinder in its highest position with the Jacquard head; C^1 the same in its lowest position; D the third twilling bar in pressure contact with the 3rd, 8th, 13th, 18th and 23rd rows of griffe blades E. These blades are normally inclined towards and immediately under the hooks A. The needles F are linked with and control the *ordinary* hooks A. The top needle combines with three hooks, but all the rest with only two hooks each. This arrangement permits the use of a *five* leaf twilling motion as in the figure; if an *eight* leaf twill binding is required, no warp is drawn through the harness controlled by the 25th row of hooks, and a new set of twilling bars is substituted. The needle board is shown at G, the spring box at H, and a portion of the Jacquard head at I. The *twilling* hooks J are looped around the ends of the hook bars B. The upper portion of each twilling hook passes freely through a perforated and fixed plate K. The extended shanks of the same hooks pass through perforations in a fixed iron plate L. The hook bars B, together with the twilling hooks, are supported in their normal positions on the iron plate L, and its duplicate at the opposite side of the machine. The *twilling* uprights in this machine are therefore only free to move in a vertical plane. They have no lateral movement whatever as was shown to be the case in the Irish twilling Jacquard. The *hooks* of the ordinary and twilling uprights are arranged to face each other. Immediately opposite each twilling hook, about *one inch* of each griffe blade E is bent from the incline to the vertical plane as indicated by the line E^1, notwithstanding which the twilling hooks are still normally clear of the griffe blades, but immediately the twilling bars oscillate any *griffe* blade E from the incline to the vertical plane (as shown in Fig. 133) so as to be clear of, and leave down its respective complete row of ordinary hooks on any given pick, the bent portion E^1 is simultaneously rocked backwards a sufficient distance to lie directly under the adjoining twilling hook and *lift* the same, together with its complement of ordinary hooks on the same given pick, irrespective of whether they have been designed to be lifted by the ordinary hooks or not.

'Carver's' Combined 5 and 8 Leaf Twilling Motion.

This twilling Jacquard is designed to automatically bind the *ground* or warp figure in *five* end sateen and the flower or *weft* figure in *eight* end sateen order. The pattern produced by this machine, like most other damasks, is woven face downwards.

The main features of the mechanism are identical with those of the Scotch twilling Jacquard.

The essential points of difference are as follows:—There are no *twilling* hooks, but the ordinary uprights have *two* hooks—one at the top of the ordinary long shank and one on a shorter shank, with the hooks facing opposite ways. There are also two sets of griffe knives compounded with the *head;* the upper set is arranged and free to oscillate as heretofore described, the lower set which is about 4in. below the upper, is free to move laterally, through the action of a specially constructed cam, or vertically, with the head. In each of the lower griffe blades there are projecting pockets directly opposite, and normally under, every *fifth* bottom hook and only the hooks immediately over these pockets can be lifted.

There are 25 uprights and 25 upper and lower griffe blades; the upper blades are controlled by eight twilling bars and produce the eight leaf twill; the lower blades are reserved for the five leaf twill.

Fig. 134 is a side elevation of a few of the uprights and a transverse section of the upper and lower griffe blades.

Fig. 135 is a front elevation of the combined eight and five leaf twilling mechanisms, together with the upper and lower griffes.

Fig. 136 is a plan of these same parts, but showing the bottom griffe only.

Fig. 137 is an enlarged plan (in part) of the bottom griffe and uprights.

Fig. 138 is a side elevation to demonstrate the rotation of the twilling cylinder shaft.

Corresponding details in the foregoing figures are indicated by the same letters.

A is the long shank and top hook; B the short shank and bottom hook for the same upright; a fixed guide rod passes through the loops C of the uprights, and prevents any tendency on their part to rotate; D the top knives; E the twilling bars; F the twilling cylinder and shaft; G the bottom griffe knives with special projecting pockets H. These knives each pass through slits in the flat steel bars $I.I^1$, between which they are free to move laterally, the bars in turn being supported to the head by suspended and fixed brackets J. The bars $I.I^1$ are *slightly* adjustable with the head through the medium of a lock nut, hook bolt and spiral spring. The top hooks are normally over the griffe knives, but only *one* out of every *five* of the bottom hooks, is and can be normally over the projecting pocket H, which is the only part of the bottom griffe designed to lift the upright. The possible lateral traverse of the bottom knives is equal to the distance of the pitch of one, two or three uprights. K is an octagonal wheel compounded with the twilling shaft F, and L is a strong flat steel spring, one end of which is attached to the Jacquard head, and the other free end fits in close contact with the wheel K. The combination of K and L prevents the twilling shaft F from rotating too far. M is a driving bevel wheel, containing 32 teeth, keyed fast to the shaft F. N is a driven bevel, containing 20 teeth, compounded with a stud shaft O and positive cam P. The stud shaft O is supported and free to rotate in the sleeve bracket support Q, in turn secured to the head. An antifriction bowl R, carried by the free arm of the cam lever S fits into the groove of the cam P as indicated by the dotted lines. The lever S is secured to a shaft T placed immediately over the ends and at right angles to the top griffe knives. The shaft T is supported to the head by suitable brackets, in which it is free to oscillate. Set screwed and adjusted to this shaft is a short lever arm U, which together with two duplicates, supports a round steel rod V, which passes through a cutting made in and near the end of each bottom griffe blade G. The combination and action of this mechanism reciprocates the griffe blades G *laterally*. A ratchet wheel W, Fig. 138, is compounded with the twilling shaft F. A horizontal pawl lever X for turning the same is pivoted at Y near the top of the fixed spindle *z*, which is compounded with a bracket casting and firmly secured to the gable of the machine as shown.

Action of the Mechanism.

The figured pattern is cut on the Jacquard cards without any binding weave as is usual for twilling machines. Then, each time the card cylinder and pattern cards are pressed into contact with the needles, the hooks A are pushed off the top griffe D by the *blank* portions, but left over the knife where the card is *perforated*. Simultaneously all the hooks A which are pushed clear of the griffe blades D press the corresponding bottom hooks B over the pockets H in griffe G, but these pockets

Fig. 135. Fig. 134.

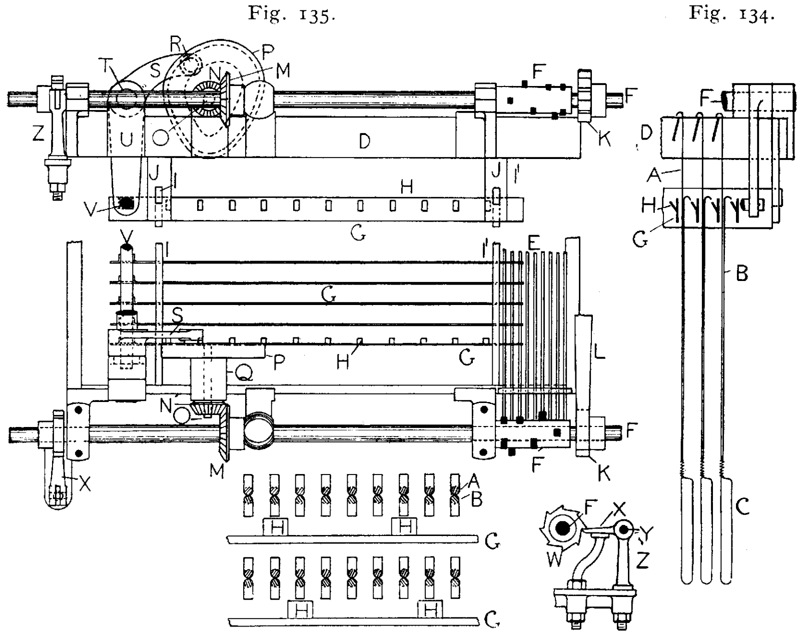


Fig. 136. Fig. 137. Fig. 138.

can only lift every *fifth* hook of those that have been left down by the top knife. The twilling cylinder F and twilling bars E act as already described to rock every *eighth* upper griffe blade D clear of the hooks A and leave the same *down* irrespective of their 'selection' by the pattern cards to form the upper or lower divisions of the *figuring shed*.

The twilling cylinder F is rotated $\frac{1}{8}$ of a revolution with each descent of the head by the ratchet wheel W being brought into striking contact with the free end of the pawl lever X, and so turning it 'one tooth' = $\frac{1}{8}$ revolution.

Then since the driving bevel wheel M contains 32 teeth and the wheel N 20 teeth,

$$\text{The velocity ratio of } \frac{\text{Cam P \& Wheel N}}{\text{Twilling shaft F}} = \frac{32}{20} = \frac{8}{5}.$$

i.e. Cam P makes eight revolutions to every five of the twilling cylinder F or $\frac{8}{5} = 1\frac{3}{5}$ times as fast as F, and since F rotates $\frac{1}{8}$ revolution for each descent of the head and shot of weft, the *cam* P ∴ *rotates* $\frac{1}{8} \times 1\frac{3}{5} = \frac{1}{5}$ revolution for each descent of the head.

The cam P is constructed to move with each $\frac{1}{5}$ revolution, the bowl R and lever S to the right or left, and through them to oscillate the shaft T and reciprocate the lever U together with rods V and bottom griffe blades G a distance equivalent to the pitch of *two* uprights when the blades G travel to the right, and a distance of *three* uprights when they move laterally to the left, which 'moves' correspond to a five leaf sateen twill thus:—

No. 1 Pick	Each pocket H	moves	to the	right	from hook	1	to hook	3
,, 2 ,,	,,	,,	,,	right	,,	3	,,	5
,, 3 ,,	,,	,,	,,	left	,,	5	,,	2
,, 4 ,,	,,	,,	,,	right	,,	2	,,	4
,, 5 ,,	,,	,,	,,	left	,,	4	,,	1

These repeat 8 times to 5 revolutions of the twilling cylinder F.

Grouping of Needles and Hooks for 5 and 8 Leaf Twills.

As previously stated, the number of rows of hooks and griffe blades for either 5 or 8 leaf twilling machines must be some multiple of one or other, or both these binding weaves according to whichever is required. The number of twilling bars must also correspond with the twilling weave.

Therefore with a five leaf twill and five twilling bars, the number of hooks from front to back and of griffe blades must be 20, 25, 30, 35 or 40 irrespective of whether the Jacquard machine contains *eight* or *twelve* rows of ordinary needles. For an eight leaf motion the number of hooks and griffe blades must be 16, 24, 32, 40 or 48 for either eight or twelve row card cylinders. These conditions are essential in order that the twilling pattern will repeat perfectly in the woven fabric.

The grouping of the hooks with each vertical row of needles for all the standard and normal possibilities from 20 to 48 griffe blades is fully set forth in Table I.

TABLE I.

Standard and normal number of hooks per needle and per row in twilling Jacquards.

No.	Twilling motion.	Rows of holes in card cylinder and needles in needleboard.	Number of hooks controll'd by each vertical row of needles.	Number of hooks per needle and order of distribution.	Relative figuring capacity of Jacquard with 600 needles. ‡
1	5 leaf	8	20	(3, 2) 4	$\frac{600 \times 20}{8} = 1500$
2	5 ,,	8	‖25	(3 × 7) + (4 × 1)	$\frac{600 \times 25}{8} = 1875$
3	5 ,,	8	30	(4, 4, 4, 3) 2	$\frac{600 \times 30}{8} = 2250$
4	5 ,,	8	35	4, 5, 4, 4, 5, 4, 4, 5	$\frac{600 \times 35}{8} = 2625$
5	5 ,,	12	‖25	(2 × 11) + (3 × 1)	$\frac{600 \times 25}{12} = 1250$
6	5 ,,	12	30	(3, 2) 6	$\frac{600 \times 30}{12} = 1500$
7	5 ,,	12	35	(3 × 11) + (2 × 1)	$\frac{600 \times 35}{12} = 1750$
8	5 ,,	12	*40	(3, 3, 4) 4	$\frac{600 \times 40}{12} = 2000$
9	8 ,,	8	16	(2) 8	$\frac{600 \times 16}{8} = 1200$
10	8 ,,	8	32	(4) 8	$\frac{600 \times 32}{8} = 2400$
11	8 ,,	8	*40	(5) 8	$\frac{600 \times 40}{8} = 3000$
12	8 ,,	12	24	(2) 12	$\frac{600 \times 24}{12} = 1200$
13	8 ,,	12	32	(3, 3, 2) 4	$\frac{600 \times 32}{12} = 1600$
14	8 ,,	12	*40	(3, 3, 4) 4	$\frac{600 \times 40}{12} = 2000$
15	8 ,,	12	48	(4) 12	$\frac{600 \times 48}{12} = 2400$

* Nos. 8, 11 and 14 are suitable for either 5 or 8 leaf twilling motions.

‖ Nos. 2 and 5 can be adapted to serve for an 8 leaf twill by casting out one of the three rows of hooks attached to the one needle.

‡ Figuring capacity of twilling Jacquards $= \frac{\text{total needles} \times \text{hooks per row.}}{\text{Needles per row.}}$

Use of the same Pattern Cards for different widths and fineness of cloth.

The twilling Jacquards afford numerous facilities for satisfying the above conditions. The manufacturer usually paints his design and cuts the pattern cards to suit a given 'harness tie,' but he also frequently uses the same set of cards for various widths and fineness of fabric.

Normal Modifications.

It is important to note that the same set of pattern cards, cut for No. 1 grouping of needles and uprights (Table I.) will also serve for any of the groupings 1 to 4 and 9 to 11 both inclusive or for any *eight* row machine of the same *normal* capacity. The same is true of Nos. 5 to 8 and 12 to 15 both inclusive or for any *twelve* row machine of the same normal capacity. The resultant difference in effect may be demonstrated as follows :—

Example 1.—Assume that a cloth is woven 72″ wide in a 1200 set and with 20 rows of uprights in an *eight* row machine as No. 1, what change in fineness or width of cloth would be involved if the same set of cards be transferred to a loom containing 25 rows of uprights as No. 2 ?

One of two things would occur, either the 'set' or the width of cloth would increase.

(1) If the fineness of the web is increased and the width remains the same

Then, $\frac{\text{Given set} \times \text{Reqd. No. of uprights}}{\text{Given No. of uprights per row.}} = \text{Reqd. set} = \frac{1200 \times 25}{20} = 1500 \text{ set.}$

(2) If the width of web is increased and the set remains constant

Then, $\frac{\text{Given width} \times \text{Reqd. No. of uprights}}{\text{Given No. of uprights per row.}} = \text{Reqd. width} = \frac{72 \times 25}{20} = 90 \text{ in.}$

Example 2.—Assume that a cloth is woven in a 1200 set and 72 inches wide in the harness, with 20 rows of hooks, what change in *width* of harness would occur if the pattern cards be transferred to a Jacquard containing 25 hooks, where the harness set is 1400 (70 threads per inch) ?

Compound Levers with Dead Weight Counterpoise.

Fig. 156 is an elevation of the driving arrangement as seen from the right hand side of a right hand loom.

Fig. 157 is a sectional elevation of parts remote from 156.

Fig. 158 is a plan of parts shown in Figs. 156 and 157.

Details of the Mechanism.

A is the bottom loom shaft, B a spur wheel containing 56 teeth, driving a second spur wheel C with 28 teeth. C is supported and free to rotate on the fixed stud D, at the same rate as the crank shaft. A stud and swivel link E combines the spur wheel C with the drawing rod F, which is adjusted by lock nuts to the swivel link G on stud H in the lever I. This lever is pivoted on the stud J in the bracket and cross rail K, which is supported between the two gantry rails L and L^1. A stud M in the left arm of the lever I combines through the link N and stud O, the lever P which is set screwed to the shaft Q. This shaft is supported above the gantry L^1 in suitable brackets, where it is free to oscillate. A single arm lever R (Fig. 157), remote from P, is fastened to the shaft Q and carries at its free end an antifriction bowl S on which the base of the head 9 rests. To the right arm of lever T a stud U connects the rod V and counterpoise weight W. All the foregoing details are duplicated at the opposite and left hand side of the loom.

Action of the Mechanism.

The spur wheel C rotates uniformly counter-clockwise at the same rate as the crank shaft. Immediately the stud E, in wheel C, has passed the top centre it commences to pull down the rod F and the right arm of lever I, and conversely to lift the left arm of the same lever, together with the connecting details M N O and lever P, and to rock the shaft Q counter-clockwise. The lever R being fixed to this shaft also rises in sympathy, and bowl S, pressing in rolling contact with the base of the head 9, lifts it the required distance.

This work has been assisted by the gravitation load of the counterpoise weight W, acting through the rod V and the stud U, upon the right arm of lever I. With the continued rotation of wheel C, the rod F and right arm of lever I are raised together with hooks per row of needles would be required when refilling the machine and how should these be grouped with the 12 needles and how should the surplus hooks be left out when refilling ?

(a) Then reduced No. of hooks per row of needles $= \frac{32 \times 70}{80} = 28.$

(b) The order of grouping might be as follows: (3, 2, 2) 4 times = 28.

(c) When refilling the machine, leave out the *last four hooks* on the first and alternate rows of hooks, also the *first four hooks* on the second and all the corresponding even rows of hooks.

Fig. 139 140 141 142

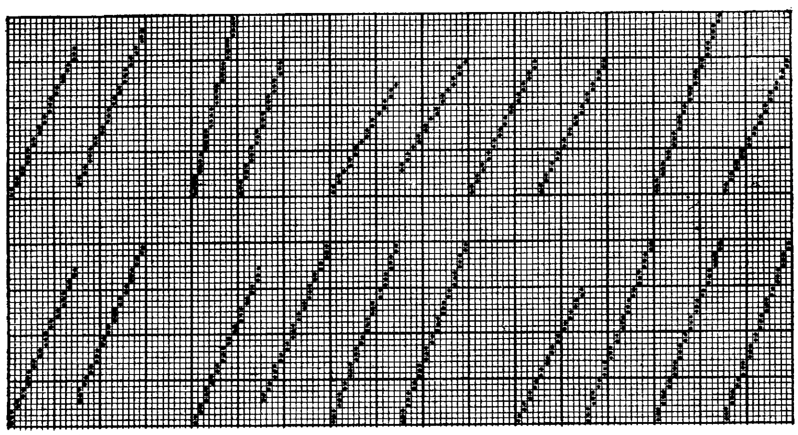


Fig. 143 144 145

An illustration of this example is supplied at Fig. 143. The longitudinal divisions represent the needles, the transverse divisions the griffe blades, and the marks thus ▪ the hooks and the number of hooks linked with each respective needle and order of distribution. This method of reducing the number of hooks per row of needles does not interfere with the continuity of the *binding* twill but it causes a *slight* 'break' in the flower details of the pattern.

TABLE II.

Special reduction of hooks per needle and per row to suit various widths and fineness of cloth.

No.	Twilling motion.	Rows of holes in card cylinder and needles in needleboard.	Normal number of hooks per needle and per row.	Required average number of hooks per row of needles.	Reduced number of hooks per needle and per row.	Number of rows of hooks in one repeat	Hooks left out on specified rows.
16	5 leaf	12	(3, 2) 6 = 30	27½ from 30	(2, 2, 2, 3) 3 (2, 2, 3) 4 = 27½	1 2	Last 3 hooks First 2 hooks
17	8 leaf	8	(4) 8 = 32	28 from 32	(4) 8 (3) 8 = 28	1 2	Last 8 hooks
18	8 leaf	12	(2) 12 = 24	22 from 24	(2, 2, 1) 4 (2, 2, 1) 4 (2) 12 (2) 12 = 22	1 2 3 4	Last 4 hooks First 4 hooks
19	8 leaf	12	(3, 3, 2) 4 = 32	28 from 32	(3, 3, 2) 4 (2) 12 = 28	1 2	Last 8 hooks
20	8 leaf	12	(3, 3, 2) 4 = 32	28 from 32	(3, 2, 2) 4 (3, 2, 2) 4 = 28	1 2	Last 4 hooks First 4 hooks
21	8 leaf	12	(3, 3, 2) 4 = 32	30 from 32	(2, 2, 3) 4 (2, 2, 3) 4 (3, 3, 2) 4 (3, 3, 2) 4 = 30	1 2 3 4	Last 4 hooks First 4 hooks
22	8 leaf	12	(3, 3, 2) 4 = 32	30 from 32	(2) 12 (3, 3, 2) 4 (3, 3, 2) 4 (3, 3, 2) 4 = 30	1 2 3 4	Last 8 hooks

Example 4.—Assume a 5 leaf twilling machine is filled with 30 hooks per 12 row cylinder, find the average number of hooks per row, if the width of the harness is reduced from $78\frac{1}{2}$ to 72 inches but the fineness remains the same.

(a) Then reduced average No. of hooks per row $= \frac{30 \times 78\frac{1}{2}}{72} = 27\frac{1}{2}$

(b) The best order of grouping the hooks with the needles is as follows:—

Odd rows of needles and hooks	(2, 2, 2, 3) 3	=	27
Even ,, ,, ,,	(2, 2, 3) 4	=	28
Total No. of hooks for two rows		=	55

$\therefore$ Average hooks per row $= \frac{55}{2} = 27\frac{1}{2}$

(c) When refilling the machine, leave out the last three hooks on all the odd rows and the first two hooks on all the even rows. See Fig. 139 which is modified to meet the requirements of No. 16 in Table II.

Table II. shows the normal and modified order of grouping the hooks to the needles for seven special reductions of hooks per needle and per row to suit various widths and fineness of cloth. These are graphically and respectively represented at Figs. 139 to 145 inclusive.

Figs. 146 to 150 represent an alternative method of distributing the reduced number of hooks in each row of needles and griffe blades. The hooks to be left out of the refilled machine are represented by the marks, thus ▪. This plan of weeding out the surplus hooks does not interfere with the flower or ground of pattern, but it fails to stitch the binding twill wherever a hook is missing.

Fig. 146 distributes the missing hooks over *five* blades for No. 16 in Table II.

Fig. 147 distributes the missing hooks, equally over all the blades for No. 17.

Fig. 148 distributes the missing hooks over four blades for No. 18.

Fig. 149 distributes the missing hooks, equally over all the blades for Nos. 19 and 20.

Fig. 150 distributes the missing hooks over four blades for Nos. 21 and 22.

Fig. 146 147 148

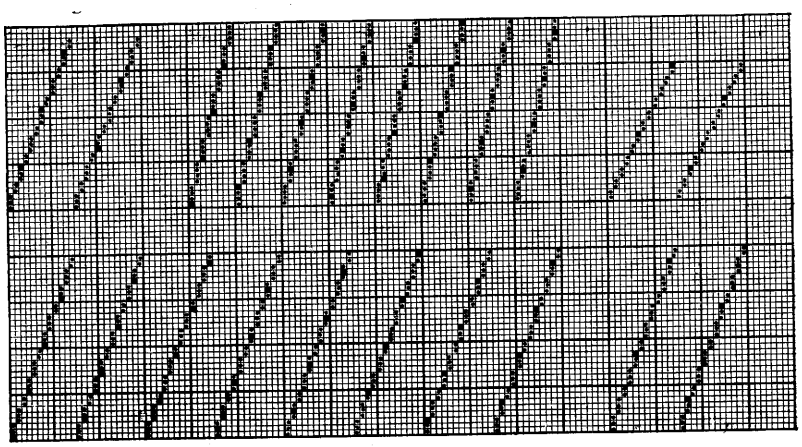


Fig. 149 Fig. 150.

Twilling and Ordinary Jacquards—A Comparison.

The designer for ordinary Jacquards and full harness mounting is not restrained in weave development of figured pattern. Any variety of structural weave, plain, twill or fancy, single, double or complex can be used with the object of increasing the variety of effect of pattern.

The *binding* intersections can be arranged to run in the same or opposite directions in the ground or figure ; they can also be designed to 'cut' each other at the junctions of the figure and ground.

Fig. 151 shows a portion of a fully developed warp and weft figure design. The white portion represents the ground, and the grey portion the figure or flower. The sateen binding twill runs to the right in the ground but to the left in the outline of the figure. Some portions of the flower are bound in regular twill order, running both to the right and to the left, other portions are shaded as shown, by increasing flushes of warp.

Advantages and Defects of the Twilling Motion.

The all important advantage of the twilling Jacquard is its great figuring capacity in comparison with the ordinary machine, and the number of needles and cards required. Like most other inventions (notwithstanding its great advantages) it has its defects. These, however, are chiefly *technical*, and are seldom perceived by the uninitiated.

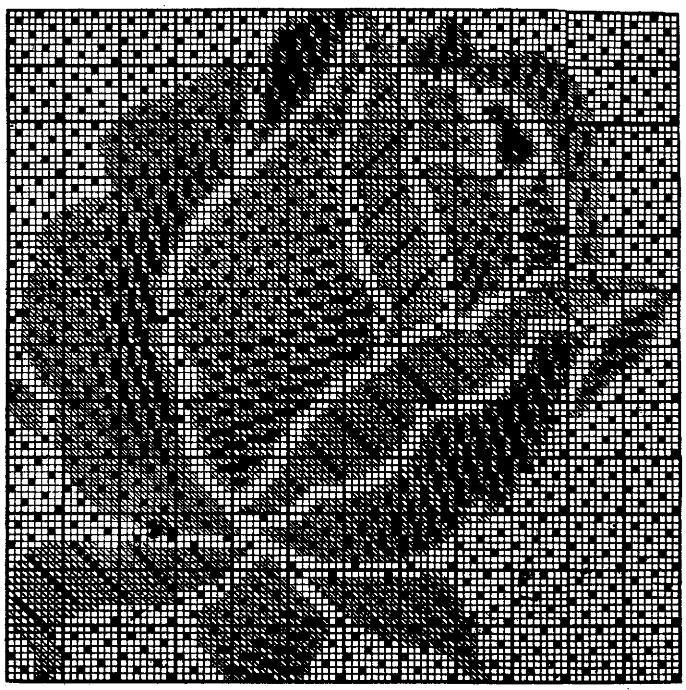


Fig. 151.

First, the binding twill produced by a twilling machine always runs in the same direction for a given direction of harness tie, both in the ground and figure. This limitation makes it impossible to obtain a perfect and minute definition of outline of ground and figure, since the intersecting binding floats of warp and weft do not exactly meet and technically 'cut' each other. This small defect is illustrated at Fig. 152, which is a portion of a warp and weft figure

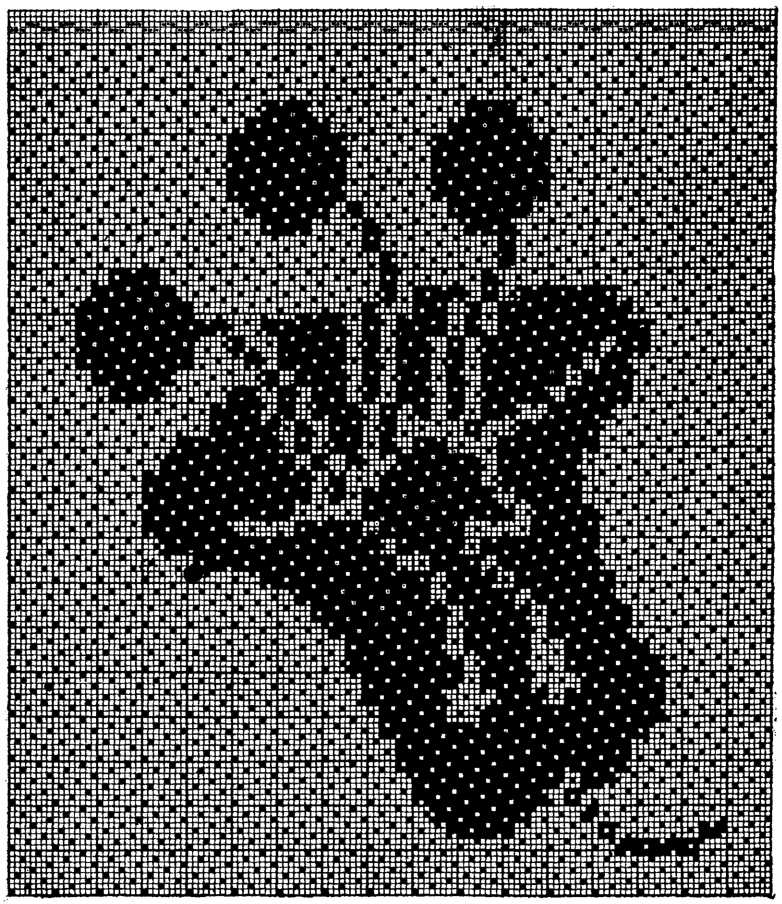


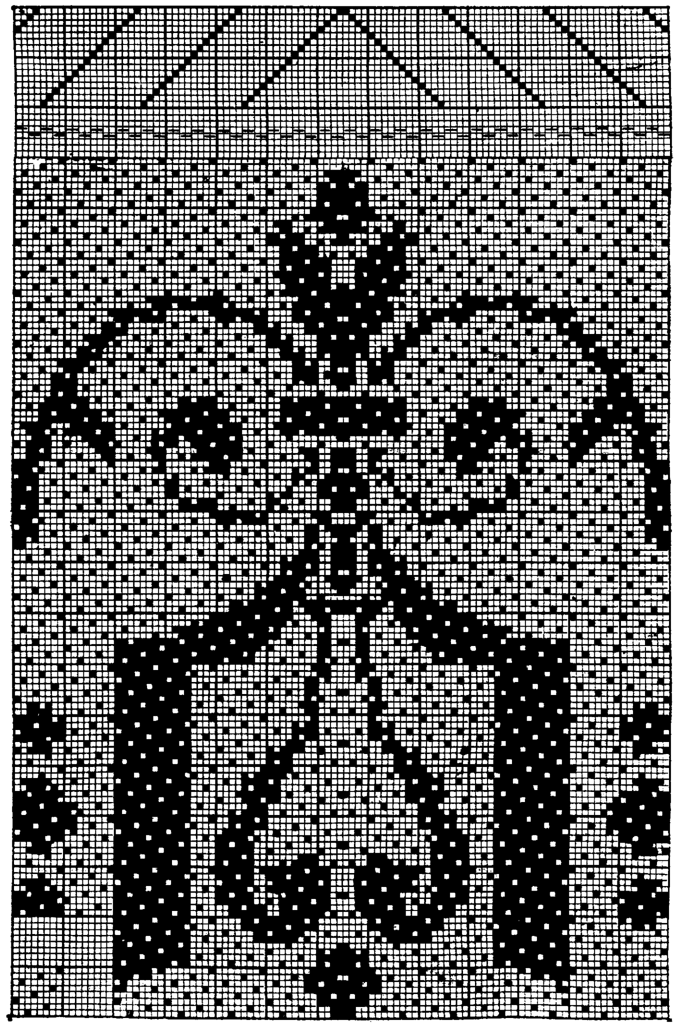
Fig. 152.

woven with three hooks to each needle, simultaneously and automatically bound by the twilling mechanism. The binding twill runs the *same* way in both the ground and figure, and at few points on the outline does the warp stitch 'cut' cleanly that of the weft.

Fig. 153.

Fig. 154.

Fig. 155.



The second and chief defect of the twilling motion is the slight *breach* made in the pattern at the *juncture* of every *turn* in the harness. At every point where the harness is reversed, the warp threads have necessarily to be drawn through the mails in the reverse direction, to coincide with the *turn* in the harness. Consequently, the harness tie combined with the drafting reverses the figured pattern as desired, but it also automatically reverses, in sympathy with the turn in the harness, the direction of the binding twill, which is not desired. The resultant effect in a bordered pattern, for example, is, the binding twill runs to the right on one side of the border and the centre, where the harness and draft is in the same direction, but it twills to the left in the opposite border, where the harness and draft are necessarily reversed.

This defect is the inherent result of confining the twilling motion to produce the twilling through the medium of the figuring hooks and harness, irrespective of the harness mounting and order of drafting. An independent twilling motion, as in the case of pressure heddles, obviates this difficulty.

The foregoing defects are illustrated as follows:—

Fig. 153 indicates a portion of the tie of the harness, together with the draft of the warp threads at the turn in the pattern; the longitudinal spaces represent the warp threads and also the mails of the harness from front to back; the transverse spaces represent the rows of the harness which correspond to the number of uprights and griffe blades. The markings represent the harness cords and mails and also the warp threads drawn through them.

Fig. 154 indicates the order of arrangement of the pegs in the twilling cylinder—in this case an eight end sateen twill.

Fig. 155 shows the resultant effect of the combined action of the draft Fig. 153, and the twilling pattern Fig. 154, which demonstrates, *first*, the *turn* in the *binding twill*, and *second*, reveals the long float or stitch of weft over twelve ends on each second pick, and over fourteen on each seventh pick in the ground, as compared with a maximum float of seven in the normal twill with full harness mounting. This pattern is woven with two hooks to each needle.

It will be perceived that no shading is shown nor possible by the binding weave.

It will be observed in the portion of the foregoing reproduced figured pattern, that the two central ends are shown exactly alike. In practice it is usual to leave out one of these harness cords, or having tied it up to the hook, to leave the mail which it supports without any warp thread.

CHAPTER XI.

Compound Driving of Twilling Jacquards.

THE driving of Twilling Jacquards is necessarily complex, because each machine contains a large number of figuring hooks, and in addition two or more machines are usually combined and worked over the same loom. The power consumed is considerable, since the average load to be lifted on every pick, for two 600 machines, when weaving 72in. damask containing 70 threads per inch, is approximately 500 lbs. Further, the motion of the 'head' is variable, for it *dwells* in its highest and lowest positions, and the action is still further complicated by having to lift this great weight, and also subsequently to check its gravitation load, which involves the introduction of a counterpoise attachment.

A counterpoise on a Jacquard is an arrangement which checks the force of gravity, and stores it up until its potential energy can be utilised to assist in lifting the Jacquard head on the next succeeding pick.

There are several methods of compound driving in actual practice, with each of which is combined a counterpoise on one of the following principles: (1) the dead weight; (2) the spiral spring; (3) a combination of the dead weight and the spiral spring.

If the required motion is *accelerated* the spring arrangement is better than the dead weight principle, since the initial force required to accelerate a dead weight is relatively greater than with a spiral spring, which has comparatively *no mass*, but which is designed to offer the same amount of resistance and produce the same amount of work. If the motion is continuous, the dead weight principle is preferable, but as already stated, the driving of a Jacquard head is *not* continuous. The *initial* work in starting an accelerated load and dead weight counterpoise is equivalent to a double load.

Compound Levers with Dead Weight Counterpoise.

Fig. 156 is an elevation of the driving arrangement as seen from the right hand side of a right hand loom.

Fig. 157 is a sectional elevation of parts remote from 156.

Fig. 158 is a plan of parts shown in Figs. 156 and 157.

Details of the Mechanism.

A is the bottom loom shaft, B a spur wheel containing 56 teeth, driving a second spur wheel C with 28 teeth. C is supported and free to rotate on the fixed stud D, at the same rate as the crank shaft. A stud and swivel link E combines the spur wheel C with the drawing rod F, which is adjusted by lock nuts to the swivel link G on stud H in the lever I. This lever is pivoted on the stud J in the bracket and cross rail K, which is supported between the two gantry rails L and L^1. A stud M in the left arm of the lever I combines through the link N and stud O, the lever P which is set screwed to the shaft Q. This shaft is supported above the gantry L^1 in suitable brackets, where it is free to oscillate. A single arm lever R (Fig. 157), remote from P, is fastened to the shaft Q and carries at its free end an antifriction bowl S on which the base of the head 9 rests. To the right arm of lever T a stud U connects the rod V and counterpoise weight W. All the foregoing details are duplicated at the opposite and left hand side of the loom.

Action of the Mechanism.

The spur wheel C rotates uniformly counter-clockwise at the same rate as the crank shaft. Immediately the stud E, in wheel C, has passed the top centre it commences to pull down the rod F and the right arm of lever I, and conversely to lift the left arm of the same lever, together with the connecting details M N O and lever P, and to rock the shaft Q counter-clockwise. The lever R being fixed to this shaft also rises in sympathy, and bowl S, pressing in rolling contact with the base of the head 9, lifts it the required distance.

This work has been assisted by the gravitation load of the counterpoise weight W, acting through the rod V and the stud U, upon the right arm of lever I. With the continued rotation of wheel C, the rod F and right arm of lever I are raised together with the weight W, while the *left arm* of lever I descends together with the lever P to rock the shaft Q clockwise. The lever R and bowl S descend in sympathy. The *weight* of the head with its complement of hooks, harness and lingoes constantly pressing upon the bowl S,

Fig. 156. Fig. 157.

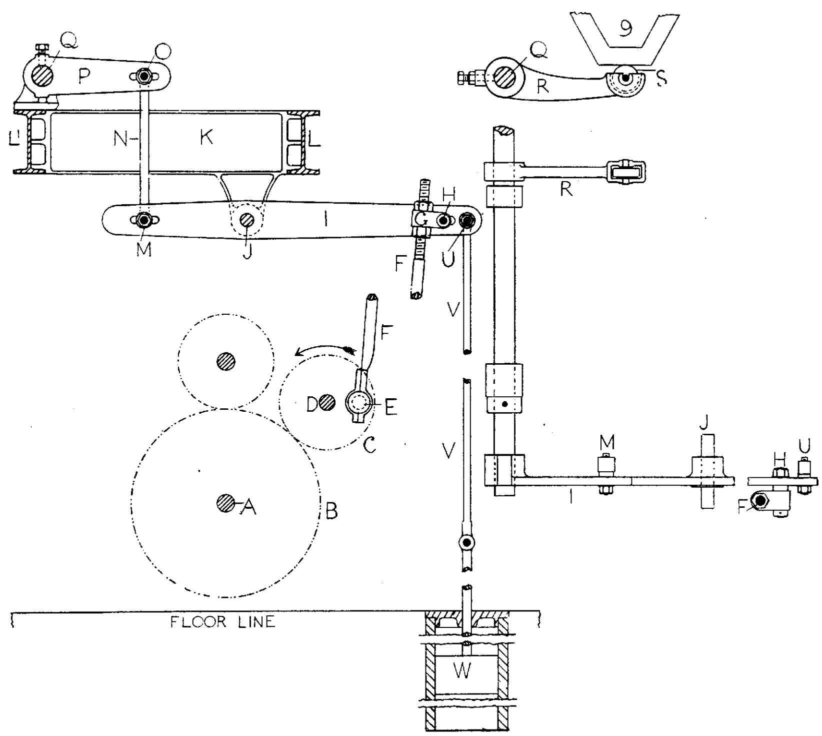


Fig. 158.

assists, through its connections to depress the lever P and the *left arm* of lever I and to elevate its right arm with which ascends the weight W and conversely operates to check any rapid fall on the part of the head 9.

Single Lever with Spiral Spring Counterpoise.

This method of driving with a single eccentric is adopted when only one twilling Jacquard is employed, *e.g.*, when weaving napkins or 'table tops.'

Fig. 159 is an elevation as seen from the right hand side of a right hand loom.

Fig. 160 is a sectional elevation of parts remote from those illustrated at 159.

Fig. 161 shews parts remote from 160.

Fig. 162 is a plan of the details in Figs. 159, 160 and 161.

Similar numerals in each diagram refer to identical details.

Details of the Mechanism.

A is the loom crank shaft and B an eccentric 9″ diameter, 2″ face and $4\frac{1}{2}$″ 'lift.' An iron collar 'strap' C circumscribes the eccentric B. A reciprocating rod D combines the collar C, through the swivel link and stud E with the lever F keyed fast to the shaft G. This shaft is supported immediately above the fixed gantry H by the bracket as shown, in which it is free to oscillate. A second single lever I is set screwed to the same shaft G but remote from F (Figs. 161 and 162). The free arm of this lever carries an antifriction roller J on which rests the base of the Jacquard head 9. Upon the same shaft G and between the levers F and I a third single lever K is double set screwed (Fig. 160). This lever carries an antifriction bowl L which is kept in rolling contact with the left arm of lever M, pivoted at N. Suspended from the stud O in the right arm of lever M is a spindle rod P circumscribed by a $\frac{1}{2}$″ strong spiral spring Q, which is supported by an iron disc plate R and nuts as shown at the base of the spindle P. The spindle and spring are both enclosed in a strong iron cylinder S which is securely bolted to a strong cross rail T combined with the fixed gantries H and H^1. The bottom of the iron cylinder is open but the top is partly closed against which the spiral spring may be compressed.

Combined action of the Eccentric and the Counterpoise.

The constant rotation of the crank shaft A with the eccentric B reciprocates the rod D and lever F which in turn, oscillates the shaft G. The oscillation of this shaft counter-clockwise, together with the lever arm I and the bowl J combines to lift the Jacquard head 9. This is assisted by the potential energy stored in the spring Q, acting through the parts R P M and K.

The oscillation of the shaft G clockwise depresses the lever I and bowl J and permits the head 9 to descend by its own gravity; its fall is however retarded by the negative resistance offered by the

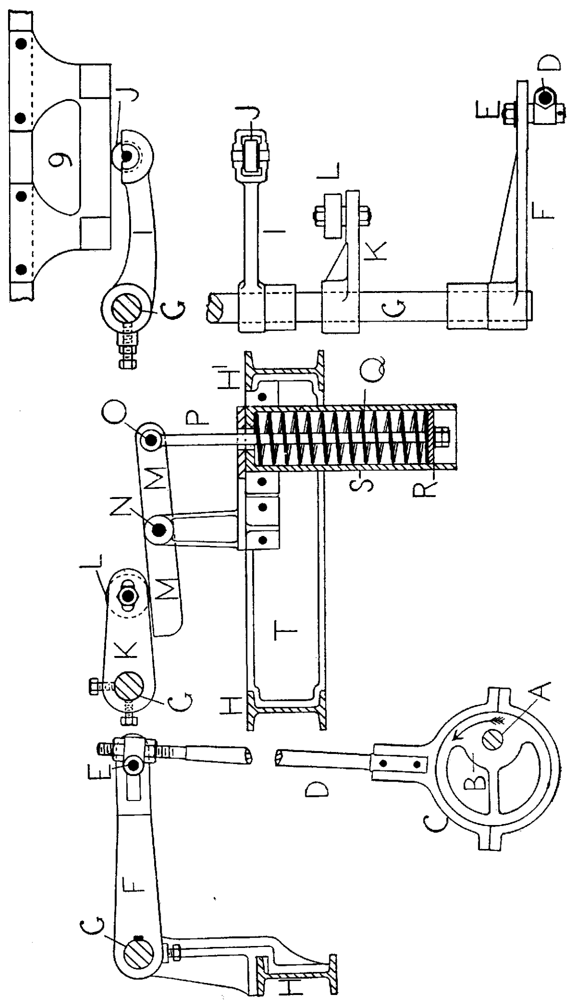


Fig. 159 Fig. 160 Fig. 161 Fig. 162

details K to S and the energy thus developed is stored up in the spiral spring Q to be afterwards expended in assisting to lift the head on the next subsequent pick.

Compound Levers, with Counterpoise of Solid Drawing Rods and Spiral Springs.

The drawing rods are made solid and about 2″ in diameter, the object being to use them as a counterpoise also and thus obviate the necessity for supplementary weights. This method was introduced by the "York Street Flax Spinning and Weaving Co., Belfast."

Fig. 163 is an elevation as seen from the left hand side of a right hand loom.

Fig. 164 is a sectional elevation of details remote from those in Fig. 163.

Fig. 165 is a sectional elevation of details remote from Fig. 164.

Fig. 166 is a plan of these details.

Details of the Mechanism.

A is the crank shaft, B the spur driving wheel geared into the spur wheel C, keyed to the low shaft D. The spur wheel D gears into a spur wheel E, containing the same number of teeth as B and free to rotate on the stud F fixed in the loom gable. An adjustable stud G set out of centre and compounded with the wheel E supports a swivel link H adjustably compounded with a *solid* draw shaft I. A stud J combines the draw shaft with the lever K pivoted at L in the upright bracket compounded with the cross rail M fixed to the gantries N and N^1. The lever K is compounded through the stud O, link P and stud Q with the lever R keyed to the shaft S which is supported to and free to oscillate immediately over the gantry N^1. A simple lever T (Fig. 165) keyed to the shaft S carries an antifriction bowl U upon which the base of the head 9 rests. W (Fig. 164) is a third simple lever keyed and set screwed to the shaft S, having its free arm resting in close contact with a $\frac{3}{8}$″ spiral spring X on the split 'spindle' Y fixed to and supported by the cross rail M^1 in turn compounded with the gantry rails N and N^1. All the foregoing details are duplicated at the opposite and right hand side of the loom.

Action of the Mechanism.

The stud wheel E and stud G rotate clockwise with uniform velocity. Immediately the stud G passes the top centre and commences to descend, it pulls down, assisted by its own gravity, the solid drawing rod I, the stud J and the left arm of the lever K, but the stud O, link P, stud Q and lever R rise and oscillate the shaft S clockwise. In

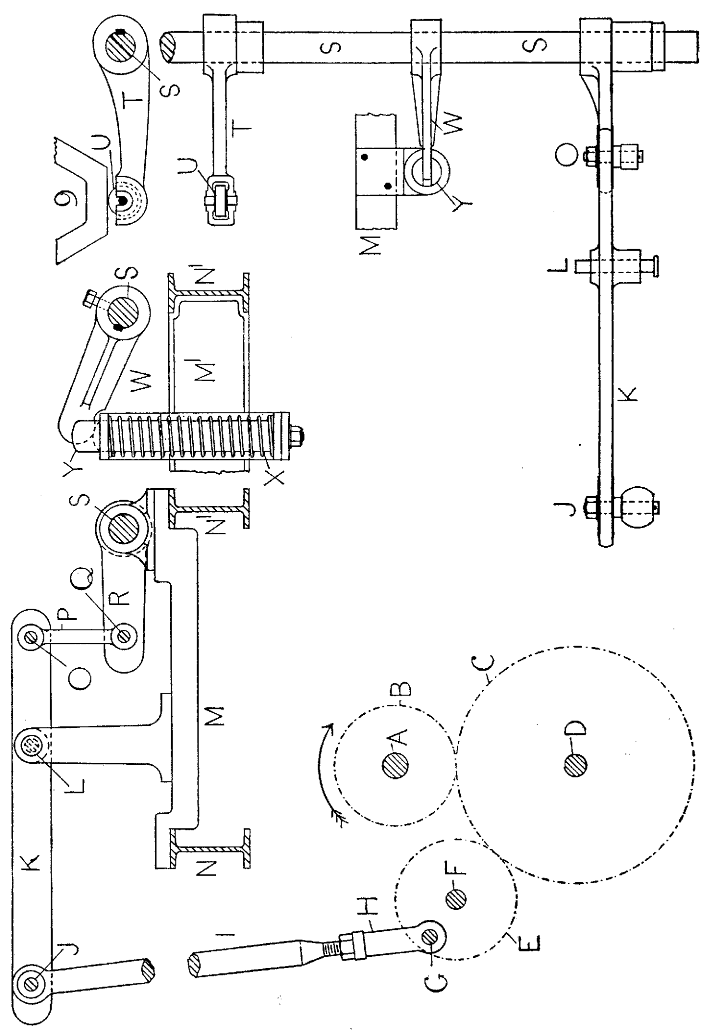


Fig. 163 Fig. 164 Fig. 165 Fig. 166

sympathy with the oscillation of shaft S, the lever T and bowl U rise and lift the head 9. The oscillation of the shaft S clockwise is further assisted by the spiral spring X acting on the free arm of the lever W.

Immediately the stud G passes the bottom centre F all the foregoing movable parts operate in the reverse direction. The stud G rises on the left side of F and lifts the rod I, stud J and left arm of lever K but depresses its right arm together with the details O P Q R to oscillate the shaft S counterclockwise and lever T with bowl U in sympathy. This combined action releases the pressure on the head which, due to its own gravity descends and simultaneously assists to rock the shaft S counterclockwise, to lift the two solid rods and to deflect the two spiral springs. The gravitation load which the head thus exerts is stored in the two heavy rods, raised to their highest point, and the deflected spiral springs, when the head is at the bottom. This stored energy is free to be utilised in lifting the head to form the next successive shed.

Problems on Compound Driving and Value of Counterpoise.

Problem 1.—Based on the dead weight counterpoise system, described in connection with Figs. 156 to 158.

Ascertain (a) The lift of the head and depth of shed in inches. (b) The work done in foot lbs., in lifting the Jacquard head on each pick. (c) The value of the counterpoise in foot lbs. together with its ratio value of the work done.

A foot lb. is the work done in lifting a mass of 1 lb. through a distance of 1 foot.

The average load to be lifted on each pick is 450 lbs. made up as follows:—two heads 184 lbs. plus 266 lbs. (half load of hooks, harness and lingoes).

The counterpoise load for both sides of the loom = 2 (weight of W, 60 lbs. plus 18 lbs. weight of rod V) = 156 lbs. The diameter of the circle described by the stud E = 6″ The distance between the centres H J = 18″; J M 10″; O Q 10″; Q S $11\frac{1}{4}$″ and J U 21″.

Then (a) the lift of the head,

$$= \frac{(\text{dia. cir. described by stud E})\ (\text{J M})\ (\text{Q S})}{(\text{Distance H J})\ (\text{O Q})} = \frac{6 \times 10 \times 11\frac{1}{4}}{18 \times 10} = 3\frac{3}{4}''$$

(b) The work done by lifting the head through a distance of $3\frac{3}{4}''$

$=$(Av. load of hd. per pk.) (Lift of hd. in ft.) $= \frac{450 \times 3\frac{3}{4}}{12} = 140{\cdot}6$ ft. lbs.

(c) Value of counterpoise and ratio value of work done.

(1) Distance travelled by weights w in feet.

$$= \frac{\text{(Dia. of cir. described by stud E) (J U)}}{\text{(H J)}} = \frac{6 \times 21}{12 \times 18} = \frac{7}{12} \text{ ft.}$$

(2) Value of counterpoise.

$=$ (Distance travd. by w in ft.) (load in lbs.) $= \frac{156 \times 7}{12} = 91$ ft. lbs.

(3) Ratio value of counterpoise.

$$= \frac{\text{Value of counterpoise}}{\text{Work done in lifting head}} = \frac{91 \times 100}{140{\cdot}6} = 64{\cdot}7\ \%$$

Work Stored in Spiral Springs.

The deflection in a spiral spring varies directly as the load. The load value of a spiral spring acting through any given distance is equivalent to half the maximum load required to deflect the spring the given distance. If the spring is initially under deflection, then the load value of the spring will be equivalent to half the original load plus half the final load, *e.g.*

(1) If the load resistance of a spiral spring is 100 lbs. per inch of deflection in the spring, then assuming the spring to be deflected 3 inches, the mean load resistance or work stored in the spring acting through 3 inches $= \frac{100 \times 3}{2} = 150$ lbs. per inch.

(2) If the spring is initially deflected $\frac{1}{2}$ an inch, then the mean load resistance

$=$ ($\frac{1}{2}$ load of $\frac{1}{2}''$ spring deflection) $+$ ($\frac{1}{2}$ load of $3\frac{1}{2}''$ deflection)

$= \frac{100}{2} \times \frac{1}{2} + \frac{100}{2} \times 3\frac{1}{2} = 200$ lbs. per inch.

The work done by the spring in giving out its stored energy over a distance of 3 inches equals

Case 1. $\frac{150 \times 3}{12} = 37\frac{1}{2}$ ft. lbs.

Case 2. $\frac{200 \times 3}{12} = 50$ ft. lbs.

Problem 2.—Based on the spiral spring counterpoise system described in connection with Figs. 159 to 162.

Ascertain (a) The lift of the head. (b) The work done in lifting the head on each pick. (c) The net amount of deflection in the spiral spring caused by the head descending from the top to the bottom. (d) The value of the counterpoise and (e) its ratio value of the work done per pick.

The average load to be lifted on each pick is 250 lbs. made up as follows:—Weight of head = 112 lbs., plus 138 lbs. (*half* load of 1824 hooks, 2810 harness and 2810 lingoes).

The normal length of the spiral spring Q is 14·6″. The initial deflection of the spring when the head 9 is at the top is nil. The load resistance per inch deflection of the spring is 175 lbs.

The throw of the eccentric B is $4\frac{1}{2}''$; the distance between the centres E G = 15″, G J = $11\frac{1}{4}''$, G L = 7″, L N = $5\frac{1}{4}''$ and N O = 7″.

(a) The lift of the head,

$$= \frac{\text{(Throw of eccentric B) (G J)}}{\text{Distance between centres E G}} = \frac{4\frac{1}{2} \times 11\frac{1}{4}}{15} = 3\frac{3}{8}''$$

(b) The work done by raising the head through $3\frac{3}{8}''$

$$= \frac{250 \times 3\frac{3}{8}}{12} = 70{\cdot}3 \text{ ft. lbs.}$$

(c) The deflection in the spring due to the falling head,

$$= \frac{\text{(Throw of B) (G L) (N O)}}{\text{Distance between centres (E G) (L N)}} = \frac{4\frac{1}{2} \times 7 \times 7}{15 \times 5\frac{1}{4}} = 2{\cdot}8''$$

(d) The value of the counterpoise in foot lbs.,

= (Mean active force in lbs. per inch) (deflection in feet).

(1) Mean active force $= \frac{175 \times 2.8}{2} = 245$ lbs.

(2) Deflection of spring in feet $= \frac{2{\cdot}8}{12} = \frac{7}{30}$

Then work stored $= \frac{245 \times 7}{30} = 57{\cdot}2$ ft. lbs.

(e) Ratio of work done,

$$= \frac{\text{Value of counterpoise}}{\text{Amt. of work done}} = \frac{57{\cdot}2 \times 100}{70{\cdot}3} = 81{\cdot}3\%.$$

The load resistance and deflection of the above spring is graphically represented at Fig. 167 and for the spring in problem 3 at Fig. 168.

Problem 3.—Based on the dead weight and spiral spring system described in connection with Figs. 163 to 166.

Ascertain (a) The lift of the head. (b) The average number of foot lbs. of work done in lifting the Jacquard head on each pick. (c) The value of the dead weight counterpoise. (d) The value of the spiral spring counterpoise, and (e) the ratio value of the combined counterpoise of the work done per pick.

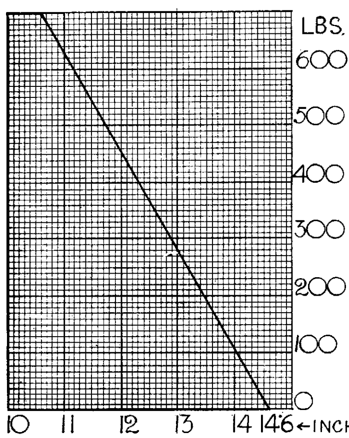


Fig. 167.

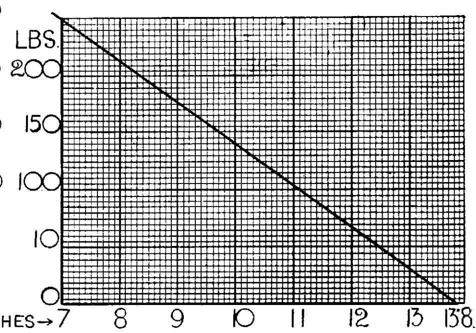


Fig. 168.

The average load to be lifted on each pick for two machines is 480 lbs. made up as follows:—Weight of two heads = 265 lbs. plus 215 lbs. (half load of 2448 hooks, 4408 harness and lingoes).

The weight of the two solid drawing shafts I = (104 + 104) = 208 lbs. The normal length of the spiral spring X is 13·8″; the initial deflection of the spring when the head is up = 0·5″, the final deflection = $3\frac{1}{2}$″. Then $3\frac{1}{2} - \frac{1}{2} = 3$″ net. The amount of load per inch deflection = 32 lbs.

The circle described by stud G = $6\frac{7}{8}$″. The distance between centres J L = $18\frac{1}{2}$″; L O = $8\frac{1}{2}$″; Q S = $9\frac{1}{4}$″; U S = 11″; Y S = 9″.

(a) Lift of Jacquard head,

$$= \frac{\text{(Dia. cir. described by stud G (L O) (U S)}}{\text{Centres (J L) (Q S)}} = \frac{6\frac{7}{8} \times 8\frac{1}{2} \times 11}{18\frac{1}{2} \times 9\frac{1}{4}} = 3\frac{3}{4}''$$

(b) The work done by lifting the head through $3\frac{3}{4}''$,

$$= \frac{480 \times 3\frac{3}{4}}{12} = 150 \text{ ft. lbs.}$$

(c) The value of the dead weight counterpoise,

$$= \frac{\text{(Weight of shafts I) (J L) (Q S)}}{\text{(L O) (U S)}} \times \text{Distance travelled by head.}$$

$$= \frac{208 \times 18\frac{1}{2} \times 9\frac{1}{4}}{8\frac{1}{2} \times 11} \times \frac{3\frac{3}{4}}{12} = 119 \text{ ft. lbs.}$$

(d) The value of *one* spiral spring,

= (Mean active force in lbs.) (deflection in feet).

(1) Mean active force $= \left(\frac{32}{2} \times \frac{1}{2}\right) + \left(\frac{32 \times 3\frac{1}{2}}{2}\right) = 64$

(2) Deflection of spring $= \frac{3}{12}$ ft.

Then work stored in spring $= \frac{64 \times 3}{12} = 16$ ft. lbs.

(e) Ratio value of the duplex counterpoise,

$$= \frac{(119 + 16) \times 100}{150} = 90\ \%.$$

This ratio counterpoise value of 90 % of the work done is approximately as much as can be conveniently used in practice. In fact, the use of the second spring X, Fig. 164, as a counterpoise was found to be a disadvantage rather than otherwise in the given loom and problem; when weaving some goods both springs are discarded. The counterpoise values in the first problem might, with advantage, be increased to 75 % of the maximum load.

Theoretically, the weight of the head and the counterpoise should balance each other and the energy required to overcome the frictional resistance should be supplied from the driving mechanism, but practical experience demonstrates that the counterpoise load should be on the light side rather than actually balance.

CHAPTER XII.

Pressure and Split Harness Weaving and Mechanism.

Pressure Harness Weaving.

THIS system of weaving is confined chiefly to the manufacture of the finest silks and linen damasks. The fundamental principle of pressure harness mounting and weaving, ranks as the oldest system of figure weaving extant, at one period being the only system in common use, for which reason it was called '*common harness*,' a designation by which it is still known, though the system is not now common. In some districts 'twilling harness' is also denominated common harness as distinguished from *full harness*, where only one harness cord in every repeat of pattern is connected to each Jacquard figuring hook, and where each hook is controlled by a separate needle.

Pressure harness nevertheless still merits favour with manufacturers of special classes of figured goods on both hand and power looms. With hand loom weavers, because it primarily increases the relative figuring capacity of the Jacquard machine, and facilitates the production of large repeat patterns without having recourse to the employment of two or more machines, which would necessarily entail more physical labour than could be conveniently expended. With power loom weavers, not only because large repeat patterns can be produced without the aid of Jacquards of normally large figuring capacity, but also because the binding weave, being controlled independently of the figuring harness is both uniform and perfect.

Linen damasks, woven on hand looms with pressure harness mounting, always command better prices than the same type of cloth woven on power looms with twilling Jacquards. The belief is firmly held by both manufacturers and merchants that the hand woven product is better in stability of texture, strength and quality of material than is its contemporary power woven product. It is perhaps important to note, that only the best warps can be used in pressure harness weaving, because of the excessive *strain* which is thrown upon the threads during the process of weaving. In the hand loom woven product, single lift Jacquards are always employed and when this type of machine is used in power loom weaving with pressure harness mounting, a fabric is produced which most nearly resembles the hand woven product.

Principles of Pressure Harness and Weaving.

Briefly, in pressure harness weaving, from 2 to 8 threads of warp pass through each mail of the harness, and afterwards, individually through separate mails in a set of heddles placed immediately in front of the harness. This simple arrangement is the factor which increases the figuring capacity of an ordinary Jacquard machine beyond its normal and initial capacity, and thus saves a considerable quantity of machinery, mounting and harness. The mails of the heddles are made a sufficient depth to allow (independently of them) a figuring shed to be formed by the groups of warp threads drawn through the harness. The Jacquard and harness operate the figuring sheds in groups of two or more threads, according to the number drawn through each harness mail. The griffe knives remain up with the lifted hooks for two or more shots of weft, during which time, the pressure heddles interchange to produce the binding twill in the ground and the figure.

Fig. 169 shows in elevation, as viewed from the side of the loom, one row of harness, the heddles, the figuring and binding sheds, and a transverse section of the woven cloth.

Fig. 170 is a plan view of a portion of the same woven cloth, the vertical lines of which represent the *weft*, and the transverse lines, the *warp*; the markings where the warp and weft intersect, indicate that the warp, at these points is raised to the surface.

Fig. 171 is an enlarged plan view of one row of harness mails from front to back, also five rows of mails in pressure heddles, and the warp threads.

Similar letters in each diagram refer to corresponding details. A represents the comberboard, B the harness, C the harness mails, D the lingoes, F the pressure heddles, G the heddle mails, H the warp threads, I the weft and J a transverse section of the cloth through the weft. A portion of the reed is shown at K and the shuttle at L.

Fig. 169.

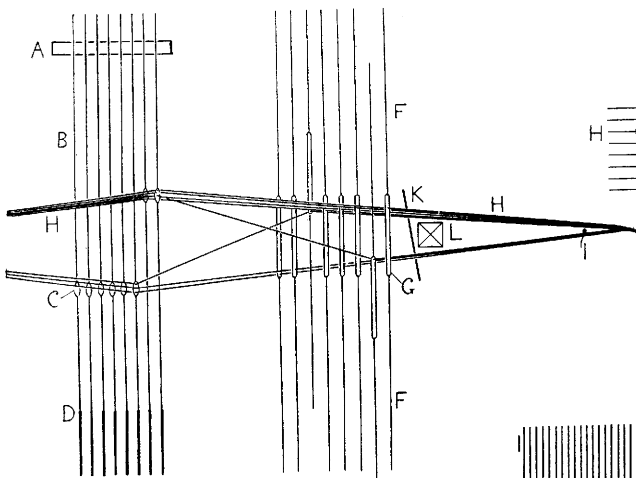
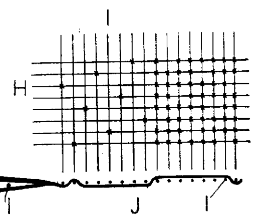


Fig. 170.



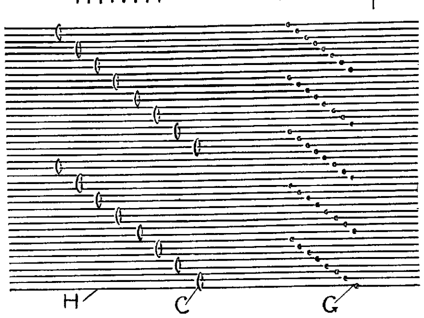


Fig. 171.

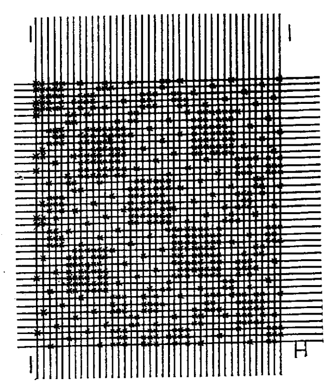


Fig. 172.

The warp threads are first drawn through the harness mails, as shown in this example (Fig. 171), in groups of 3, 2, 3, 2, 3, 2, 3, 2, *i.e.*, 20 warp threads through 8 harness mails, equal to an average of $2\frac{1}{2}$ threads per mail. The threads H are then shown to be drawn singly through separate heddle mails G.

The increased figuring capacity of the Jacquard due to this arrangement is equal to the product of the number of uprights and the average number of threads drawn through each harness mail, thus :—

No. of uprights in Jacquard mach. × Average No. threads per mail.

Then given two 600 machines

$$\frac{600 \times 2}{1} \times \frac{3 + 2}{2} = 3000 \text{ threads, capacity.}$$

Fig. 172 is a plan view of the woven cloth.

Fig. 173 is the fully developed pattern design for same, complete on 40 ends and picks, to demonstrate the value of the foregoing mechanism. The figure effect of pattern is produced by 16 hooks and harness, and the binding weave in 8 end sateen order by 8 pressure heddles as shown in plan at Fig. 171. It should be observed that the masses of figure for the grouping of the threads given, can only be formed of 2, 3, 5 (the sum of 2 and 3), and multiples of 5 plus either 2 or 3 threads. The definition at the outline of the figure cannot be less than 2 or 3 threads, excepting where the binding weave happens to divide them. Simultaneously with the formation of the figuring shed, one of the pressure heddles (Fig. 169) *descends* and *depresses* every eighth thread of the warp that has been lifted by the harness. Similarly one pressure heddle *rises* on every pick and *lifts* every eighth thread of warp that has been left down by the harness. The harness changes to form a new figuring shed according to the required number of shots per card, but the heddles change on every shot, usually in sateen order. The depressed heddle binds the warp figure and the raised heddle, the weft figure.

Depth of Sheds.

The depth of the shed is primarily governed by the elasticity of the yarn. Linen yarn, though very strong is non-elastic in comparison with cotton or wool. If the warp is overstretched it hangs slack in the shed. The necessary formation of the two sheds—one in the harness and one in the heddles—puts considerable strain upon the warp yarn, consequently the size of the shed in the heddles and in front of the reed is usually very small. The shuttles used are always very shallow and seldom exceed one inch in depth.

The following practical details are suitable for a loom weaving linen damask 78″ wide in the reed. Depth of shuttle, $\frac{15}{16}$″; breadth of shuttle $1\frac{3}{4}$″. Stroke of lay—reed in point of contact with the cloth, $7\frac{3}{4}$″. Fell of cloth to eighth or back heddle, 13″. Fell of

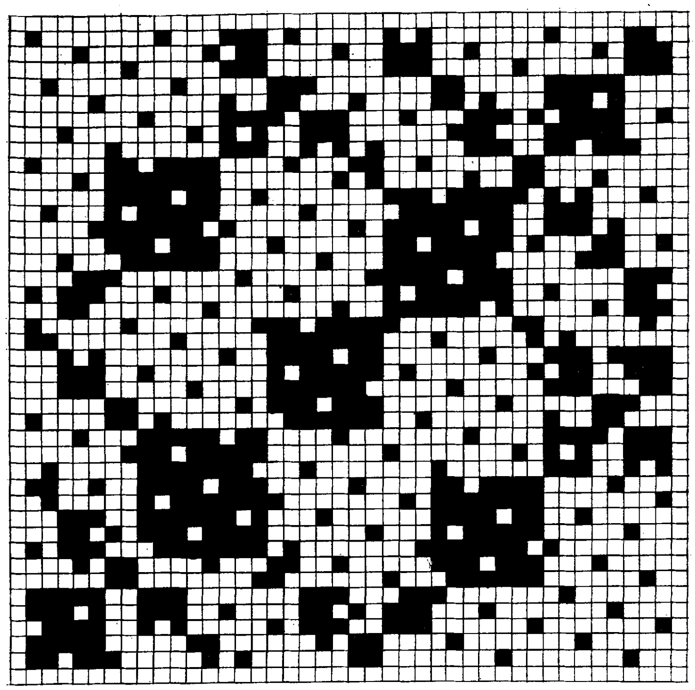


Fig. 173.

cloth to back harness mail, 28″. Fell of cloth to back or warp rail, 65″. Fell of cloth to point of contact with breast or cloth rail, $4\frac{1}{2}$″. Width of cloth rail $6\frac{1}{2}$″. From the foregoing data the following solutions may be ascertained.

(1) The depth of the shed in the heddles, or lift of the back heddle,

$$= \frac{\text{Depth of shuttle} \times \text{heddle from cloth}}{\text{Stroke of lay} - \text{width of shuttle}}$$

$$= \frac{\frac{15}{16} \times 13}{7\frac{3}{4} - 1\frac{3}{4}} = \frac{15}{16} \times \frac{13}{6} = \frac{65}{32} = 2\tfrac{1}{32}''.$$

(2) The depth of the shed in the harness,

$$= \frac{\text{Depth of shed in the heddles} \times \text{harness from cloth}}{\text{Heddle from cloth}}$$

$$= \frac{65}{32} \times \frac{28}{13} = 4\tfrac{3}{8}''.$$

Experience teaches that in order to obtain a *clear* shed, of the required depth, the Jacquard head and griffe knives must traverse a distance which is slightly in excess of the actual size of the required shed. In this example the lift of the head should be about $4\frac{3}{4}''$ with a possible adjustment up to 5 inches.

Intermittent Driving of Pressure Harness Jacquards.

The Jacquard head with the griffe knives, in power loom weaving for pressure harness, is usually operated by tappets, which are constructed to lift and keep the head up for two or more picks of weft, so as to allow the insertion into the cloth, of two or more shots for each figuring card; during the dwell of the Jacquard, the pressure heddles are free to interchange twice or oftener to form the binding sheds. The manufacturer who adopts this type of Jacquard and mounting usually has to design his own method of driving, consequently there are many systems in use, most of which are similar in principle. The single lift Jacquard is most frequently employed, but a double lift machine can also be successfully adopted.

Driving Single Lift Pressure Harness Jacquards.

Fig. 174 is an elevation of a section of a single lift mechanism in actual work, designed by the writer. A is the crank shaft, keyed fast to which is a spur pinion B containing 24 teeth. A single intermediate spur wheel C on stud D combines pinion B with the large spur wheel E containing 120 teeth. This wheel is compounded with a sleeve F supported and free to rotate on the bottom shaft G at one-fifth the rate of the crank shaft A and pinion B. Set screwed to the sleeve F is a driving tappet H designed specially to lift the head for 3 and 2 shots per card alternately.

The tappet H is kept in rolling contact with an antifriction roller I which is free to rotate in the adjustable bracket K. This bracket is bolted to the treadle lever L, pivoted on the stud M in turn supported by a casting N securely fixed to the floor of the room. The free arm of the lever L combines through stud O, swivel link P and reciprocating rod Q, the head lever of the Jacquard. The constant rotation of the tappet H intermittingly reciprocates the roller I and through connections described elevates and regulates the fall of the head and griffe knives. The lower wing of the tappet H, shown in contact with bowl I gives two picks, and the upper wing, three picks per card.

Driving Pressure Harness Jacquards on the Double Lift Principle.

Fig. 175 is a side elevation and Fig. 176 a front elevation of an arrangement, designed by the writer to operate the reciprocating rods combined with the head levers of two double lift Jacquards to give two or more shots of weft per card in regular or other order.

The compounding of the reciprocating rods and the head levers with the griffes, may be upon any one of the methods illustrated and detailed in Chapter VIII. The same letters in Figs. 174, 175 and 176 refer to corresponding details.

The chief points of difference in the two systems of driving are as follows:—Two single winged tappets H^1 and H^2 Figs. 175 and 176, are employed instead of one double winged tappet H, Fig. 174. The parts L to Q inclusive are in duplicate.

The tappet H^1 combines with and operates bowl I, treadle lever L and through the last, the reciprocating rod Q and the front head lever, to lift the head which remains up for *three* shots of weft after which it descends and dwells down alternately for *two* shots.

Conversely the tappet H^2 lifts, through its duplicate connections shown, the back head lever and head which then dwells up for two picks after which it descends and dwells down alternately for three picks of weft.

Amount of Dwell for Jacquard and Pressure Heddle Shedding.

Owing to the binding shed in pressure harness being very small, it is necessary to keep the warp threads tight, from the

Fig. 174.

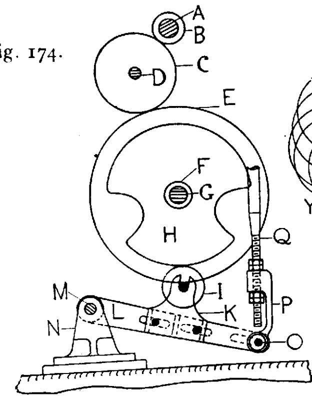


Fig. 177.

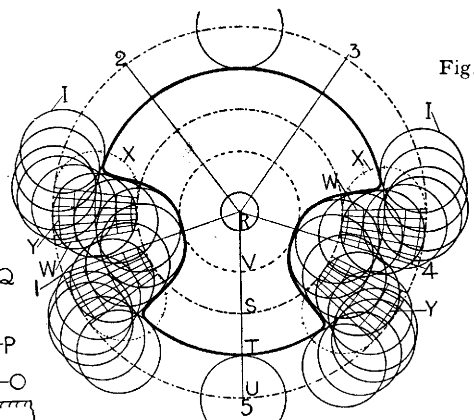


Fig. 175.

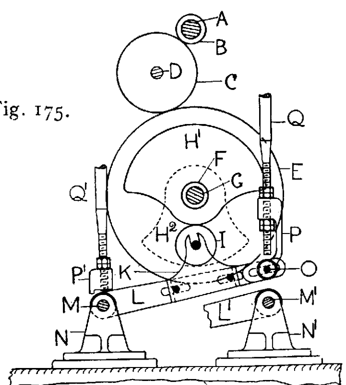
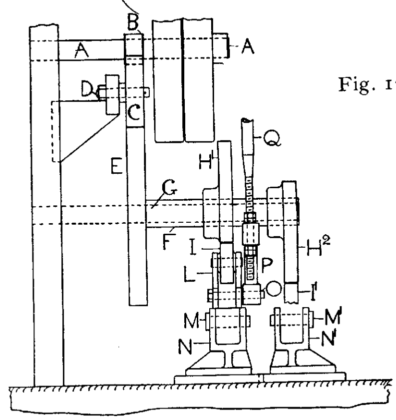


Fig. 176.



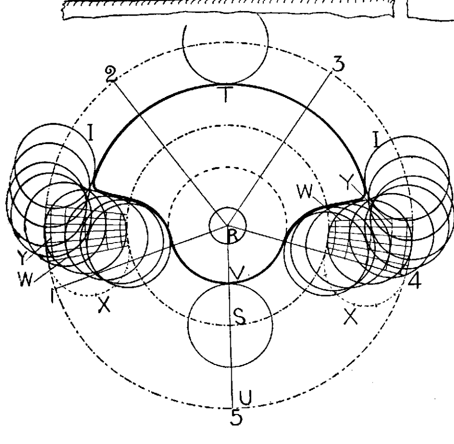


Fig. 178.

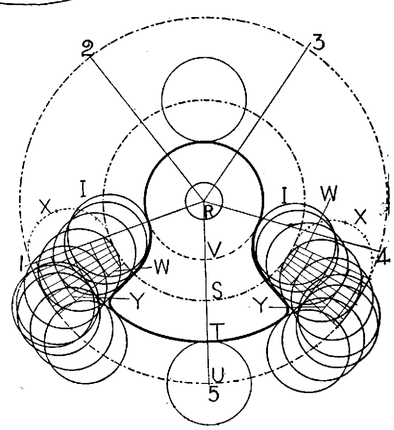


Fig. 179.

moment the shuttle enters the shed to its exit. Slack threads cause wrong stitching or interlacing of the pattern and tend to divert the shuttle from its normal straight course. Experience demonstrates that the pressure heddles require to dwell for about a half revolution of the crank shaft to allow the shuttle to pass through the shed. This is about twice the time of the normal dwell of the Jacquard head. A compromise is effected by giving $\frac{3}{8}$ of a revolution to the Jacquard shed, which, after allowing for the extra time occupied by the griffe blades in travelling from and to the hooks, combined with the increased distance travelled by the Jacquard harness mails as compared with the mails of the pressure harness, approximately neutralises the two actual differences in amount of dwell. In practice there is no appreciable difference manifest.

Problems on, and Construction of Tappets.

A tappet is a mechanical contrivance for converting circular motion into reciprocating. When the object to be alternated is to receive a series of lifts with intervals of rest, the actuating mechanism is designated a 'tappet,' but if the motion is continuous the mechanism used is termed a 'cam;' though either term is frequently used indiscriminately.

Tappets are either *negative* or *positive*. When negative, they are only capable of acting on the heddles so as either to pull them down or lift them up and external mechanism has to be introduced to impart an opposite movement. When positive they control the heddles in both directions without the aid of secondary apparatus.

The ordinary method of forming the shed by the use of tappets is negative and open.

The data requisite to construct the three tappets H H^1 H^2 Figs. 174, 175, 176, may be ascertained from the following actual details.

Problem 1.—Find the required 'stroke' of tappet to lift the Jacquard head through a distance of 5 inches when the following particulars are known :—Length of head lever, 15″ on the Jacquard side of the fulcrum and 18″ from the fulcrum to the reciprocating rod Q; centres O M in treadle lever $L = 14''$; centres $I\ M = 8''$. Then stroke of tappet equals,

$$\text{Lift of head} \times \frac{18 \text{ inches}}{15 \text{ inches}} \times \frac{\text{centre I M}}{\text{centre O M}} = \frac{5 \times 18}{15} \times \frac{8}{14} = 3\tfrac{3}{7}''.$$

Problem 2.—Construct three tappets H H^1 H^2 for lifting the Jacquard head as in Figs. 174, 175 and 176, to the following particulars:—Diameter of tappet bore $1\frac{1}{2}''$; diameter of tappet barrel 5″; stroke of tappet $3\frac{1}{2}''$; diameter of treadle bowl $3\frac{1}{2}''$. Allow $\frac{1}{8}$ revolution of crank shaft for dwell of head at the bottom when the shed is closed; $\frac{3}{8}$ dwell at the top when the shed is open; $\frac{1}{4}$ revolution for the rise and $\frac{1}{4}$ for the fall. Give five picks to the round.

The three tappets H H^1 H^2 are shown fully constructed at Figs. 177, 178 and 179 respectively. R represents the bore of the tappet, which fits on to the sleeve F (Fig. 174); V the periphery of the tappet barrel; T the extreme periphery of the tappet wing; I the antifriction bowl; S the centre of traverse of the bowl I when it is in rolling contact with the tappet barrel V, and U the centre of traverse of bowl I when in rolling contact with the extreme periphery (T) of the tappet.

Problems on Construction.

The construction of tappets involves the following considerations.

1. The number of picks of weft to each revolution of the tappet.
2. The order of depressing or permitting the rise of the treadle or treadle levers, to coincide with the required shed.
3. The required stroke of the tappet.
4. The diameter of the tappet barrel, which should always be greater than the stroke of the tappet and increase with the number of picks to the round.
5. The diameter of the treadle bowl, which should be as large as possible but never greater than the stroke of the tappet.
6. The amount of dwell or period during which the shed remains open.
7. The nature of the movement required to be imparted to the treadle lever and through its connections to the shed.

The treadle bowl should be made to vibrate exactly in the same variable ratio as is required by the shed, see page 27.

In order to attain this object the tappet must *first* be constructed on the centre of the traverse of the treadle bowl.

The correct size of the tappet is then obtained by a reduction in its radius at all points, equivalent to the radius of the treadle bowl. This ensures that the peripheries of the treadle bowl and tappet coincide at all points.

How to Construct a Tappet.

Any negative or positive tappet may be accurately constructed by observing the following directions.

(1) With R (Fig. 177) as centre and radius equal to the radius of the tappet barrel plus the radius of the treadle bowl, describe a circle S to represent the centre of the treadle bowl when it is raised (Problem 2).

$$\text{Then radius S} = (2\tfrac{1}{2}'' + 1\tfrac{3}{4}'') = 4\tfrac{1}{4}''.$$

(2) Add to circle S an amount equal to the lift of the tappet and describe a circle U concentric with S, to represent the centre of the traverse of the treadle bowl when it is depressed.

$$\text{Then radius U} = (4\tfrac{1}{4}'' + 3\tfrac{1}{2}'') = 7\tfrac{3}{4}''.$$

(3) Divide the circle U into as many equal parts as there are picks required to the round of the tappet *e.g.* 5.

(4) Sub-divide each division or pick on which the tappet changes into any convenient number of parts to suit the time allowed for dwell, and change for rise or fall.

(5) Sub-divide each division on which the tappet changes into six or any other convenient number of equal parts by radial lines W, the greater the number the more perfect the tappet.

(6) Describe a semi-circle X on any one of the radial lines W, between circles S and U, equal in diameter to the stroke of the tappet.

(7) Divide the semi-circle X into six or a corresponding number of equal parts, and through each point draw lines perpendicular to the diameter and the radial lines W.

(8) Through each point on the diameter line draw arcs of circles Y concentric with circles R and S.

(9) Taking the points where the radial lines W and concentric arcs of circles Y, cut each other (on circles S and U representing the centres of the traverse of the treadle bowl) describe circles equal in diameter to the treadle bowl.

(10) To obtain the correct form of the tappet, draw lines from V to T touching the circumference of the bowl circles.

The intersecting points W and Y represent the changing positions of the treadle bowl during its rise or fall. V represents the periphery of the tappet barrel and T the periphery of the tappet wing.

The distances between the radial lines W being equal, represent equal times on the tappet circle. The distances between the concentric arcs of circles Y, decrease from the centre in both directions. Consequently with the uniform rotation of the tappet, the centre of the treadle bowl moves a gradually *increasing* distance from the circle S to midway between S and U, and *decreases* from this point to U during equal periods of time represented on the tappet circle. The result of this causes the treadle bowl to gradually increase in speed from its position of rest to the centre, and to decrease from the centre to the end of its stroke in the same arithmetical ratio. This imparts the requisite and corresponding variable velocity to the lifting harness or heddles.

Pressure Heddle Mechanism.

The function of pressure heddles is to *bind* the ground and figure threads which have been lifted or left down by the Jacquard harness. To accomplish this, the heddles must be adjusted and operated so as to occupy one of the following three positions.

(1) A *central* or *normal* position which allows the Jacquard harness to produce a warp shed through the *mails* of the heddles of sufficient depth for the free passage of the shuttle, the eye in the heddle being made long enough to admit of this operation.

(2) A *top* position to which one of the heddles must rise on every pick and thus lift *one* out of every *five* or *eight* threads from the mass left down by the harness constituting the weft portion of the figure, the object being to bind this latter in 5 or 8 leaf sateen twill according to the number of shafts employed.

(3) A *bottom* position, where the object is to bind down one out of every 5 or 8 threads from the group of warp threads lifted by the harness and constituting, conversely, the *warp* portion of the figure.

The combined operation of forcibly lifting some warp threads from the lower to the upper division and of depressing others from the upper to the lower division of threads in the natural Jacquard shed produces an artificial and strained shed. This factor has caused the system to be denominated PRESSURE HARNESS. When any of the heddles are in their highest or lowest position, the Jacquard shed is therefore modified in proportion to the number of heddles up or down, but with those heddles in the central position, the Jacquard is free to raise the warp threads as required. The operating of the heddles, midway or at full distance, in power loom weaving, may be accomplished by employing a set of positive tappets, a small positive dobby or by setting aside a limited number of Jacquard uprights. The first of these methods is the most satisfactory and the last the most objectionable, since it involves lifting the Jacquard head on every pick.

In hand loom weaving, a separate set of treadles is employed.

Operating the Pressure Heddles by Positive Tappets.

Figs. 180 to 184 illustrate the essential features of the positive tappet mechanism, designed to lift or depress the heddles, midway or full distance and retain them in such position for any number of shots of weft.

Fig. 180 shows in elevation one of the eight whole plate positive tappets, including its connections with the top and bottom jack or heddle levers.

Fig. 181 is a vertical section through the given positive tappet.

Fig. 182. A front elevation showing the connection of the jack levers with the heddles.

Fig. 183. A plan of the eight treadle levers and arrangement of driving the shedding tappets.

The same letters in each refer to similar details. A is the crank shaft; B a spur pinion (containing 30 teeth) keyed to the shaft A and gearing into and driving a spur wheel C, containing 240 teeth, denominated the 'plate wheel.' Compounded with the plate wheel C are two plates D and D[1] and eight whole plate positive tappets E. In each tappet barrel there are eight holes equidistant and concentric

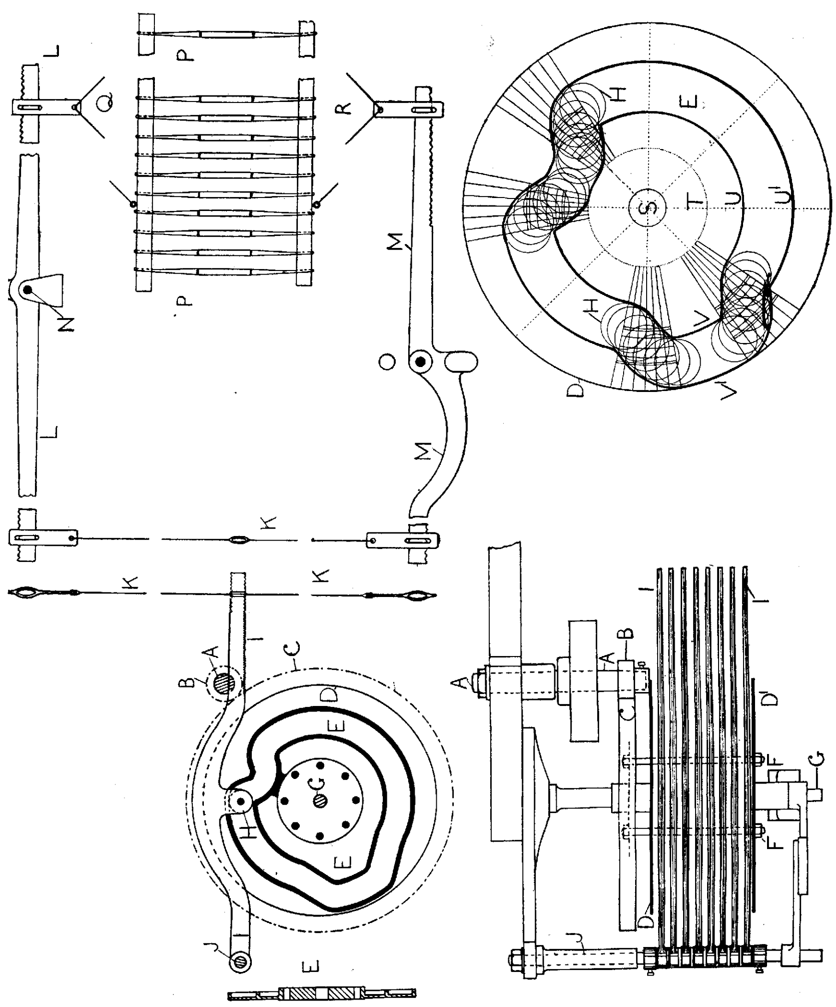


Fig. 182

Fig. 184

Fig. 180

Fig. 181

Fig. 183

with the bore of the tappet; through each of these holes and similar holes in the plates D D[1] and the plate wheel C, strong bolts F are passed which compound these several parts. The whole is placed, supported and free to rotate on the stud shaft G fixed in the gable. Contained between the outer and inner projections of each tappet E is an antifriction roller H. These rollers are centred on the treadle levers I pivoted on the common stud J. The free arms of the treadle levers I are adjustably attached through the medium of strong cords K to the outer and left arms of a like number of jack or heddle levers L immediately *above* the heddles, and to jack levers M directly *below*. The levers L are pivoted at N and the levers M at O. The heddles P are suspended from the respective right arms of levers L by bow bands Q and connected with levers M by similar bow bands R (Fig. 182).

Fig. 184 shows the details of construction of one of the eight positive tappets E drawn to scale for eight picks to the round with the following given particulars:—Diameter of tappet bore S, $1\frac{1}{2}$in.; radius of tappet barrel T, $2\frac{3}{8}$in.—the position when in contact with the treadle bowl, the heddle being at its highest point. The *first* lift of the tappet = $1\frac{1}{2}$in. Then radius U for same = Radius T + First lift of tappet = $2\frac{3}{8} + 1\frac{1}{2} = 3\frac{7}{8}$in.—the position in contact with the treadle bowl, when the heddle is in its central position. The *second* lift of the tappet = $1\frac{1}{2}$in. Then radius V, for same = Radius U + second lift of tappet = $3\frac{7}{8} + 1\frac{1}{2} = 5\frac{3}{8}$in.—the position in contact with the heddle when in its lowest position. Diameter of treadle bowl H, 2in.; dwell of heddle = half revolution of the crank shaft. U^1 and V^1 represent outer projections on the tappet, concentric with and corresponding to U and V respectively.

The completed tappet consists of a disc plate, on one side of which are two raised narrow surfaces U V and U^1 V^1. The construction of the inner projection U is identical in principle with the ordinary negative tappet; the outer projection is concentric and parallel with the *smallest* diameter of the inner raised surface. The outer formation is therefore a duplicate in variation and construction of the inner formation. A groove is thus formed through which the treadle or antifriction bowl can travel, but the space is generally arranged to be $\frac{1}{8}$ inch greater than the diameter of the treadle bowl, so as to prevent any locking. The inner projections U and V of the tappet elevate the treadle bowl H together with the treadle lever I, and these through the connections described and shown in Figs. 180

and 182 depress the heddle P. The narrow projections U^1 and V^1 operate in turn upon the uppermost side of the treadle bowl H and so produce through the connections illustrated, an elevation of the heddle P.

In a similar way the remaining heddles are controlled by duplicate tappets immediately in front of E, which in turn operate upon the respective treadle bowls and treadle levers—these, through their respective connections, elevate and depress the heddles. Since the number of teeth in the spur wheel B is just one eighth of those in the spur wheel C, the latter makes one revolution every eight picks. Each tappet is therefore constructed to elevate and keep the heddle P up for one pick, in the centre for six, and down for one to each revolution.

Split Harness.

Split, sometimes called 'scale' harness is designed like pressure harness to weave the finest figured silks, linens and cottons. The system is chiefly used for fabrics which are 'set' much closer in the warp than in the weft. Some of the rich fine silks are woven with about 400 threads of warp per inch and half the number of picks of weft.

Technical Details.

The chief mechanical details of this method of mounting and weaving to increase the relative figuring capacity of the Jacquard machine are illustrated at Figs. 185 and 186. The former shows one row of Jacquard uprights, harness twines, mails and lingoes together with the transverse section of a special set of shafts introduced for binding purposes, and the latter, one row of spare uprights to which strong cords are looped which in turn support the binding shafts. The same letters in each diagram refer to similar details. The ordinary griffe blades are shown at A, the cross wires, etc., at B, the uprights at C; C^1 are the spare uprights which combine with and lift the heddles; they are placed immediately in front of the uprights C. The resting board and bars for the uprights are shown at D, the neck band at E and the harness twine at F. To each harness twine F at the point G, two harness twines F^1 are knotted fast. Each of these twines is then passed through the comberboard H and threaded through the mail I and then turned upwards and knotted fast about six inches above the mails at the point J to form the loop K. Through the loops of each row of harness in the comberboard an iron or hard wood shaft L is passed, $\frac{1}{8}''$ thick, $1\frac{1}{8}''$ to $1\frac{1}{4}''$ deep. There may be 8, 12, 16 or 24 shafts according to the number of rows of harness from front to back in the comberboard or to suit the required binding weave. The lower couplings and lingoes suspended from the mails are shown at M. The strong cords N (Fig. 186) connect one row of spare hooks C^1 with the shafts L in the order shown and each upright controls two shafts to weave in eight end twill or sateen order. Sometimes a second row of spare uprights is employed and connected with the shafts 9 to 16 inclusive to bind the pattern in sixteen end sateen order. One or two rows of spare hooks on the opposite side of the machine are similarly connected to the opposite ends of the shaft L.

The Jacquard controls the figure, each upright lifting the harness and warp threads in pairs to form the warp figure, whilst the groups or masses of warp threads left down by the Jacquard in multiples of two, constitute the weft or ground portion of the figure. The binding operation in the *ground* is accomplished by lifting *one shaft* out of any number and in any order on every pick to suit the predetermined pattern. The *binding* in the warp portion of the figure is obtained by leaving down *one upright* in any order or number to suit the pattern. The shafts lift the binding threads singly in the ground, but the Jacquard uprights bind down the warp figure in two or multiples of two, according to the number of neck bands which are attached to each upright. This is a serious defect since it tends to give the fabric a coarse appearance except where *very* closely 'set.'

It is, however, possible to split the two binding threads and lift one of them by the shafts L but the order of connecting the cords N with the hooks C^1 and shaft L must be designed to coincide with the order of depressing the binding harness.

When figured patterns of large repeat have to be very closely woven, two or more neck bands, each supporting two mails and lingoes, are connected to and operated by the same upright. Each

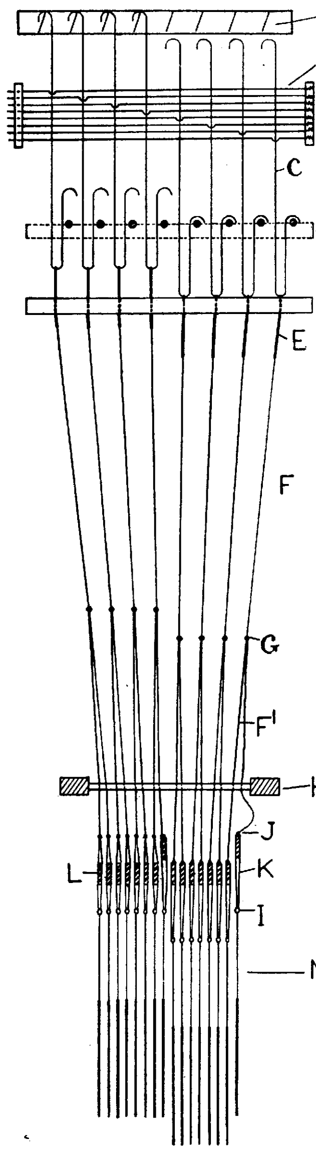


Fig. 185

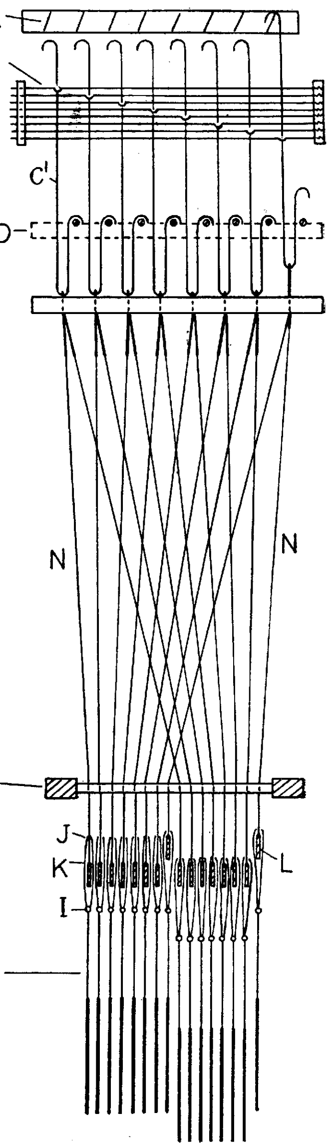


Fig. 186

harness twine is, however, threaded on to a separate shaft and operated in any predetermined order by the spare uprights in the Jacquard machine. These latter, which rise on every pick with the Jacquard head may be controlled by the ordinary pattern cards or independently, if the hooks are placed near enough to the ends of the cylinder to permit short cards to operate outside those used for figuring.

If the fabric is woven *face upwards* the weft or ground portion will be bound singly and the warp portion of the figure in twos or multiples of two according to the number of neck cords connected to each upright; obviously then, these conditions will be reversed when the fabric is woven face *downwards.*

It will be seen, in Fig. 185, that one half of the uprights is lifted to form the figure and the remainder is left down for the ground portion of the pattern. In Fig. 186 only one of the binding uprights with shafts 1 and 9 is lifted on the first pick for binding the ground; the remaining uprights are selected and lifted in the usual sateen order on each subsequent pick.

The advantage of the foregoing system is that it increases the normal figuring capacity of the Jacquard machine in multiples of two for each neck band attached to every Jacquard upright.

CHAPTER XIII.

Gauze or Leno Jacquards.

THE 'Leno' Jacquard, as it is commonly called, is designed to combine with the loom to weave figured fabrics in which cross weaving (gauze or leno) is introduced as an additional means of ornament.

The gauze or leno structure is uniformly open and net-like in effect. It is this characteristic which adds value to its combination with ordinary weave and brocade interlacings.

Given a Leno Jacquard with full harness mounting and independent douping, it is possible to weave an indeterminate variety of gauze effects, separately or in combination at will, with any variety of weave interlacings, to produce figured or brocade patterns up to the limit of the figuring capacity of the Jacquard machine.

The enunciation of the fundamental principles of gauze structure, drafting, douping, easing and weaving with doups and heddles is outside the scope of this treatise. Information on these points will be found in connection with Chenille weaving, pages 250 to 258, *Carpet Manufacture*.

In these pages it is purposed to consider the manufacture of figured 'gauzes' with the aid of the Leno Jacquard or an ordinary Jacquard with one, two or more doups.

Nomenclature of Gauze Mounting.

To avoid confusion of terms, the following distinctive names are employed in gauze weaving.

(1) The half heddle or slip is called the doup.

(2) The heddle or harness which supports the doup is called the *front* or *doup standard*.

(3) The heddle or harness which forms the natural shed, and through which the crossing warp threads pass, is called the *back standard*.

(*d*) The heddle or harness through which the non-douped threads are drawn is called the regular heald or harness standard.

Mechanical Details of Gauze Mounting.

Fig. 187 shows in elevation one row of ordinary harness, doups, doup standards and easing harness, together with the uprights and needles which are connected to and operate these respective sections. The drawing is made from the left hand side of a right hand loom, when the *gauze* or crossed shed is being formed.

Fig. 190 shows the same details and interchange of parts when the *natural* shed is being formed. The same letters in each diagram refer to corresponding details.

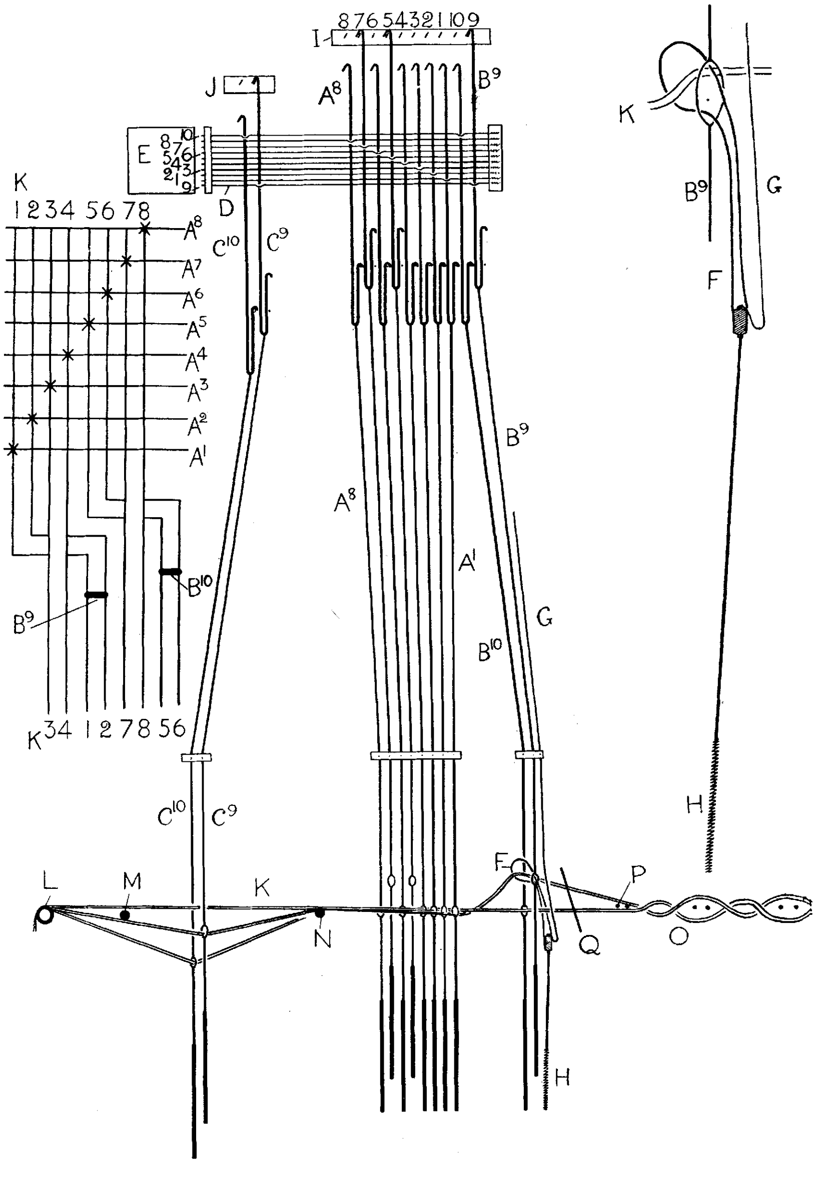
The Jacquard machine contains twelve griffe or brander blades, and a like number of uprights, harness cords, mails and lingoes in each row from the front to the back of the machine. A^1 to A^8 represent the ordinary hooks, harness, etc.; B^9 and B^{10} the doup standards; C^9 and C^{10} the easing standards; D^1 to D^{10} the needles and E a ten row card cylinder; F shows the half heald or doup, slipped through the mail of the doup standard B^9; G is a strong cord which supports the doup to a special strong hook, or it may be securely fastened to the Jacquard head, since it must always rise on *every* pick. H is a fixed spiral spring combined with the doup F to keep it normally under tension. An enlarged and detached view of this detail is shown separately at Fig. 188.

The ordinary hooks and harness A^1 to A^8 and the doup standards B^9 and B^{10} are controlled by the same head I as shown.

The easing hooks and harness C^9 and C^{10} are under the separate control of a small and detached head J.

The warp threads K, a few only of which are shown, run in pairs. The first pair after leaving the back rest L pass under an auxiliary easing bar M and then through the easing harness mail C^9 and over a fixed round bar N. They are then separated, one thread being drawn through the ordinary harness mail A^1 and the other through the harness mail A^2. The second pair or third and fourth warp threads pass from the back rest, over M and freely between the easing harness C^9 and C^{10}, then over the rod N, after which the third

Fig. 189 Fig. 187 Fig. 188



thread is drawn through the ordinary harness mail A^3 and the fourth thread through the mail A^4. Both threads then pass forward together freely between the doup standard harness B^9 and B^{10} to the fell of the cloth O which shows a transverse section through the weft P.

The first pair of threads 1 and 2 are next passed under threads 3 and 4 and then drawn *together* through the doup F on the remote side of threads 3 and 4, from which point they pass forward to the fell of the cloth O. These *four* threads form a *group* and they must therefore pass through the same split in the reed. Each *group* of *four* warp threads is similarly treated until the whole of the warp has been drawn in.

It is usual to first draw all the warp threads through the ordinary harness mails singly and afterwards to draw the crossing threads through the doups; this operation is called douping.

A diagrammatic plan of the order of drafting and manner of douping is shown at Fig. 189. Only *two groups* or eight warp threads are shown; these represent one complete row of harness from front to back. Each additional row of harness is similarly drafted. Each doup, doup standard, back standard, regular harness and easing harness is free and can be independently controlled. The parts shown in this plan are lettered to correspond with the same details in Fig. 187.

The free end of the doup, threaded through the doup standard, is only kept in position by the pair of crossing threads 1 and 2 drawn through it. If these break during the process of weaving, the slip then falls on to the single stave on which all the doups F are contained. Before proceeding to weave, the fallen slip must be threaded again through the mail of the doup standard and the crossing warp threads drawn through as before.

In Fig. 187 the gauze shed is formed by lifting the doup standard B^9 and the doup F on the remote side of the third and fourth warp threads. The hooks and harness A^5 and A^7 are shown lifted for plain weave where gauze effect is not required. In order to ease the strain on the crossing threads 1 and 2, the easing harness C^9 is also lifted as shown.

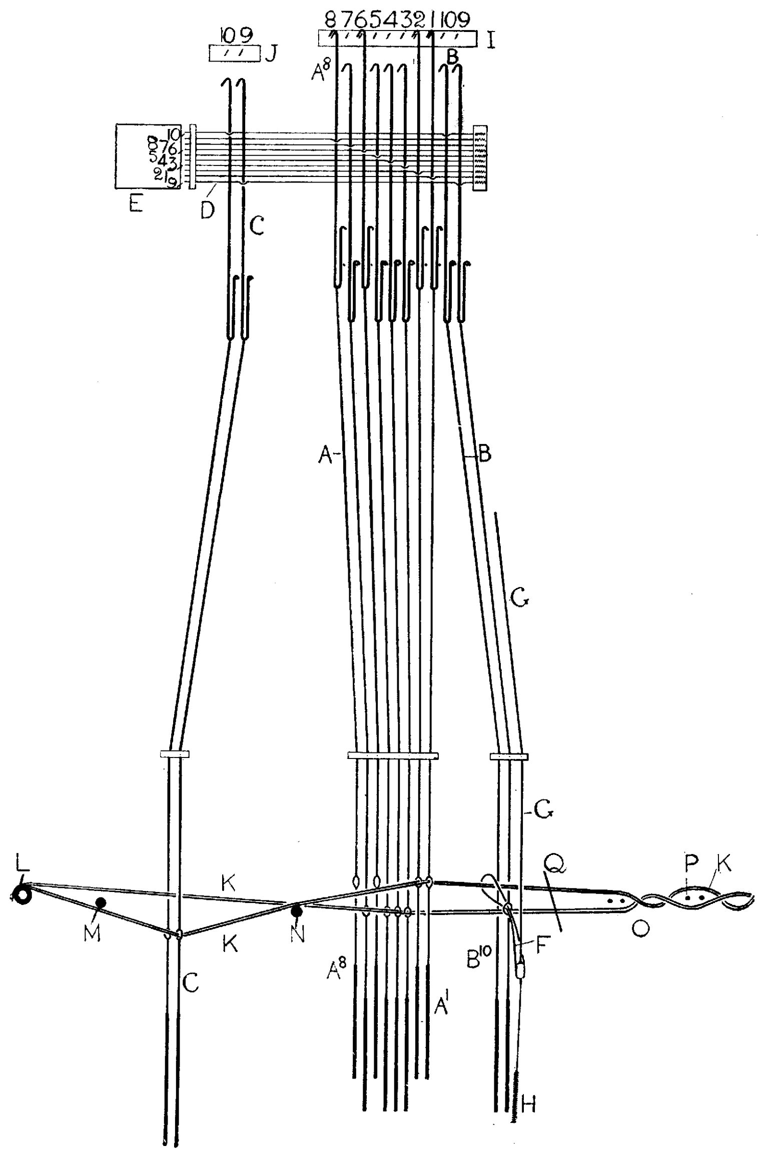


Fig. 190.

In Fig. 190 the natural shed in the gauze structure is formed by lifting the back standards A^1 and A^2 with threads 1 and 2. The doup rises in sympathy on the near or *non*-crossed side of the third and fourth threads of warp, and the easing harness C remains down as shown. Simultaneously the hooks and harness A^6 and A^8 are lifted to produce the opposite pick of plain, in the ground.

It is most important to note that each doup standard is free to be lifted or left down independently of the rest. This is the chief advantage as compared with doups and heddle weaving or of placing and working one or more doups in front of an ordinary Jacquard harness mounting. In a 400 Jacquard machine there are usually 100 doup standards with slips to suit. Each doup standard B is therefore equivalent to a separate doup. The crossing threads are usually arranged as in the illustration, with *two* threads crossing *two*, but the number of shots of weft in the gauze or natural shed is not limited.

It therefore follows that with each group of four threads of warp, it is possible to produce either gauze or ordinary cloth; then if any of the doup standards B are allowed to remain down for a series of picks of weft, the back and regular harness standards are free to form any ordinary weave effect of pattern in proportion to the number of consecutive doup standards left down for any given number of shots of weft.

The relative changes in the position of the harness and doup standards necessary to produce ordinary plain or other regular weave effects are as follows:—Leave down the doup standards for each group as required, lift the corresponding doup and then select the back and regular harness according to pattern exactly as in ordinary Jacquard weaving.

Plan of Gauze Harness and Web.

Fig. 191 shows a plan of the warp together with its controlling factors from the shell of the back rail to the web. The respective details illustrated are the warp K, back rest L, auxiliary easing bar M, easing harness C^9 C^{10} etc., regular harness A^1 etc., doup standards B^9 etc., reed Q (where each group of four warp threads are shown drawn through each split), web O and weft P. The web consists of a simple check pattern composed of gauze, 2 ends crossing 2 ends

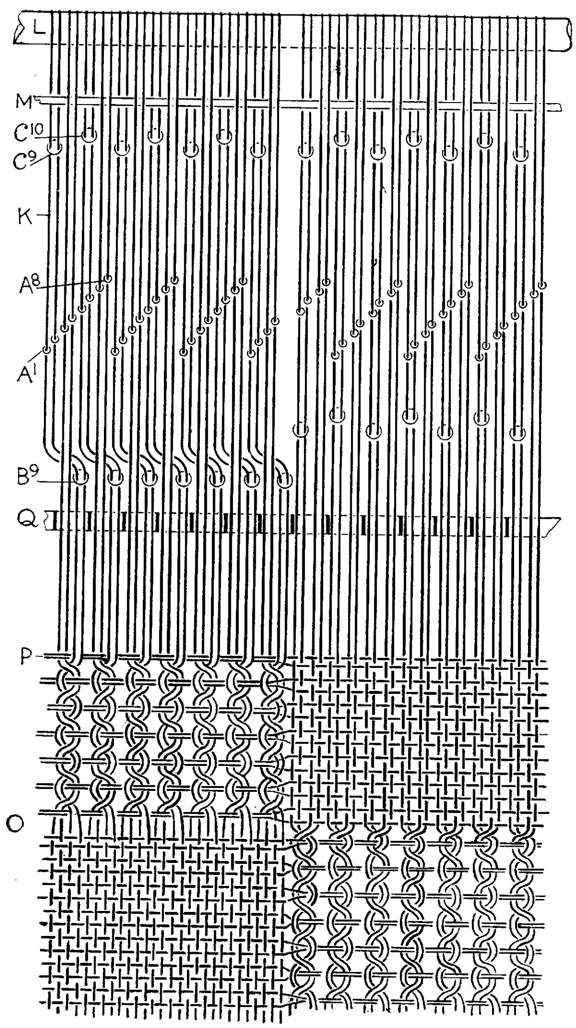


Fig. 191.

over 2 picks, and ordinary plain weave. In the top left hand corner, where the gauze is being formed, the doup standards B together with the doups and crossing threads are shown on the right hand or *crossing* side of each respective group. In the top right hand corner of the pattern where the plain weave is being formed, the slips have been drawn by the back standard on to the left or natural side of each respective group of warp threads.

The given portion of the web O is illustrative of the change from gauze to plain weave and *vice versa*, but any other ordinary weave can be produced up to the full capacity of 400 ordinary hooks A which this machine contains.

The type of crossing represented above is usually denominated *two* threads crossing *two*. The chief reason for douping the threads in pairs and mounting the harness to suit, is because the plain weave approximately balances the gauze structure composed of two threads of warp working together. It is for the same reason that the foregoing arrangement of harness mounting has virtually become standardised. See also page 207.

Easing Motion Auxiliary.

In the manufacture of figured gauzes composed of *linen* or other strong yarns, each group of crossing threads at the point where they pass through the easing harness C (Fig. 187), gradually overcomes the load resistance of the heavy lingoes and assumes a horizontal line which then becomes normal. The result of this action is to make the easing harness non-effective.

In order to obviate this inherent defect, the following auxiliary motion has been designed. Whilst it is effective, it does not interfere with the individual easing harness. The mechanism operates to bring all the crossing threads to the same *depressed initial* plane. Fig. 192 shows all the essential details in elevation.

The parts common to Figs. 187 to 191 inclusive are indicated by similar letters and the auxiliary parts by numerals.

1 is the sword of the going part pivoted on the rocking shaft 2. The crank shaft 3 is linked as shown to the sword 1. An adjustable straight rod 4 combines the sword 1 at the point 5 to the bell crank lever 6 through the medium of stud 7. The lever 6 is pivoted on the stud 8 in the bracket 9 which is compounded with the loom

by the stud 10. The upper arm of lever 6 is set screwed to a short lever arm 11 in turn compounded with a round steel bar M. The bar M passes over all the crossing warp threads and under all the non-douped threads to the opposite side of the loom, where it is similarly supported by duplicate mechanism of parts 1 to 11 inclusive. All the warp K passes over the back rail L and the fixed round bar N, towards the harness as shown.

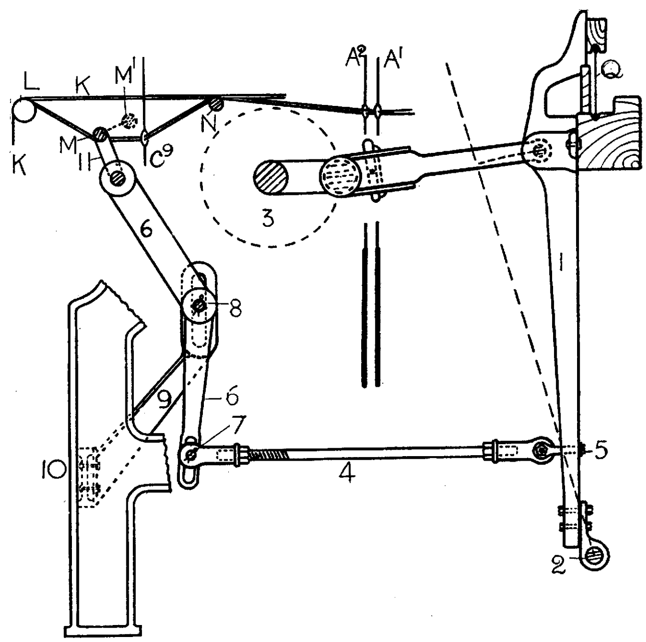


Fig. 192.

Before the operation of weaving is commenced all the crossing threads are slackened and depressed, below the normal warp line, through the medium of the lingoes, suspended from the harness C^9 and its duplicates. With each ascent of any of the doup standards B to form the gauze shed, the corresponding easing harness C is raised to ease the tension put upon the crossing warp threads, through having to form a shed between the limited distance of the back and the doup standards.

A reference to Fig. 187 shows that the same needle controls the corresponding doup standards and doup easing hooks and harness. For ordinary warps such an arrangement is ample. With very strong warps, as stated, the auxiliary mechanism must be added.

Action of the Auxiliary Easing Mechanism.

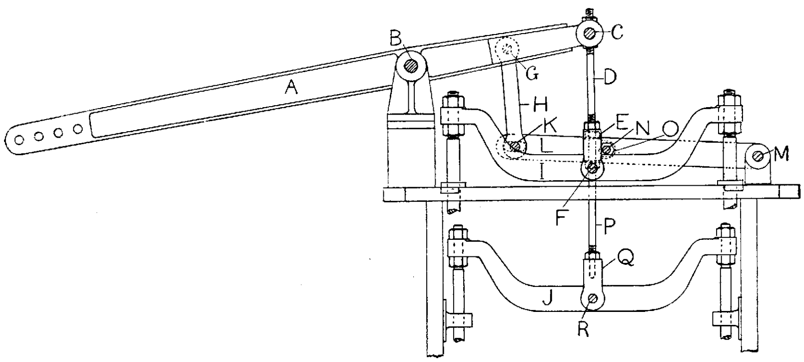
The lingoes suspended from the easing harness C^9 initially depress the crossing warp threads K to their lowest point and subsequently assist in maintaining this same position. The special oscillation of the steel bar M ensures the depression of *all* the crossing threads to the same uniform angle of depression immediately after the formation of each shed. With each forward movement of the lay sword 1, the rod 4 travels in sympathy a lateral distance of $1\frac{3}{8}''$ through the points 5 and 7. The arms of the lever 6, then partially rotate counterclockwise, an approximately similar distance, until the steel bar M is brought into contact with the surface of the crossing warp threads and thus positively ensures their deflection to the same uniform point. But as the lay sword recedes from the 'fell' for the next gauze shed, the bell crank lever 6, partially rotates clockwise, in sympathy with which the steel bar M rocks away from the crossing warp threads to the position M^1 and thus permits any of the easing harness to be individually lifted according to the requirements of the pattern. In a similar manner the operation is repeated with the most satisfactory results.

Driving the Jacquard Head and Easing Mechanism.

It has already been demonstrated that each crossing thread or threads in each group must be free to be slackened independently of the others. These threads which, as previously shown, are passed through the mails of the easing harness near to the back rail, have to be lifted simultaneously with the doup standards, but they do not require to be raised quite as much as the regular and doup harness, since it is only necessary to release the excessive strain upon the yarn during the formation of the gauze shed. It is therefore essential that the lift of the easing harness can be adjusted and modified independently of the figuring harness. This desideratum is accomplished by the addition of a supplementary head provided with two griffe blades, one for each row of easing harness. These lift or leave down the uprights supporting the easing harness according to pattern.

Fig. 193 shows in elevation the connection of the main Jacquard and supplementary heads with the ordinary lifting lever.

Fig. 193.



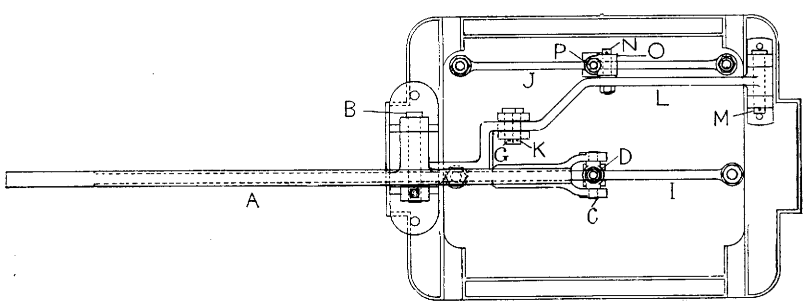


Fig. 194.

Fig. 194 is a plan of these same details. The same letters in each diagram refer to corresponding details. A is the reciprocating head lever pivoted at B, and connected after the usual manner to the crank shaft. A stud C combines through an adjustable swivel link and rod D, a second swivel link E and stud F with the main cross head I. A stud and bracket G in lever A, midway between B and C, support a spindle H, in turn compounded through stud K with the lever L pivoted at M. A stud N passes through the lever L and supports a swivel link O and a rod P which combines through the swivel link Q and stud R to support the *supplementary* cross head J.

The constant rotation of the crank shaft reciprocates the head lever A about the pivot B, and through the mechanism described above simultaneously lifts the two heads I and J on every pick.

The respective distances which the heads I and J traverse may be calculated when the following particulars are known.

Throw of eccentric crank = 10″; length of left arm of lever A B = 28″; distance C B = 12½″; distance G B = 7″; distance K M = 23½″ distance N M = 17″.

(1) Then lift of main head

$$= \frac{\text{(Throw of eccentric) (C B)}}{\text{A B}} = \frac{10 \times 12\frac{1}{2}}{28} = 4\tfrac{1}{2}''$$

(2) And lift of supplementary head

$$= \frac{\text{(Throw of eccentric) (G B) (N M)}}{\text{(A B) (K M)}} = \frac{10 \times 7 \times 17}{28 \times 23\frac{1}{2}} = 1{\cdot}8''$$

which it will be observed is less than half the distance traversed by the main cross head I. The calculated traverse of the head is always slightly in excess of the actual depth of the clear warp shed, which in the foregoing example is actually 4″.

Transferring the Design on to Point Paper.

Point paper designs have necessarily to be prepared in such a manner as will facilitate the work of the card stamper. It is important to note that the doup standards B^9 and B^{10} and back standards A^1 A^2 A^5 and A^6 (Fig. 187) which control the crossing threads are *never* required to be raised on the same pick of weft in any part of the pattern, see Fig. 191. It therefore follows that *each* crossing warp thread can be represented on the point paper by a single longitudinal division of small squares, irrespective of whether it must be lifted on the right, by the doup standard, or on the left, by the back standard. It is therefore only necessary on each pick, on the point paper, to indicate the elevation of each crossing warp thread by a given mark for the doup standards and a different kind of mark for the back standards. This arrangement obviates any distortion of the pattern when disposed on the point paper and simplifies the transference of same. The development of the non gauze section of the pattern is therefore unaffected in any way.

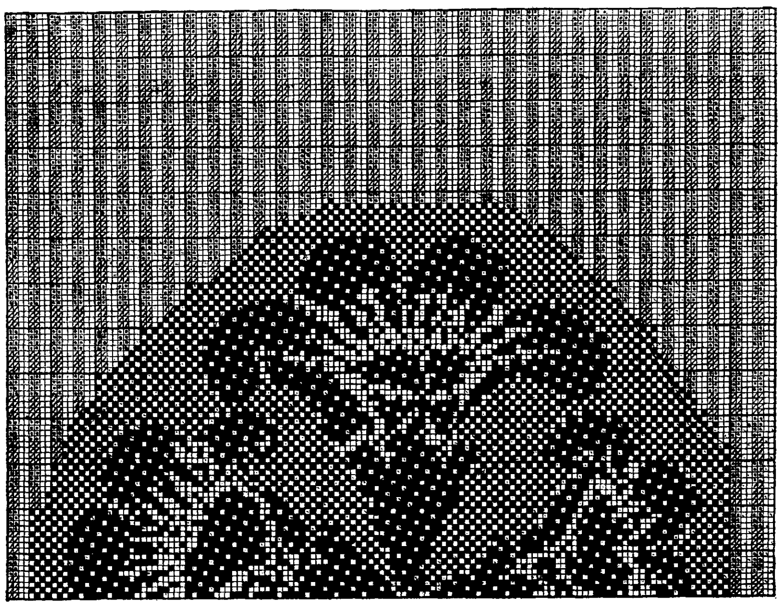


Fig. 195.

Fig. 195 shows a portion of a gauze brocade fully developed on 8 × 8 point paper. The flower is bound in five end sateen, the outline of the figure is plain and the ground is composed of gauze—2 threads crossing 2 for 4 picks of weft. The 4 picks in each shed in the gauze are necessary to balance the sateen weave and brocade figure. The solid squares thus ■, represent the weft on the surface of the cloth; the marks thus [/], the elevation of the doup standards and [·], the back standards. The card cutting instructions are therefore as follows:—Cut white in figure and plain and marks [/] and [·] in the ground.

The Leno Jacquard usually contains 10 rows of needles and a like number of rows of holes in the card cylinder as illustrated in Fig. 187. The first and last rows of needles connect and control the doup standards and easing uprights. The remaining eight rows are connected to and operate the back and regular harness standards. This arrangement permits the card stamper to cut the pattern for the ordinary figure portion of the design by working the four fingers on each hand, over the back keys of the piano card stamping machine in the usual manner. (See Card Stamping, Part IV.) The two keys which control the card punches for the doup standards are in front of the keyboard, on the piano machine, and these the card stamper operates with his thumbs.

Figuring with One Doup and an Ordinary Jacquard Mounting.

Simple brocade and geometrical effects of pattern may be produced on a plain gauze or other limited gauze ground by employing only one doup in front of an ordinary full harness mounting.

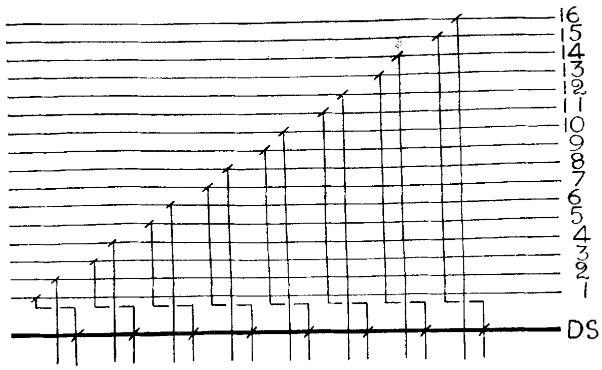
If two, three or four doups are used along with the Jacquard mounting, the production of variety and elaboration of effect may be so extended as to suggest a full harness mounting with independent doups.

Fig. 196 shows the draft and order of douping with one doup in front of a single lift 400 Jacquard machine. The first 16 threads only are shown, since the remainder are all similarly treated. The longitudinal lines represent the warp threads and the transverse lines—1 to 16, the harness mails; D S indicates the doup standard and the doup placed immediately in front of the harness.

The warp threads are first drawn through the harness in the usual and regular order, as indicated by the markings where the horizontal and vertical lines intersect, Fig. 196. Each of the *odd* threads counting from the left, is then *crossed* under the opposite side of the adjacent even threads and then 'douped,' *i.e.*, drawn through the half heald or slip. All the slips are on the same half heald and passed through the mails of the same doup standard. They must therefore all rise or fall together, either in sympathy with, or without the doup standard.

With the foregoing completed draft, any of the following combinations of figure may be produced. (1) Plain gauze contrasted

Fig. 196.



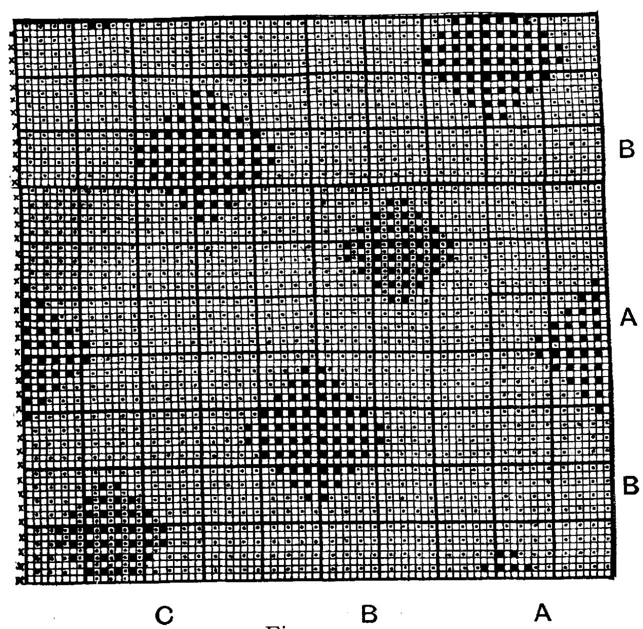


Fig. 197.

with plain weave in large or small masses, up to the limit of the figuring capacity of the Jacquard machine. (2) Plain gauze interchanged with either warp or weft figures and plain weave.

The attainment of the foregoing and many other modified results, involves careful attention to the following fundamental technical points.

(1) Whenever the elevation of the doup standard is followed by the elevation of the back standard a gauze crossing results, *e.g.* If the doup standard is lifted on the odd picks and the back standard on the even, a plain gauze structure is formed.

(2) Whenever the elevation of the doup standard is followed by the elevation of the regular standard, no gauze *crossing* results, *e.g.* If the doup standard is lifted on the odd picks and the regular standard on the subsequent even picks, ordinary plain weave is the result, but with the crossing thread working on the gauze side all the time.

(3) If the doup standard and any of the regular standards are lifted on the odd picks, followed by the elevation of any two or more adjacent back and regular standards on the even picks no interlacing of any kind occurs, and hence a warp figure will be formed on the surface of the cloth.

(4) A weft figure is obtained by weaving the cloth face downwards.

Then, since the production of figured patterns on a gauze ground for the draft given, involves the application and simultaneous combination of the foregoing fundamental data, the doup standard must rise on every alternate or odd pick, after which on each succeeding pick the back standards of each *group* must be selected for elevation where gauze texture is required, but on the same even pick where plain weave is necessary, the regular standards must be lifted, whilst if any portion of the pattern must consist of warp figure, the back and regular standards must be raised on both picks and repeated to suit the pattern.

Fig. 197 is a fully developed point paper design for a small figured pattern produced to demonstrate and suggest the inherent possibilities of the above principle. The gauze portions of the design are marked A; the ordinary plain weave part B; the warp or weft figure C; the lifting marks for the doup standard X; the back standards ■ and the regular standards ⊡.

Relative Balance of Structure and Combinations of Gauze and Ordinary Weave Interlacings.

The difference in balance of structure of woven cloths of gauze with ordinary methods of interlacing is considerable, for which reason some observations at this juncture will not be out of place. It is desirable, however, to avoid any undue trespass, though otherwise a welcome and inspiring task, into the region of gauze designing—a field unlimited in its possibilities.

The subjoined facts should nevertheless be known by all users of Leno Jacquards and especially where only one or two doups are employed with ordinary Jacquard mounting.

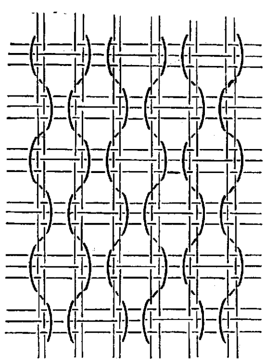
The *ordinary and plain* method of interlacing the warp and weft threads, produces the *lightest* weight of fabric which can be made compatible with the same perfect balance of structure and for the same quality, thickness and counts of yarn.

A *lighter* weight fabric for the same relative perfection in balance of structure can be produced, with the same yarns, but fewer in number, when the *plain gauze* method of interlacing is substituted. This result is primarily due to the partial twisting of the yarns round each other, which not only keeps each distinctive group of threads apart, but also obviates any tendency on their part to 'slip' over each other and so close up the open or net-like spaces between each group of threads. It will now be manifest that if plain cloth and plain gauze are woven together in the same fabric, with the same yarns and number of ends and picks, the balance of the two will not agree. These weaves can only be used in combination, either when frequent changes occur or when the mass of pattern of the one weave is great as compared with that of the other.

If the plain part of the cloth is normally perfect in balance of structure, the gauze part will be tight and present a somewhat *drawn* appearance. On the contrary, if the number of warp and weft threads, be arranged to suit the gauze plan, the ordinary plain weave, with the same setting will be loose and flimsy in handle and appearance.

The knowledge of these facts makes it imperative in all combinations of gauze and ordinary weaves to introduce some structural modifications. (1) By decreasing the relative number or thickness of the yarn in the gauze crossings until the two types of cloth just balance each other in structure; this plan can be satisfactorily adopted when gauze stripes are required.

Fig. 198.



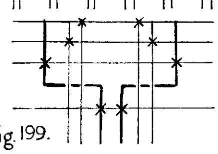
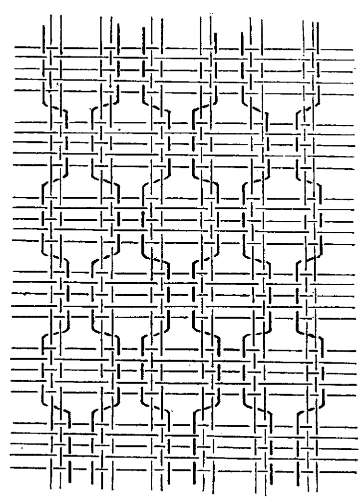


Fig. 199.

Fig. 200.



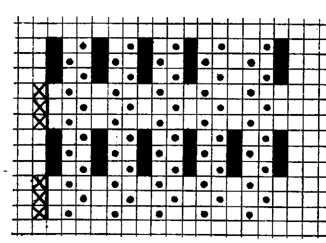


Fig. 201.

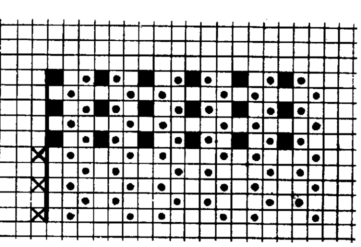


Fig. 202.

(2) By grouping two or more warp threads together and operating them as one in the gauze part of the pattern and inserting two or more shots of weft into each shed in the same gauze part; this is the most suitable plan for brocade patterns.

Experience has demonstrated that two threads of warp crossing two threads of warp with the insertion of three shots of weft in the gauze portion of any figured design approximately balances the plain weave in the same cloth. Larger groupings are necessary for combinations with weaves other than plain (see Fig. 195).

(3) By employing a thick thread in lieu of two or more of the normal threads and crossing it under two or more ends for any given number of picks. The picks and ground warp threads interlace as in ordinary plain weaving. In some instances the thick gauze warp weaves plain on both sides of the crossing.

Fig. 198 is a plan view of the *gauze section* of a figured stripe. The figured part (not shown) is composed of ordinary weave interlacings. The gauze part is 'point' drafted as illustrated at Fig. 199.

Fig. 200 shows a plan view of the gauze portion of a figured stripe, when the thick crossing threads weave plain on each side of the crossing.

Figs. 201 and 202 show a few repeats of the weave for the stamping or card cutting for gauze sections of Figs. 198 and 200 respectively. The marks [x] indicate the lifting of the doup and doup standards; the marks ■ the back standards and the marks [·] the regular standards.

CHAPTER XIV.

The Gauze Reed and Jacquard.

THE combination of the gauze reed with the Jacquard is designed to produce an embroidered effect of pattern on a plain gauze ground.

The gauze reed produces the perfect gauze crossings without the aid of the usual doups and doup standards. The Jacquard simultaneously produces the ornamentation independently of the gauze reed.

The foregoing combination of mechanism is chiefly employed to weave a type of cloth defined as *Madras muslin*, the warp of which is usually fine cotton and combines with a similar fine cotton weft to produce the gauze texture. A thick and soft twisted cotton weft is used for the ornamentation effect. It is interwoven in plain or modified plain weave order in given portions of the cloth to suit some predetermined pattern. In the remaining portions of the cloth where no ornament is required, the thick weft floats freely over the surface of the web; these loose floats are all cut off after the weaving process has been completed. The resultant effect is a closely woven figure on a loose, open and net-like ground texture.

For purposes of variety, especially when required for window curtains, two or more coloured figuring wefts are introduced.

Fig. 203 is a photographic representation of a Madras muslin woven with two figuring wefts. The photograph is taken from the cut or figure side which is in greater visible relief and is frequently classed as the face. The uncut side is usually neater in appearance and clearer in definition of outline for which reason it is finished for the 'face' when the material is to be used for dresses. The fabric can be woven with the floats on the surface or at the back of the cloth; the former method, which is the usual, is both better for the warp yarn and the Jacquard machine.

Fig. 204 is an enlarged plan view of a figured Madras muslin woven with only one figuring weft and Fig. 205 is a similar view of a second fabric woven with *two* coloured figuring wefts.

Fig. 206 is a transverse section through the weft of the former. A represents the gauze warp threads; B the regular warp yarn; C the ground weft; D the first extra or figuring weft; E and E^1 the two figuring shots (Fig. 205). These letters are common to the warp and weft yarns throughout this chapter.

Fig. 203.

Fig. 207 is a sectional elevation of the web, reeds, harness and lease rods when the figuring shed is formed.

Fig. 208 shows the same details when the gauze or ground shed is formed. F indicates the lease rods; G the harness mails and lingoes; H a 'tug' reed, 5″ deep, free to move laterally; I a dipping bar or easing rod, free to rise and fall at will; J a specially constructed reed, also free to rise and fall at will, denominated the 'gauze reed' which constitutes the chief feature of this system of weaving. The ordinary, final and fixed reed is shown at K.

A detached and enlarged sketch, in perspective, of the gauze reed is shown at Fig. 209. It consists of an ordinary reed with the addition of *half* dents fixed in the lower rib of the reed. The half dents are pointed at the top and project slightly in front of the ordinary dents; they are perforated near to the points. For full constructional details see Figs. 217 to 221. The crossing warp threads A pass from the lease rods F consecutively through the harness but *not* through the mails, then under the easing rod I and tug reed H, through the eyes in the half dent of the gauze reed J, and finally through the fixed reed K to the web. The regular threads B pass in consecutive order through the mails of the harness G, the tug reed H, the gauze reed J and then through the *same* splits in the common reed K, which contain the adjoining crossing threads A with which each respective warp thread B twists.

Fig. 210 illustrates the order of drafting and reeding of the warp threads from the harness mails G to the fixed reed K.

Fig. 211 is a small geometrical figure design, fully prepared on point paper, for fabrics woven with only one figuring shot, as Fig. 204. The marks represent the figuring warp raised.

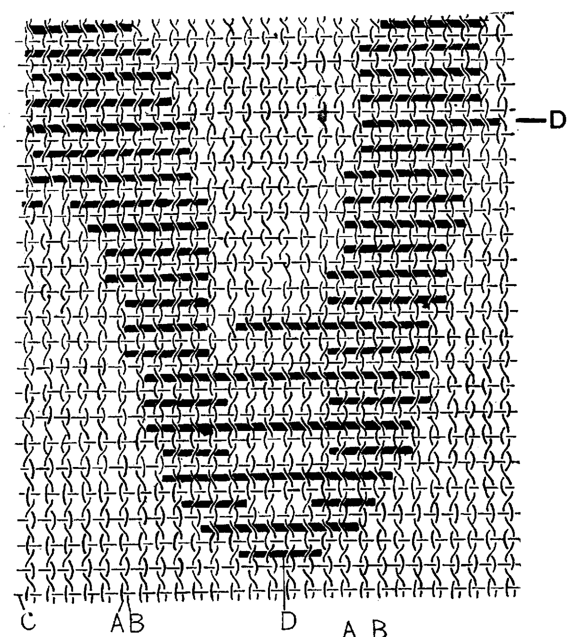
The card cutting instructions are as follows:—On each figuring pick and figuring end, controlled by the Jacquard harness, cut all black, insert the figuring weft, which consequently passes under all the figuring warp threads B, and over all the ground threads A in the figure portion of the pattern, but floats freely on the surface of the ground texture, where no figure effect is required.

The Jacquard head must therefore be controlled to rise, and the card cylinder to strike, only on the figuring shots.

Briefly, the operations of weaving with one shot of ground, alternately with one shot of figure, is as follows:—

First pick:—Gauze ground. Leave down all the harness G with threads B, pull tug reed H slightly to the left so that each thread B

Fig. 204.



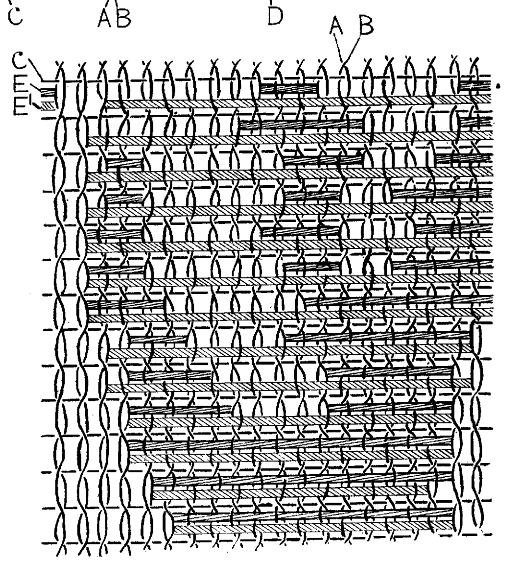


Fig. 205.

moves to the left of each respective thread A in the same split; lift the easing rod I and the gauze reed J with the crossing threads A, which therefore rise on the right side of the regular threads B; insert the ground weft C, depress the easing rod I and the gauze reed J, and beat up the weft.

Meanwhile the tug reed H automatically moves laterally from the left to the right, carrying with it each thread B to the right and normal side of each adjoining and respective thread A. (Fig. 210).

Second pick:—Figure. Lift all the harness G with threads B where the ornament is required; insert the thick figuring weft.

Third pick:—Gauze ground. Repeat first pick, except that the tug reed with B remains normally on the right. The gauze threads A therefore rise on the left side of those of the regular threads B.

Fourth pick:—Figure. Repeat the second pick. Continue the sequence of operations, only varying the lifting of the harness G on the figuring shot to suit the varying ornament.

Details and Operation of the Gauze Reed Mechanism.

The details of the mechanisms which operate the gauze and tug reeds, the easing rod and shuttle boxes are fully illustrated at Figs. 212 to 215 inclusive.

Intermittent Reciprocation of the Gauze Reed.

The gauze reed must rise and fall on every gauze or ground pick and remain at rest, in its lowest position, during the insertion of each figuring shot of weft. The required intermittent reciprocation is controlled from the lay of the going part combined with the shuttle box mechanism.

Fig. 212 is a front elevation of the suspended gauze reed.

Fig. 213 is a side elevation of the controlling details as viewed from the left hand side of a right hand loom.

The position of the parts in Figs. 212 and 213 represents the reed in its highest position.

Fig. 214 shows the same side elevation and parts when the gauze reed is in its lowest position and the figuring shot is being

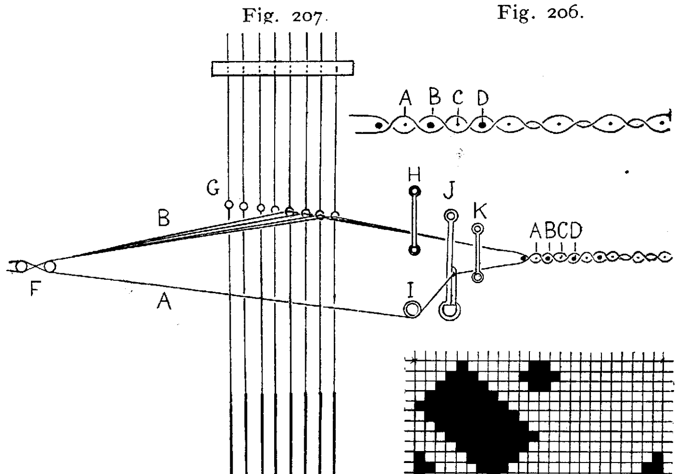


Fig. 207.

Fig. 206.

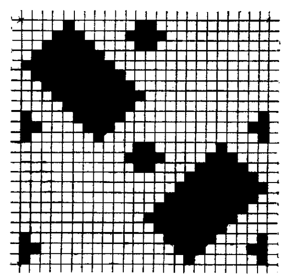


Fig. 211.

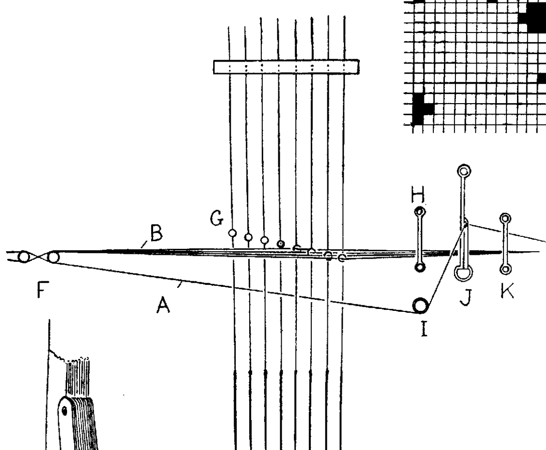


Fig. 208.

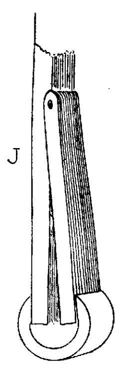


Fig. 209.

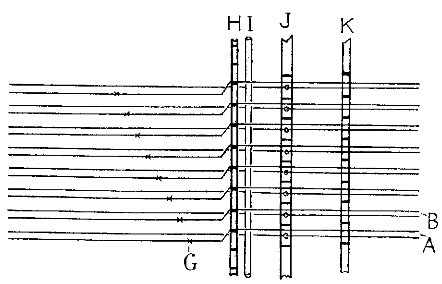


Fig. 210.

inserted. - The letters indicate parts that have already been detailed and similar numerals in the three diagrams refer to corresponding parts.

The gauze reed J is suspended by leather straps and buckles 1 and 1^1 from two bell crank levers 2 and 2^1 pivoted on studs 3 and 3^1 which are fixed into the top cross rail of the loom. A connecting rod 4 combines the bell crank levers 2 and 2^1, through studs 5, 5^1 and 6 with the bell crank lever 7 pivoted on the fixed stud 8. A stud 9 combines the lever 7 with a swivel link 10 in turn combined through stud 11 with an adjustable reciprocating rod 12, the lower part of which passes freely through a guide bracket 13 secured to the loom gable. A stud 14 combines the rod 12 with a bell crank lever 15 pivoted on the fixed stud 16. The upper and vertical arm of lever 15 is bent over at the top to form a 'hook' as at 17. A 'tongue' projection 18 compounded with an angle iron 19 is free to be kept up and enclosed with the hook 17 or depressed at will; the angle iron 19 is secured through bolts and nuts 20 and 21 to the shuttle boxes 22 compounded with the lay of the going part and the box spindle 23 adjusted in tube 24, in turn pivoted on the stud 25. This stud combines the tube 24 and spindle 23 with the simple balk lever 26 fulcrumed on the shaft 27 which passes underneath the loom to support and control duplicate box mechanism, at the opposite and right hand side of the loom. The left arm of lever 26 is combined through stud 28 and link 29 with a stud pin 30 which passes through the disc collar 31 in close contact and at right angles to the periphery of a disc plate 32, see Fig. 215. The collar 31 circumscribes the disc plate 32 which is set out of centre and compounded and free to rotate with a stud shaft 33. The stud shaft 33 is compounded with and rotated, according to pattern, by a clutch wheel, under direct control of the pattern cards. The pin 30 in collar 31 is linked to a second clutch wheel under similar but independent control. This double eccentric and compound arrangement is known as Whitesmith's patent; it controls and operates the four shuttle boxes.

Fig. 215 shows four relative positions of the stud pin 30 and eccentric 32 with the fixed centre 33, which operate to place the

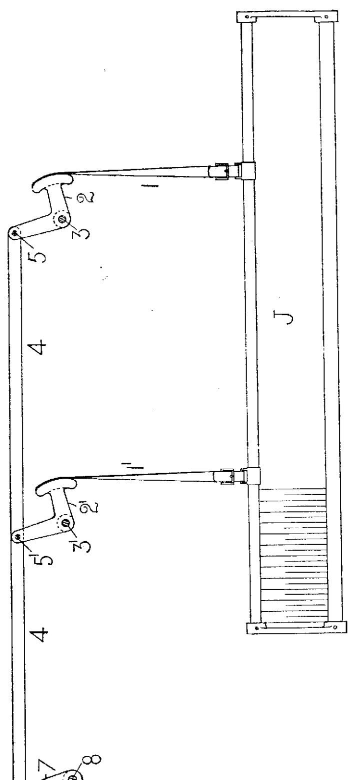


Fig. 212.

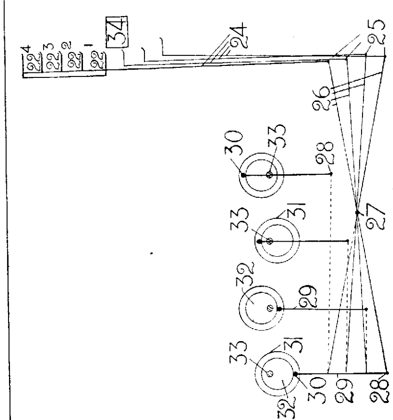


Fig. 215.

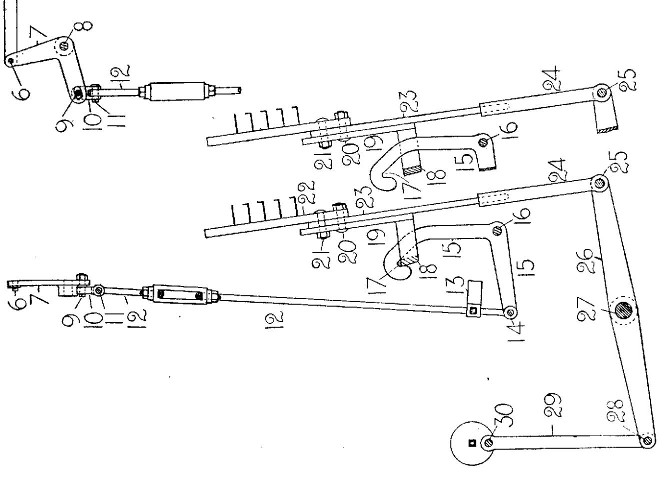


Fig. 213. Fig. 214.

respective shuttle boxes 22^1, 22^2, 22^3 and 22^4 level with the shuttle race 34 as required by the pattern.

Action of the Mechanism.

With the movement of the lay and shuttle boxes 22 towards the harness, the tongue 18 in angle iron 19, presses against the left side of hook 17 at the top of lever 15, and rocks the last, counter clockwise so that the horizontal arm of lever 15 descends and depresses in sympathy the parts 14, 12, 11, 10 and 9, which operate to rock the bell crank lever 7 counter clockwise, and through the lateral movement of rod 4, simultaneously to rock the levers 2 and 2^1 counter clockwise, which elevate through straps 1 and 1^1 the gauze reed J.

The forward movement of the lay and boxes reverses the action of these enumerated parts, which thus permits the gauze reed to fall by gravity to its lowest position. It is, however, suitably checked as indicated at Fig. 216.

The bottom box chamber 22^1 usually contains the ground or gauze weft, and the second, third and fourth chambers the figuring wefts, according to the number required in the pattern.

Then, when the figuring weft D is required the shuttle boxes descend until the chamber 22^2 is level with the shuttle race 34. This depression of the shuttle boxes lowers in sympathy the angle iron 19 until the tongue 18 is clear of the hook 17, Fig. 214. Consequently as the lay and boxes recede towards the harness, no influence is exercised on the lever 15, nor, through its connections, on the gauze reed J, which therefore always remains down during the insertion of the figuring weft.

The Easing Rod and its Action.

Fig. 216 shows in elevation the combination of the easing rod and the gauze reed, which operate in sympathy. The ends of the gauze reed J contain solid round studs 35, which are enclosed and free to reciprocate in a slot 36, formed in the fixed bracket 37. A stud 38 combines a link rod 39 through stud 40, with a simple lever 41 pivoted at 42 in the bracket 43, compounded with the loom rail 44. A stud 45 combines the lever 41 through rod 46 with the easing bar I.

It will now be manifest that with each ascent of the gauze reed J and the crossing warp A (Fig. 208), the rod 39, lever 41, rod 46 and the easing bar I will ascend in sympathy; the easing bar I simultaneously releases the tension on the crossing warp threads A. Conversely when the figuring shed (Fig. 207) is being formed by the Jacquard harness, this same bar I descends in sympathy with the gauze reed, and depresses the crossing threads to their lowest and uniform level.

Constructional Details of the Gauze Reed.

The additional and complete details of this special reed are fully illustrated as follows:—Fig. 217 shows a front elevation, partly in section, of the left hand side of the gauze reed. The reed proper with the ordinary and half splits is shown at J; the top and bottom balks are encased in strong steel tubes L combined with equally strong steel ends M. Split pins N are passed through the tubes L and the reed J as shown. A special suspension clip O is set screwed to the upper tube L; a transverse section of this detail is shown at Fig. 218.

A sectional elevation of the complete reed is supplied at Fig. 219.

Fig. 220 shows a front elevation of the reed on the right hand side, and provided with an alternative suspension clip P, a transverse section of which is shown at Fig. 221.

Tug Reed Reciprocating Mechanism.

The tug reed, in most respects, is like an ordinary reed. Each end of it is strengthened by the insertion of a strong steel plate about $\frac{3}{4}$ inch wide. The support, control and action of this mechanism is fully illustrated at Figs. 222 to 225 inclusive.

Fig. 222 is a front elevation of the tug reed and its lateral supports.

Fig. 223 is a side elevation of the operating mechanism.

Fig. 224 is a similar but enlarged view of part of the same details.

Fig. 225 is a plan of part of these details.

Similar numerals refer to corresponding parts.

The tug reed H is supported laterally in its normal position, by two horizontal forces, acting in diametrically opposite directions. Perforations are made in the steel ends of the reed, and an iron hook 48 is passed through the hole at the right hand side of the reed and linked through the medium of a strong helical spring 49 to an adjustable hook 50, bolted fast to a bracket 51 in turn fixed to the loom gable. The opposite or left side of the reed is supported by a hook 52 combined with a leather strap 53. This strap runs over a loose flanged pulley 54, free to rotate on the stud 55 and bolted fast to the bracket 56 in turn compounded with the loom gable. The strap 53 is combined with an adjustable swivel link 57 to a simple lever 58, pivoted at 59 in a fixed bracket 60. The free end of the lever 58 carries an antifriction roller 61 which is kept in rolling contact with an oval shaped cam 62 compounded with a square prism 63, centred and free to rotate on the common stud 64. A rod and hammer 65, supported in a fixed bracket 66, is kept, through the action of a spiral spring 67, in close contact with the square prism 63 to obviate any tendency on its part to rotate too far. A small bracket casting 68 is adjusted by the set screw 69 to the vertical and reciprocating rod 12 (Fig. 213). A stud pin 70 fixed in the bracket 68 supports a small swivel lever 71 which is free to oscillate about the stud 70 but normally rests in contact with the bottom right shoulder of the square prism 63.

Action of the Mechanism.

The tug reed H is normally at rest on the extreme right of its lateral traverse through the constant influence of the spiral spring 49. The position of the reed as represented by the positions of the movable parts, in the illustrations Figs. 222 to 225, is at the extreme left side of its lateral traverse. Then, with each *ascent* of the rod 12 to depress the gauze reed J, the casting 68 rises with the swivel lever 71, the free end of which presses against the bottom right shoulder of the square prism 63 and rotates it, together with the cam 62, one quarter of a revolution whilst the hammer 65 and spiral spring 67 prevent an excess of rotation. The cam 62 then assumes a position (as shown by the dotted lines, Fig. 223) which permits the bowl 61, lever 58 and rod 57 to rise and the strap 53 to pass freely over the roller 54, which in

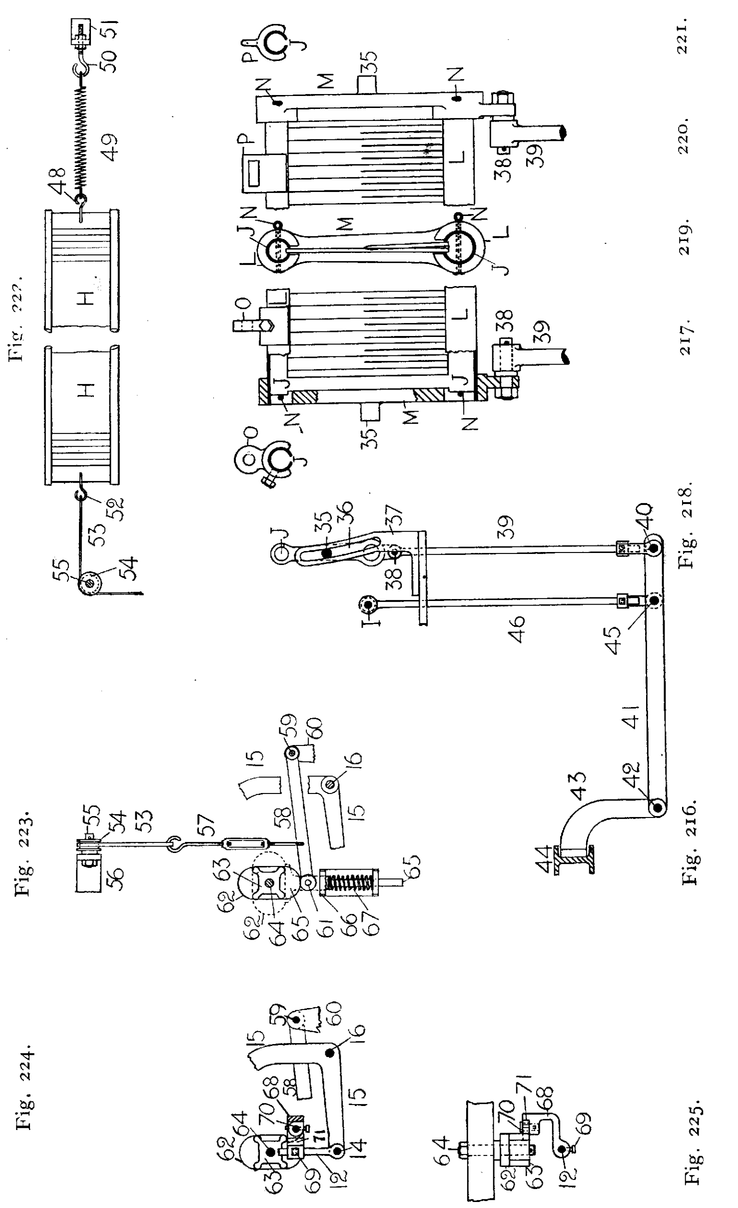


Fig. 216. Fig. 217. Fig. 218. Fig. 219. Fig. 220. Fig. 221. Fig. 222. Fig. 223. Fig. 224. Fig. 225.

turn permit the reed H under the influence of the spiral spring 49, to return to the extreme limit of its traverse to the right, causing the regular and non-gauze threads B to move over to the right of threads A in the half dents of the gauze reed J (Fig. 210). This reed then rises as heretofore described to produce the gauze ground texture and the rod 12 *descends* carrying with it the casting 68 and the swivel link 71 which swivels clockwise about the stud 70 until the swivel lever is clearly below the bottom right shoulder of the square prism 63. Then, with the next ascent of the rod 12 the swivel lever 71 rotates the prism 63, a further quarter of a revolution and turns the cam 62 into the position shown in the diagrams. The bowl 61, lever 58 and link 57, through the strap 53, pull the tug reed H together with the threads B to the left preparatory to the next gauze crossing.

It will thus be seen that when the *gauze reed* is *stationary*, the *tug reed* must also of necessity remain normally *at rest* as for example, when the figuring shots of weft are being inserted.

CHAPTER XV.

The Swivel and Jacquard.

The swivel is an adjunct to the loom ; it is most advantageously and effectively employed in conjunction with the Jacquard machine, and is introduced to weave small spot effects of colour, which are distributed by the aid of the Jacquard or other shedding apparatus over a plain or figured ground.

Extra Warp and Weft Figures.

The common method of distributing these extra spot effects is by using additional coloured *warp* or *weft* threads and floating them upon the surface of the texture at suitable places, so as to give any desired effect. The different kinds of extra warp or weft threads are expressly introduced for the ornamental details of the design, and when not required upon the surface are floated loosely on the back of the texture to be afterwards cut off, or are fastened to the ground cloth at suitable distances apart. In backed and double cloths, the extras are frequently made to float in between the two fabrics at those places where they are not required for figuring.

Relative Advantages of Extra Warp and Weft Spotting.

The relative and comparative advantages of warp and weft spotting may be defined as follows:—When spotting with extra warps no extra shuttles are necessary, and consequently the web can be woven in the minimum of time; no additional pattern cards are required but two warp beams are requisite, and the extra warp yarn must be crammed into the same splits in the reed as the ground warp. When spotting with extra weft a relatively less costly yarn may be employed as compared with that for warp spotting; the figuring capacity of the Jacquard machine is not reduced as is the case when extra warp is used, and only one warp beam is required. The introduction of extra wefts retards the output pro rata with the increase in the number of shots of extra weft as compared with the number of ground picks in each repeat of the spot pattern.

Either of the foregoing methods, it will be perceived, is wasteful of the figuring material, and generally most expensive.

Object and Advantage of Swivel Weaving.

The primary advantage of the swivel is that it practically only uses as much of the extra figuring material as the pattern requires. When displayed in the woven fabric it presents the appearance of an *extra weft*.

The swivel may be used for spotting either single or double cloths, including brocades, dress materials and vestings.

Spotting Brocades and Figured Fabrics.

Fig. 226 is a small figured dress goods design; the detached figure is arranged in simple drop order; the centre of the flowers is spotted with silk weft by the aid of the swivel mechanism illustrated and described on pages 229 to 244. The design is fully developed on 192 ends and picks as a weft sateen figure on a plain ground, and the figure is spotted with an extra silk weft as indicated by the solid marking, thus :— ■. The cloth and pattern are woven face downwards. The distance between contiguous swivel shuttles in this example is *two* inches. The figuring capacity of the Jacquard machine is 400 hooks and 100 harness cords per inch, reduced to 384 hooks and 96 ends per inch to suit the given figure design.

The full details of weaving are as follows :—

Warp.	50s warp twist cotton. 96 threads per inch.
Weft.	50s weft ,, 96 ground shots per inch.
Swivel Weft.	30/2 spun silk, woven pick and pick with the ground shots in the positions indicated in the fully developed point paper design. Fig. 226.

The card cutting instructions for the given pattern are :—

1. Cut all white and insert the cotton weft on the ground picks.

2. Cut marks ■ for the swivel cards and lace them alternately with the ground cards; insert the swivel weft alternately with the ground shots and cards.

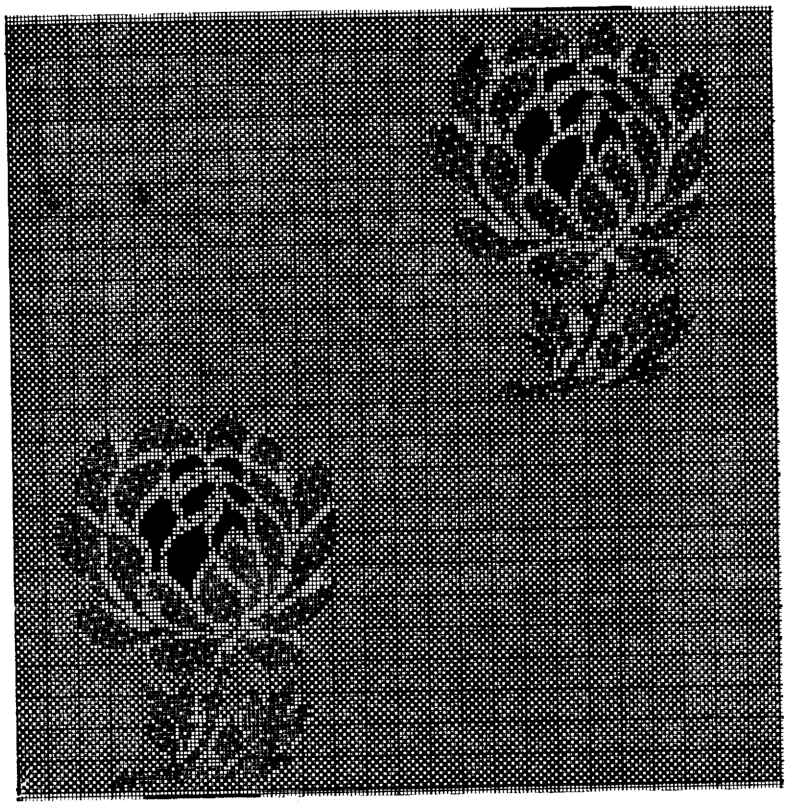


Fig. 226.

Compound Vesting Spotted with the aid of the Swivel Mechanism and Jacquard Mounting.

The decoration of vestings usually consists of a series of small spots or minute figures judiciously arranged and composed of bright coloured yarns such as silk, mohair, etc., upon a wool, cotton or linen surface. The ground weave of the texture is generally some standard make or a simple and effective design, enhanced in value by the combination of two or more weaves to produce a check effect of pattern, which is then spotted with the special colouring threads to suit. It is the introduction of the coloured threads which gives to the fabrics their special features, and furnishes a field for the designers ingenuity in the disposition of the small coloured spots, and in making them distinctly visible on the surface of the texture.

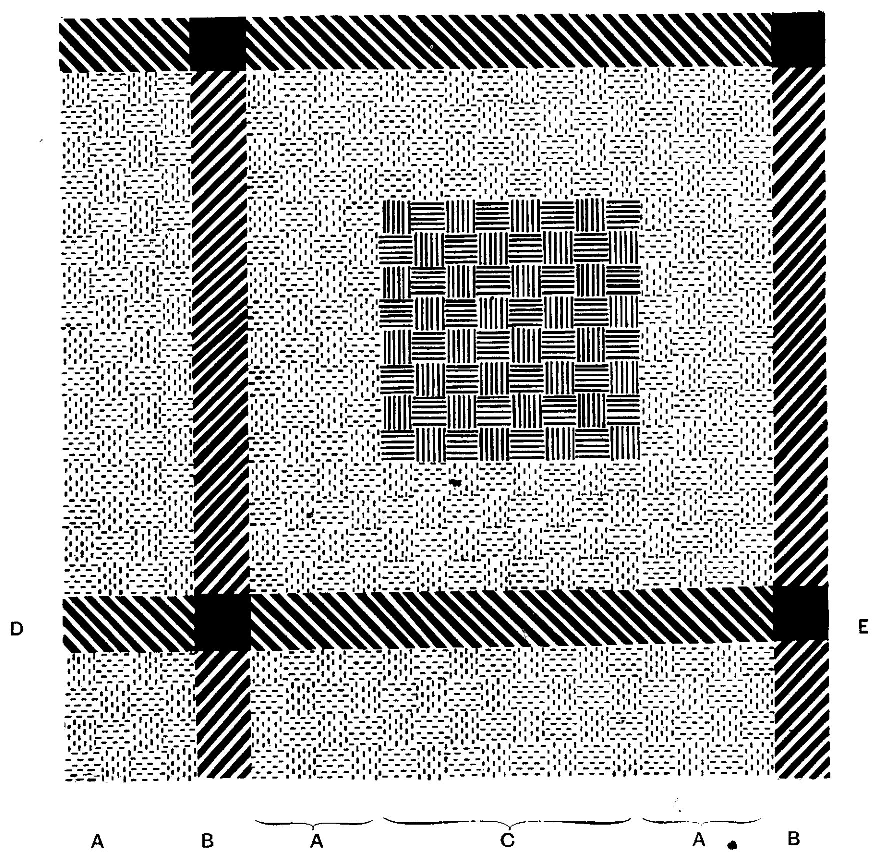
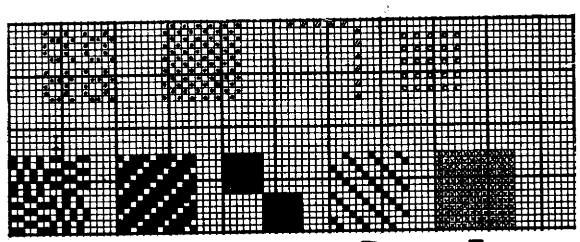


Fig. 227.

If the coloured spotting threads are used with compound weaves, the more thoroughly the designer is conversant with the fundamental principles of backed and double cloth designing, the greater will be his opportunity for obtaining the best results, both as regards decoration and construction, though fairly good results may be obtained with only a limited knowledge of backed and double cloth structure.

Figs. 234 235 236 237



A B C D E

Figs. 229. 230. 231. 232. 233.

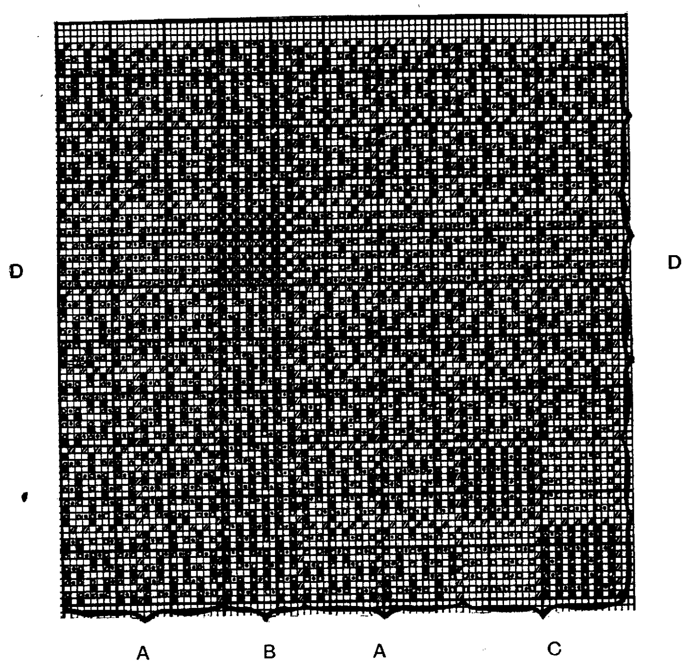


Fig. 228.

Fig. 227 is a sketch plan of the face effect of a compound woven vesting fabric.

Fig. 228 is the fully developed point paper design.

The fabric is woven with *one* end and pick of face to *one* end and pick of back, exclusive of *seven* extra swivel shots. There are *four* effects of pattern, A, B, C and D, exclusive of the swivel spot where B and D intersect, on the surface of the cloth; these represent the face weaves which are shown separately and respectively at Figs. 229, 230, 231, and 232, and the swivel effect at 233. The backing weaves for these parts are supplied at Figs. 234 and 235, the former is for the back of parts A and C, and the latter for B and D. Marks represent warp raised, except in the swivel spot where marks × represent weft on the surface of the cloth. Every *sixth* end of *backing* warp floats over each face and under each backing pick; every sixth backing pick floats over each face and under each backing end, which is equivalent to plain weave in the compound structure. The result is a perfect "cut" and a complete stitching of the two cloths on every twelve ends and picks. This cutting and binding weave is detached and separately illustrated at Fig. 236.

The different marking of these elementary weaves, Figs. 229 to 237, is retained in the compound weave Fig. 228, which incidentally, locates their respective positions.

The separation of the two cloths, by lifting all the face warp threads when the backing weft is being inserted, is represented by the marks thus, [o]. Fig. 237.

The card cutting instructions for weaving the fabric face downwards are :—

1. *For ground*, cut all white and insert ground weft.

2. *For swivel spot*, cut all marks thus [×] on the face and odd picks opposite the part D. Insert after each face pick, the swivel figuring weft.

The complete details of make for the given cloth are as follows :—

Warp	1 thread	2/10s grey fawn mercerised cotton—face	} 204 ends	
,,	1 ,,	2/48s ,, ,, ,, —back		
Set	102 threads of warp per inch			

Weft	1 shot 2/10s grey fawn mercerised cotton	face	72 times	= 144
	1 ,, 2/48s ,, ,, ,,	back		
	1 ,, 2/10s ,, ,, ,,	face	6 ,,	= 18
	1 ,, 30/2 spun red silk	swivel		
	1 ,, 2/48s mercerised cotton	back		
	1 ,, 2/10s ,, ,,	face	24 ,,	= 48
	1 ,, 2/48s ,, ,,	back		
	1 ,, 2/10s ,, ,,	face	(binding)	= 1
	Shots in one repeat including spotting shots			= 211

Swivel Mechanism.

All the essential details of swivel weaving together with its operating mechanism are exhaustively illustrated in the following diagrams, drawn to scale from Wm. Smith & Bros. swivel loom.

Fig. 238 is a front elevation of the swivel frame and swivels combined with the hand rail of the 'going part.'

Fig. 239 is a plan of the swivels and swivel frame.

Fig. 240 is an enlarged plan of one swivel and spool.

Fig. 241 is an enlarged sectional elevation through the swivel frame, swivel and spool.

Fig. 242 is a detached elevation to show the connection of the swivel shuttles with a movable rack fitted into a groove at the back of the swivel frame.

Corresponding numerals in each diagram refer to similar details.

There are sixteen swivels distributed over a width of cloth of 32″ to 33″; the pitch between each contiguous pair is 2″, including a space of about $\frac{1}{2}''$ which permits a portion of the warp to rise between each pair of shuttles. Any other convenient number of swivels may be employed to suit the pattern.

1 is the lay and shuttle race; 2 and 2^1 the ordinary shuttle boxes; 3 the hand rail or sley cap. Adjustably arranged on the top of 3 is a wood rail 4 normally at rest but free to move laterally at will. At the top and near each end of rail 4, two angle iron brackets 5 and 5^1 are fixed; these support a half-inch round iron rod 6 which

is free to oscillate in them. Set screwed to rod 6 on the inside, but in contact with each respective bracket 5 and 5^1, are short levers 7 and 7^1 which are combined through the respective studs 8 and 8^1, swivel links 9 and 9^1 and pivot studs 10 and 10^1 to the brackets 11 and 11^1. These brackets are screwed fast to the top of the swivel frame 12 which is free to rise and fall in a vertical plane. Compounded with the adjustable rail 4 are two right angle brackets 13 and 13^1, the perpendicular parts of which are smooth round spindles which pass through and are free to reciprocate in the bracket sleeves 14 and 14^1 also set screwed fast to the swivel frame 12; these are the factors which obviate any tendency of the swivel frame to deviate from a true vertical plane.

Adjustably set screwed to the oscillating rod 6 are two small segment levers 15 and 15^1. These are placed immediately over the respective horizontal arms of the brackets 13 and 13^1 against which they come in contact with each descent of the swivel frame 12 and thus serve to limit its fall.

Slotted grooves 16 are formed in the swivel frame which support the sixteen or other suitable number of swivel shuttles 17, each of which carries a small spool 18 containing the weft 19. A small brass spiral spring 20 with a smooth head constantly presses against the yarn on the spool; a second spiral spring 21 circumscribes the spindle on which the spool rotates, and constantly exercises a pressing and retarding influence on the end of the spool. The combined action of the two springs prevents any tendency on the part of the spool 18 to rotate too far, whenever the weft is being drawn from it for figuring purposes.

Independently of the swivel frame 12, the shuttles 17 are free to move *en masse*, laterally to the right or left, a distance of two inches, equal to the pitch between the shuttle centres. The details of the mechanism which facilitates this lateral movement are as follows:— A movable rack 22, with leather teeth, $\frac{1}{4}$in. pitch, is fitted into a groove 23 at the back of the swivel frame 12, Fig. 242; along this groove the rack is free to reciprocate. The leather teeth of rack 22 gear into those of a small rack pinion 24 centred and free to rotate on a fixed stud pin 25, compounded with the frame 12; the teeth of

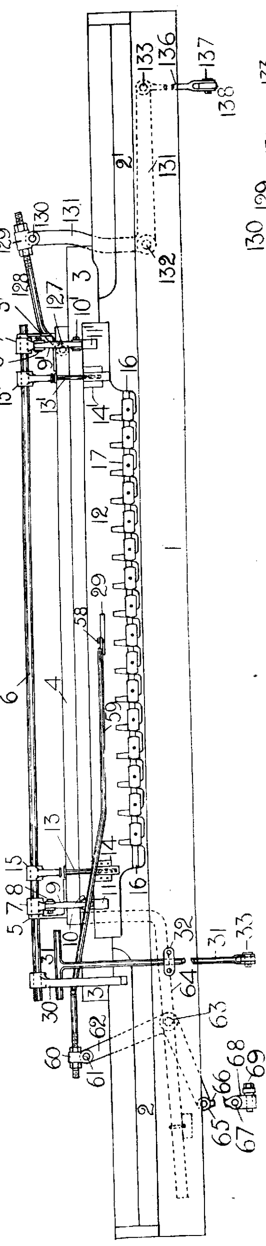


Fig. 238

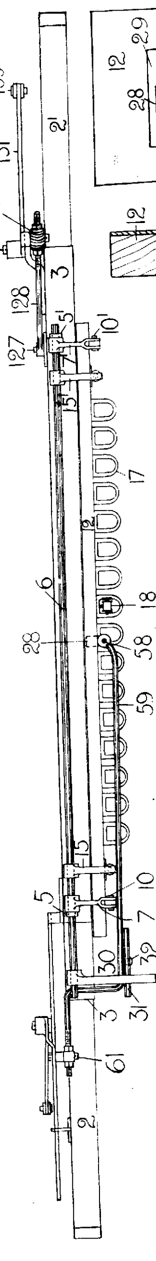


Fig. 239

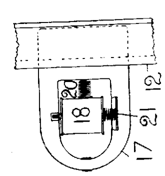


Fig. 240

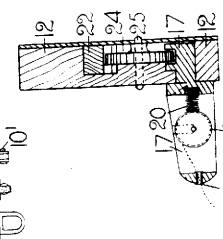


Fig. 241

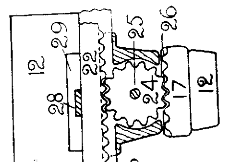


Fig. 242

the rack pinion 24 in turn, gear into the teeth of a small rack 26 compounded with the lower and rear side of the swivel shuttle 17. Each shuttle is similarly combined with and controlled by the rack 22. This rack is combined with a projecting flat iron plate 28, which passes through a slot 29 in the swivel frame 12 in which slot it is free to be reciprocated as subsequently described.

The swivel frame always contains one slotted division more than there are swivel shuttles in use, consequently whenever the shuttles are moved laterally to the left side of the swivel frame the extreme division on the right is empty, and vice versa.

Requisite Action of the Swivel Frame and Shuttles.

Whenever a shot of weft is required from the swivel shuttles, the Jacquard machine must select for lifting according to pattern, those threads under which the extra weft must float. The warp threads selected for elevation can only be from among those threads which are directly in the same vertical plane as the spaces between the contiguous shuttles 17. Then when the lay of the going part is travelling towards the harness, and the figuring shed is gradually forming, the swivel frame 12 together with the shuttles must simultaneously descend until the shed is completely opened and the frame is fully down. During the period which the shed usually remains open, the swivel shuttles, independently of the frame, must be made to travel laterally to the right or left. Then as the lay travels towards the fell of the cloth, the frame 12 must gradually rise to its highest and normal position.

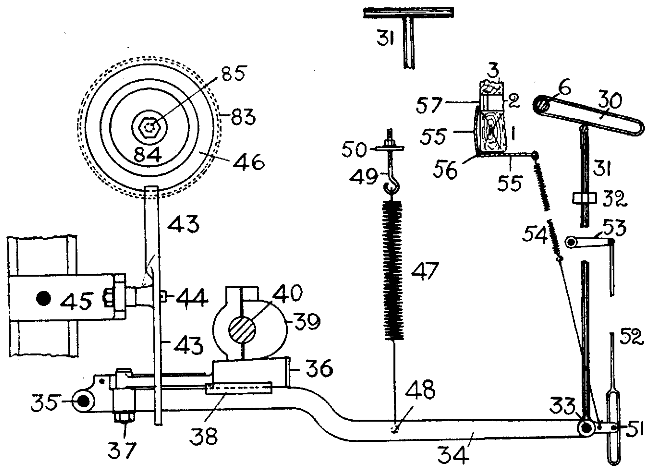
During each insertion of the extra flowering shots, the ordinary picking motion must be automatically thrown out of action.

Details of Swivel Controlling Mechanism.

Vertical Reciprocation of the Swivel Frame.

The mechanism designed to produce this vertical reciprocation of the swivel frame is illustrated on the additional diagrams at Figs. 243 and 244; the former is a side elevation and the latter a plan of the operating details as viewed from the left side of a right hand loom. The parts shown combine with those in Figs. 238 and 239 as follows :—A small lever arm 30 is set screwed to the horizontal shaft 6. The free arm of this lever rests in negative contact with the top of the crosshead of a **T** shaped vertical rod 31 which is adjustable and passes freely through a slotted bracket 32 compounded with the front of the shuttle race 1. The rod 31 is supported and pivoted on a loose stud 33 which passes freely through and near the free end of a treadle lever 34 pivoted on the

Fig. 243.



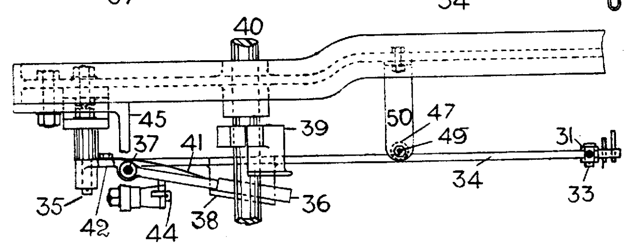


Fig. 244.

fixed stud 35. Combined with the treadle 34 is a small lever 36 pivoted on the stud 37 which passes through the treadle lever 34 in the position shown. The lever 36 is free to move at right angles to the treadle lever 34 irrespective of whether the latter is in action or not. The free arm of lever 36 rests passively upon a horizontal flat plate 38 which is compounded with the treadle lever 34. A small cam or eccentric 39 is compounded with the bottom shaft 40;

against this cam or the low shaft the free arm of lever 36 rests normally in contact, notwithstanding the constant pressure of a strong steel spring 41, pivoted on the stud 42, which exercises its energy to press the lever 36 clear of the eccentric. The action of the spring 41 may be overcome by the lower arm of a simple lever 43 pivoted on the stud 44 in a fixed loom bracket 45. The upper arm of the lever 43 is in constant contact with a clutch wheel 46 which is free to rock the lever 43 about its pivot stud 44 at will; the lower arm of the lever 43 rests in contact with the outside of lever arm 36, so that whenever the upper arm of lever 43 is rocked outwards the lower arm is simultaneously rocked inwards and overcoming the resistance of the steel spring 41 places the lever 36 normally under the cam 39, the nose of which as it rotates, presses on the top of lever 36 and through it, reciprocates the treadle lever 34 which in turn elevates or depresses the **T** shaped rod 31. The depression of this rod permits the lever 30 (Fig. 239) to fall and oscillates the rod 6 clockwise, which in turn, through parts 5 to 11 inclusive combines to depress the swivel frame 12 once for every two revolutions of the crank shaft (two picks), whenever the swivel effect of pattern is being produced. Immediately the pressure of the tappet nose 39 is released, the treadle lever 34 normally ascends, due to the action of a strong spiral spring 47 which combines the treadle lever, through the stud 48 and an adjustable hook 49, to a fixed bracket 50 compounded with the loom gable.

The ascent of the treadle lever 34 elevates the rod 31, and lever 30 which last rocks the rod 6 counterclockwise and through details explained, lifts the swivel frame 12 together with the shuttles clear of the warp and reed.

In the non swivel portion of the pattern, the lever 36 is pressed by spring 41 normally clear of the cam 39, and the swivel frame consequently remains in its highest position and out of operative action.

At the right end of the lever 34, a projecting stud 51 is bolted fast; the projecting arm of this stud passes freely through a slotted vertical rod 52 suspended from a fixed bracket 53. The projecting stud 51 checks any tendency in the lever 34, to fall below the bottom of the slot in the fixed rod 52.

Neutralising the Operative Action of the Weft Fork.

It will be evident that when the reed strikes against the fell of the cloth on the swivel pick and when the ordinary picking motion is detached, that the weft fork will normally operate to stop the loom in the ordinary way, but this tendency is neutralised as follows :—(Fig. 243). A cord and spiral spring 54 combine the treadle lever 34 with a bell crank lever arrangement 55, pivoted at 56 ; the upper arm of the lever 55 is shaped as shown and is free to be rocked into or out of contact with the back of the weft fork grid 57. Normally the upper arm of the lever 55 rests clear of the grid. When the ordinary picking motion is thrown out of action and the reed is travelling towards the fell of the cloth to beat up the swivel shot, the cord and spring 54 tighten and draw down the horizontal arm of lever 55 but move the upper arm across the back of the grid 57 and tilt the weft fork in the same way as happens when the ordinary weft lies across the face of the grid.

The Lateral Reciprocation of the Swivel Shuttles.

The additional mechanical details designed to attain this object, and also to work in unison with the vertical reciprocation of the swivel frame are illustrated at Figs. 245 and 246 ; the former is a front elevation and the latter a plan.

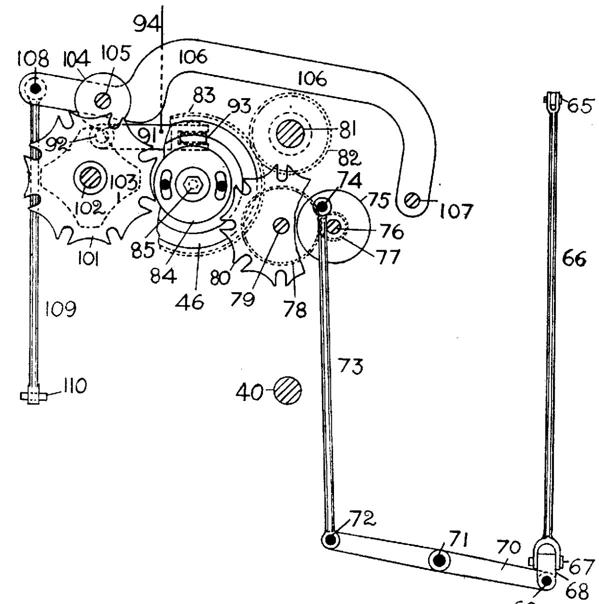
A stud 58 combines the rack 22 (Fig. 239) with a horizontal connecting rod 59, which is adjustably connected by a swivel link 60 and stud 61 to a bell crank lever 62 pivoted on the stud 63. This stud is compounded with a flat iron bar 64, which in turn is screwed fast to the back of the wood frame 4 and consequently moves in sympathy with it. A stud 65 combines the horizontal arm of lever 62 with that of a vertical swivel and adjustable link 66 in turn combined through stud 67, swivel link 68, and stud 69 with a simple balk lever 70, pivoted on the fixed stud 71, Fig. 245. An adjustable stud 72 in the left arm of lever 70 combines with an adjustable link rod 73, in turn supported by and suspended from a stud 74, set out of centre in a disc wheel 75 which is pivoted and free to rotate on a fixed stud 76. The boss of wheel 75 on the remote side is cast with ten spur teeth 77, which gear into a spur wheel 78 containing forty teeth, supported and free to rotate on a fixed stud 79. Compounded with the boss of wheel 78 is an eight socket star wheel 80, which is free to be intermittingly rotated clockwise, at will, once on every two picks, whenever the swivel pattern is required. 81 is a section through the crank shaft, and 82 a broad toothed spur pinion containing thirty-two teeth which gears into and drives a clutch spur wheel 83 containing sixty-four teeth, and which therefore rotates at half the speed of the crank shaft. The spur wheel 83 is compounded with a large segment boss 84, four inches in diameter, supported and free to rotate on a strong stud 85 fixed in the loom gable.

The segment boss 84 with wheel 83 is free to move laterally along the stud 85, and is kept normally at the extreme limit of its inward traverse through the constant pressure of a strong spiral spring 86 which fits loosely on the stud 85, combined with a washer and nut 87 as shown. The clutch spur wheel 83 contains three projecting studs, one (88) on the near, and two (89 and 90), at the rear side. The stud 88 is free to engage with one of the notches in the star wheel 80 and the studs 89 and 90, which are diametrically opposite to each other, engage alternately with a second sprocket or star wheel 101.

The outward movement of boss 84 with wheel 83 is obtained as follows:—On the side nearest the loom gable the boss forms a segment only, part of it being removed. A simple lever 91 pivoted on the fixed stud 92 carries an antifriction bowl 93 in its free end; this lever is connected by a cord 94 to the right arm of a balk lever 95, pivoted on the fixed stud 96 combined with the top cross rail of the loom, Fig. 247, which is an elevation as seen from the back of the loom. The left arm of lever 95 is kept normally down by a weight 97, which consequently lifts the lever 91 and bowl 93 normally clear of the segment clutch 84. A cord 98 joins the lever 95 to one of the Jacquard figuring hooks 99. The griffe and knife are shown at 100.

A perforation in the Jacquard card causes the hook 99 to lift the left arm of balk lever 95 and depress its right arm, which then permits the bowl lever 91 to engage the bowl 93 with the segment of boss 84 (Figs. 245 and 246), which in turn is moved laterally outwards along its pivot stud 85, overcoming the resistance of the spiral spring 86 until the projecting steel pin 88 is directly opposite

Fig. 245.



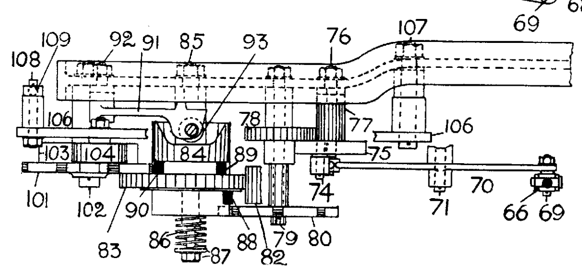


Fig. 246.

one of the notches in the star wheel 80, which it then rotates one eighth of a revolution. The star wheel 80 revolves the spur wheel 78 through which the spur boss 77 is rotated counter clockwise together with the disc wheel 75 and stud 74. This circular movement of the stud reciprocates the link rod 73 and rocks the balk lever 70, which through the connecting link 66 oscillates the bell crank lever 62 (Fig. 239) about the stud 63 and through the horizontal connecting rod 59 and flat plate 28 moves the rack and rack plate 22 laterally to the right and left, and through parts 17 to 24 inclusive (Fig. 242) the swivel shuttles.

When the 'eccentric' stud 74 is rising on the right side of the stud 76, it moves through details described the swivel shuttles to the right; on the contrary when the stud 74 is descending on the left side of stud 76 it combines to produce a lateral movement of the swivel shuttles to the left. The traverse of the swivel shuttles to the right inserts the extra figuring weft and their traverse to the left brings them to their normal and stationary position; hence these parts of the mechanism are only in operation when the swivel figure is being woven.

Automatic Detachment of the Picking Mechanism.

Whenever the swivel pattern is required to be woven, the swivel mechanism automatically picks on alternate and normal shots of weft; this involves that the ordinary picking mechanism must be automatically thrown out of action during the insertion of each swivel shot of spotting weft.

On the other hand, where no swivel pattern is required the whole of the swivel mechanism is automatically detached from action, the loom runs as ordinarily and the picking takes place alternately from opposite sides of the loom as usual.

Fig. 248 is an elevation as seen from the back of the loom, of the supplementary details to the ordinary picking mechanism and which are necessarily connected with the depicted details in Figs. 245, 246 and 247.

Fig. 249 is a plan view of the same added details. Reverting to Figs. 245 and 246, the projecting steel studs 89 and 90 in clutch wheel 84 are free to engage, according to pattern, alternately with the notches of the second star wheel 101, pivoted on the fixed stud 102; compounded with the rear side of the star wheel 101 is an octagonal cam 103 formed with four convex and four concave sides; in continuous contact with one or other side is an antifriction roller 104 pivoted on an adjustable stud 105 in lever 106 fulcrumed on the fixed stud 107. The free arm of lever 106 supports, through an

Fig. 248

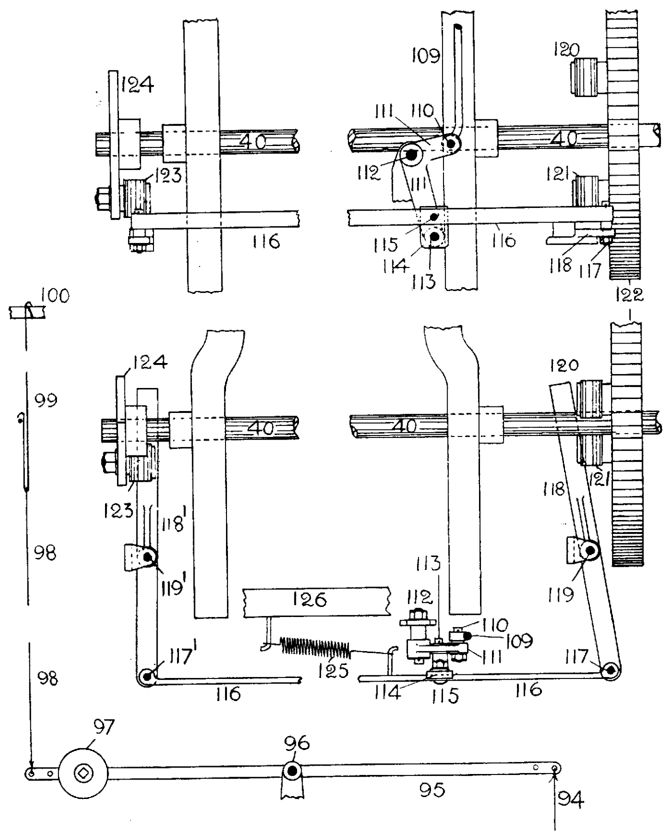


Fig. 249

Fig. 247

adjustable stud 108, a vertically suspended link 109 which in turn, through a stud 110, combines with a bell crank lever 111, pivoted on the fixed stud 112 (Fig. 248). The vertical arm of lever 111 combines with the horizontal link rod 116, through a stud 113 compounded with a small bracket 114 in turn adjustably connected through a stud 115 fixed in the above link rod 116. This link is connected on the right side by a stud 117 to a lever 118, pivoted on the stud 119 projecting above the face of the ordinary 'treadle' picking lever, Fig. 249. The free arm of lever 118 carries the picking 'shoe' which usually is combined with, and projects above the surface of the ordinary picking lever. The free end of the lever 118 with the projecting picking shoe is at liberty to move laterally and at right angles to the surface of the picking treadle lever, into or out of contact with one or other of two picking bowls 120 or 121, adjusted diametrically opposite each other and compounded with the driven spur wheel 122, keyed to the low shaft 40.

The detailed parts are duplicated at the opposite side of the loom. A third picking bowl 123 is keyed fast to a crank lever 124, in turn keyed fast to the low shaft 40.

A spiral spring 125 combines the link rod 116 with the loom cross rail 126 as shown. The energy exercised by the spring pulls the link rod 116 to the left and through it, operates to bring the free arm of lever 118 with the tappet shoe into striking contact with bowl 120 or 121.

Regular and Intermittent Action of the Picking Mechanism.

1. *Regular Action.* The constant rotation of the crank shaft 81 with pinion 82, rotates the clutch spur wheel 83 together with the projecting studs 88, 89 and 90. The second or last of these studs engages with one of the sockets in star wheel 101 and rotates this wheel one eighth of a revolution for each pick or revolution of the crank shaft 81. In the diagram Fig. 245 the convex portion of the cam 103 is in rolling contact with the bowl 104, which is consequently raised to its greatest height together with the free end of lever 106 and stud 108, which in turn lift the link 109 and stud 110 to rock the bell crank lever 111 counterclockwise; the vertical arm of the lever 111 moves, sympathetically to the right, the link rod 116 and stud 117. The result of the combined action is to move the lever 118 about its pivot 119, until the picking shoe is out of striking contact with bowls 120 or 121, according to whichever is passing the bottom on the given pick. The foregoing position of

parts, automatically places the picking shoe combined with the free end of the duplicate lever 118 into striking contact with the picking bowl 123 at the opposite side of the loom.

The next and subsequent pick and revolution of the crank shaft 81 brings one of the projecting studs 89 or 90 into the notched recess of the star wheel 101 and rotates it an additional eighth of a revolution until the concave part of the cam 103 rests directly under the centre of the bowl 104, which is thus permitted together with the free end of lever 106, to fall by gravity, assisted by the pull of the spiral spring 125 acting on the rod 116 to rotate the lever 118 about its pivot 119; this results in placing the tappet shoe, in the free end of lever 118, directly under the striking bowl 120.

This sequence of operations is continued as long as the swivel mechanism is detached from action. During this period the picking bowl 121 never comes into striking contact with the picking shoe, on lever 118, since the latter is always moved out of striking range of bowl 121 when it is passing the bottom centre.

2. *Intermittent Picking*. When the swivel figure is being woven, the Jacquard hook 99 is lifted on alternate picks and revolutions of the crank shaft 81. The hook 99 operates through the mechanism already described to lower the free arm of lever 91 with bowl 93 into acting contact with the segment clutch socket 84, and move it outwards until the clutch studs 89 and 90 are out of striking contact with the star wheel 101, but it simultaneously places the clutch stud 90 into working contact with the star wheel 80, and through mechanism already described operates the swivel details.

The ordinary shuttle during the foregoing period must consequently remain stationary at either the left or the right hand side of the loom. The addition of the picking bowl 121 makes it possible to pick from this same side of the loom on either the odd or even picks of weft.

Supplementary Lateral Movement of the Swivel Frame and Swivels.

It is frequently desirable to weave each second and subsequent alternate horizontal row of spots, so that they fall midway between the first and alternate rows, as in Fig. 226. When this is successfully accomplished it is equivalent to doubling the number of swivels with which any given loom is equipped.

Part of the mechanism added for this purpose is shown in Figs. 238 and 239. The wood frame 4 which supports the swivel frame 12 and swivels 17, is combined through a stud 127 and link 128 with an adjustable swivel link 129, which through a stud 130 is connected with a bell crank lever 131, pivoted on the stud 132 in the shuttle race 1. The lever 131 is combined, through a stud 133, a vertical reciprocating link 136 and a stud 137, with a lever 138.

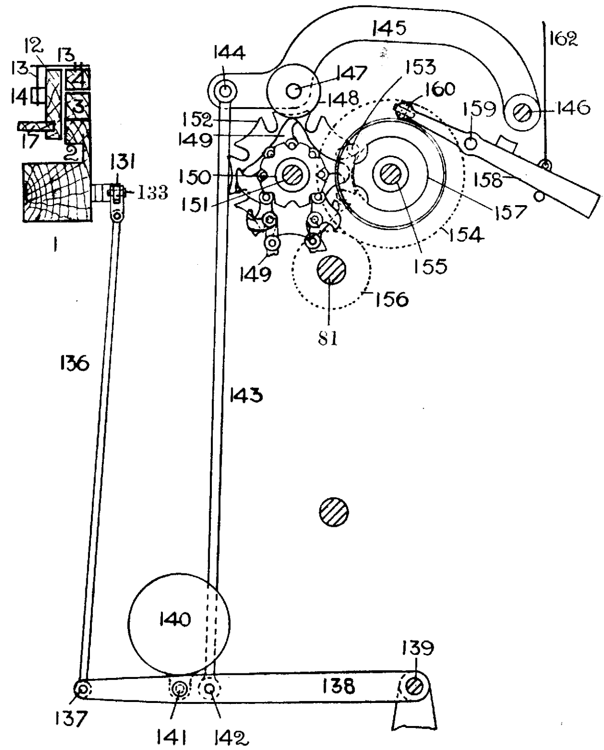
The remaining details of the mechanism designed for the attainment of the above object are illustrated at Figs. 250 and 251; the former is a side elevation and the latter a plan.

The reciprocating rod 136 is combined through a stud 137 with a simple lever 138 pivoted on the fixed stud 139. A heavy weight 140 is combined by a bolt 141 with the lever 138 as shown. A stud 142 combines the lever 138 with a vertical connecting rod 143 which in turn is linked through the stud 144 to the lever 145 fulcrumed at 146. The lever 145 carries a stud 147 on which an antifriction bowl 148 is free to rotate. This bowl is kept, through the gravitation force of weight 140 in close or rolling contact with a set of tappets 149. The chain of tappets is combined and rotates with a chain cylinder 150 on the fixed stud 151. Compounded with the same boss as the chain cylinder 150 is a star wheel 152 containing eight notches in its periphery, any one of which is free to engage, as required by the pattern, with a clutch pin 153 projecting from the back of a spur wheel 154, free to rotate on the fixed stud 155.

The spur wheel 154 is geared into and continuously driven by a spur pinion wheel 156, keyed fast to the crank shaft 81. The face of the wheel 154 is raised to form a cam 157. A small lever 158, centred and free to rock on the fixed stud 159, carries, near the end of its left arm a stud 160 and a small antifriction bowl 161, which is normally out of contact with the face of the cam 157, due to the gravitation action of the right arm of lever 158 which is the heavier. A cord 162 connects the heavy arm of lever 158 with one of the

Jacquard hooks. A strong steel spring 163 is in constant contact with the boss on the remote side, of the clutch spur wheel 154,

Fig. 250



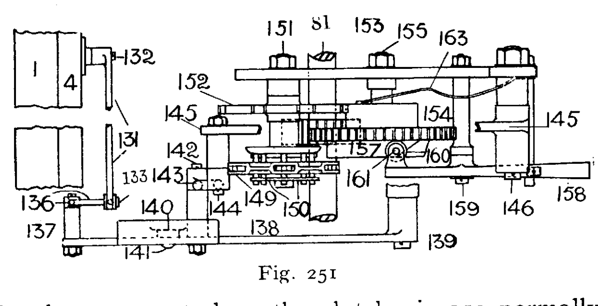


Fig. 251

which thereby operates to keep the clutch pin 153 normally out of working contact with the star wheel 152.

Action of the Mechanism.

A hole punched in the pattern card opposite the controlling hook linked with the cord 162 results in this last being lifted together with the right arm of lever 158 and also in depressing its left arm with bowl 161 into operating contact with the cam face 157; the result and effect of which is to move the spur wheel 154 with the projecting clutch pin 153 laterally along the stud 155 and overcome the resisting force of the steel spring 163. The lateral movement of the clutch wheel 154 moves the clutch pin 153 into working contact with the star wheel 152 which it immediately rotates one eighth of a revolution. This wheel rotates in sympathy with it, the chain cylinder 150 which consequently rotates the next successive link tappet 149 into contact with the bowl 148.

If the change of tappet is from the larger to the smaller size then the bowl 148 together with the free arm of lever 145, link rod 143 and the free arm of lever 138 descend, assisted by the gravitation load of weight 140.

In sympathy with the falling lever 138 the rod 136 descends, which, acting through stud 133, rocks the bell crank lever 131 clockwise, the upper and vertical arm of which moves the swivel frame with the swivel shuttles to the right, a distance equivalent to the requirements of the pattern. The various parts of the mechanism can be finely adjusted to accurately suit any lateral traverse of the swivel frame.

In the above changed position, the swivel frame and shuttles remain and operate, according to pattern, until the cord 162 is again lifted and as heretofore described, rotates the next and larger tappet 149 into contact with the bowl 148 which it consequently lifts to operate through mechanism described to rock the bell crank lever 131 counterclockwise and through its action moves the swivel frame 12 laterally to the left into its original position as illustrated in the diagram.

CHAPTER XVI.

Index and Special Types of Jacquard Machines.

THE 'Verdol' index and fine pitch Jacquard as now made by Herm. Schroers, Krefeld, is used in the linen damask, as well as the silk trade, where very large repeat patterns are common.

An upright hook and needle is provided, in this machine, for each thread of warp in one repeat of pattern, hence the development of the figure together with the binding twill of the pattern is free and unfettered as compared with split, pressure harness and twilling Jacquards which are also designed for, and extensively employed in weaving large repeat patterns.

The machine is constructed on the centre or open shed principle and designed to accommodate the maximum number of uprights in a minimum amount of space, the saving thus effected in this respect being fully 25%. The greatest economy is attained in the saving of cards and card lacing. The number of square inches of pattern paper per pick for an 896 Schroer's machine is $12\frac{5}{8}'' \times 1\frac{1}{16}'' = 13{\cdot}4$ whereas for an ordinary 408 machine and pitch, each pattern card measures $16\frac{1}{2}'' \times 2\frac{1}{2}'' = 41{\cdot}25$ sq. ins.—equal to a saving of approximately 700% of paper in favour of the fine pitch machine. Card lacing is unnecessary, since instead of the usual paste board cards, a continuous roll of paper is used, perforated according to pattern to produce the requisite varieties of warp sheds.

The pitch of the perforations in the card cylinder plate is so fine that it is impossible to operate the cross wires directly from the pattern cards and cylinder; the usual crosswires or needles are therefore extended about seven inches beyond the ordinary needle board by a supplementary and detached straight needle, and are subsequently operated upon by a set of very fine vertical wires which in turn are controlled by the continuous roll of perforated paper. All the essential principles of this machine are fully illustrated from Figs. 252 to 263 inclusive.

Figs. 252 and 253 are sectional elevations showing one row of uprights, crosswires, 'feelers,' driving plates and card cylinder. The uprights 1 are formed of double wire, the non hook part projects five inches above the ordinary hook. The hooks normally project over the griffe blades 2; the bottom or return portion of the double wires rests normally in the board 3; the tug cords attached to these hooks pass through perforations in board 3. The board 3 and griffe 2 are supported between two sliding blocks which are free to move in a vertical plane. An iron grid 4 carrying fixed wooden staves 5, is suspended from the griffe 2 by strong wires 6 as shown; the wooden staves are passed between the two shanks of each respective upright. Then with each ascent of the griffe bar 2, the staves 5 rise in sympathy and are thus free to neutralise any tendency in those uprights, when lifted clear of the board 3, to rotate on their axes.

The ordinary crosswires or needles 7 are supported in the needle board 8 and at their right terminals in a fixed brass grid plate 10, where they are each doubled backwards to form a loop about half an inch long; through each vertical row of the loops a pin wire 9 is inserted to limit its forward traverse. These pin wires are fixed to and suspended from the top of the grid plate 10. The needles 7 project slightly and freely through a perforated plate 11 combined as shown with a like perforated plate 12. A second and supplementary set of needles 13 is passed through the perforations in the plate 12. Compounded with the right terminals of needles 13 are small round heads 14 each of which is placed directly opposite the left terminal of its corresponding needle in the series 7.

The left terminals or free ends of each row of needles 13, rest freely on the surface of a corresponding number of plates 15 each of which is turned down on the outside to form a short vertical arm or right angle with the horizontal part. The whole of these plates is rigidly connected into a compact series by brass mountings the ends of which are adjusted and set screwed to suitable bracket levers which together with the angle plates 15 are free to travel outwards to the left and simultaneously rise on every pick. A detached and separate elevation of plate 15 is shown at Fig. 261.

A number of very fine wires 16, denominated feelers is suspended from fixed crosswires 17. Each wire 16 is looped round a

Fig. 256

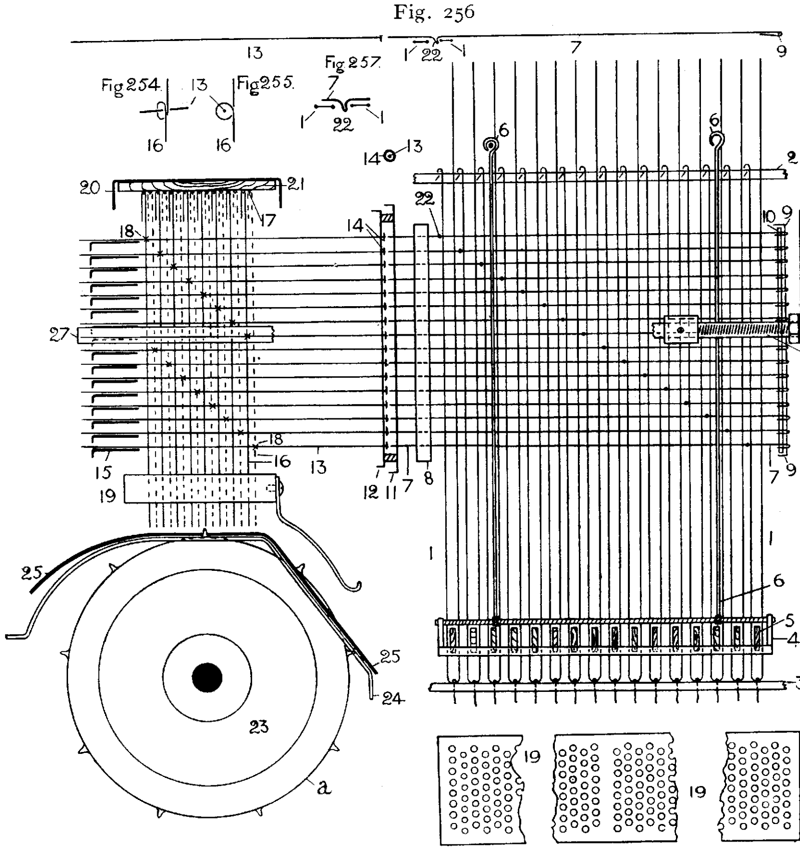


Fig. 252

Fig. 253

Fig. 258

separate needle 13 at the points 18 as illustrated separately at Figs. 254 and 255. The lower terminals of the suspended wires 16 are threaded through perforations in a fixed plate 19, a plan of which, showing the arrangement of the perforations is supplied at Fig. 258.

A brass plate 20, with turned down sides both front and rear, is fixed about $\frac{5}{16}$in. above the upper terminals of the feeler wires 16. It serves the double purpose of keeping the dust from lodging amongst the fine wires and limiting the upward traverse which they are free to make.

A flat piece of wood 21, $\frac{3}{16}$in. thick, is placed inside the cover 20 and rests loosely on the top of the feeler wires 16. Its weight is sufficient to keep the wires down, but not so great as to prevent their free ascent.

A plan of one of each of the wires 7 and 13 is shown at Fig. 256. Each wire 7 is doubled to form a short projecting arm 22, also illustrated on an enlarged scale at Fig. 257. When the wires 7 are placed in position in the Jacquard machine the projection 22 is in front of the respective upright under its control and immediately behind the back of the spring part of the preceding hook. Its function is to press, as required by the pattern, its own hook 1 clear of the griffe knife 2 and assist, on its return, to place the preceding hook into its normal position on every pick.

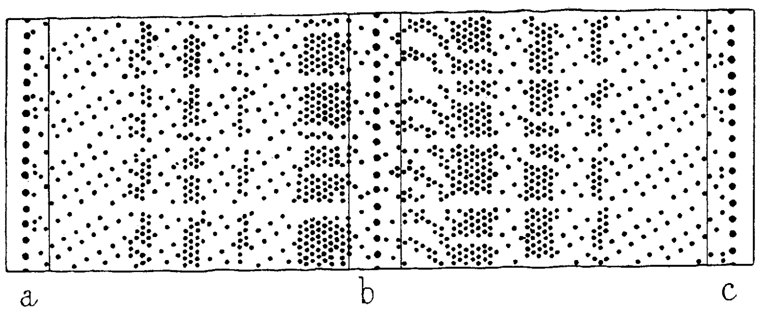
The card cylinder 23, more correctly a roller, is adjusted and suspended from the ends of the fixed perforated plate 19. An elevation of the card cylinder, etc., is shown at Fig. 260. It contains three plate wheels *a b c; a b* and *b c* are equidistant. Nine spikes, as shown, are fixed into the periphery of each wheel and the card paper is subsequently punched with holes at the sides and centre to coincide with these spikes.

Immediately above the card roller 23 and directly underneath the plate 19 is a semi-circular brass plate 24, the top of which is flat and perforated to correspond with the holes in the plate 19; additional parts are cut away to permit of the free rotation of the spikes in wheels *a b c*, through and just above the surface of the plate 24, as shown.

A continuous string of card paper 25 fits on to the spiked rollers *a b c* and is free to be rotated clockwise over the plate 24 and under the feeler wires 16.

A clamp board 26 is bolted fast to four iron rods 27—two at either side of the machine and supported by passing through the back gable of the machine and the needle board 8. Their free terminals are almost in close contact with the closed ends of the driving plate 15. A spiral spring 28 circumscribes each rod 27 and is contained between the adjustable collar and nut 29 and the machine gable. This spring normally exercises its energy to keep the clamp board in contact with the double terminals of the needles 7.

Fig. 259



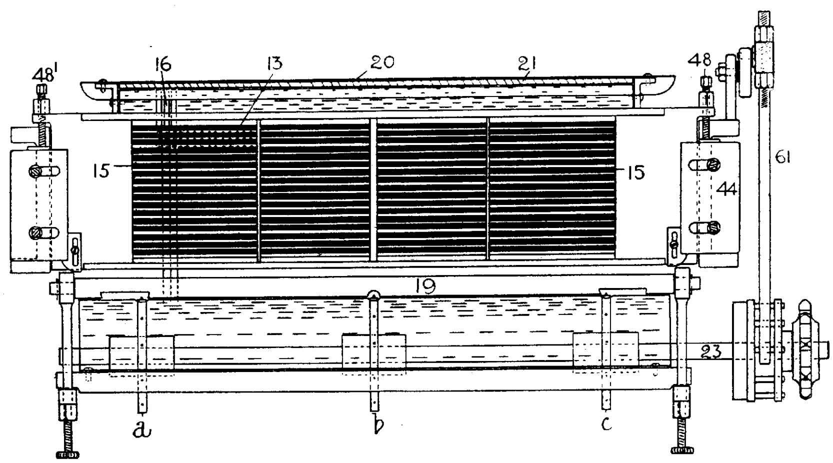


Fig. 260

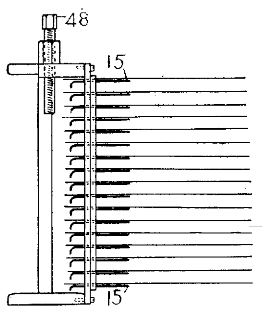
Fig. 259 shows a length of the perforated card to equal four shots of weft and reduced to $\frac{1}{4}$ scale. The body of the roll is about $\frac{1}{80}$in. thick, but at the sides and centre (portions *a b c*) where the 'peg' holes are cut, it is increased by an extra layer of paper ($\frac{3}{4}$in. broad), to about $\frac{1}{50}$in. in thickness.

Action of the Jacquard Cards and Mechanism.

With each ascent of the Jacquard head, the driving series of plates 15 are pushed outwards to the left about $\frac{3}{4}$ of an inch and simultaneously raised approximately half an inch. The upward traverse lifts all the free ends of the needles 13, which in turn lift the feeler wires 16 until their free ends are clear of the lower surface of the perforated plate 19 which ensures an opening, between 19 and feeler plate 24, of sufficient depth to allow the spiked card roller 23 to rotate the next 'pick' length of paper 25, forward until the perforated section is directly under the vertical feeler wires 16.

Immediately the Jacquard head begins the descent, the needle driving plates 15 return inwards and simultaneously descend, thus permitting the feeler wires to fall on to the partly perforated paper, assisted by the gravitation load of the wood 21. Then wherever there are perforations in the paper, the feeler wires 16 pass freely through and also through the perforations in the brass guide plate 24 and therefore exercise no influence on the needles 13 and 7 and uprights 1. The non-perforated part of the paper holds up the feelers 16 directly over this part and the feelers in turn keep *up* the needles 13 until the vertical parts of plates 15 have receded a sufficient distance to be clear of and free to press on the ends of the needles 13, the round heads 14 of which press against the free end of the needles 7 until the projection 22 moves the upright hook 1 clear of the griffe blades 2. Consequently, on the succeeding pick these uprights, falling in sympathy with the board 3 gradually lower the corresponding threads to form the lower division of the warp shed. On the contrary the remaining uprights which are left normally over the griffe blades 2 are lifted to form the upper division of the warp shed. When the driving plates 15 press on the free terminals of the needles 13, the closed ends of the frame which carries the plates, also press against the free terminals of the rod 27, overcome the resistance of the spiral spring 28, and move the clamp board 26 outwards, to permit the free lateral traverse of the needles 13 and 7. Immediately the pressure is released from the rods 27 and needles 7 by the plate 15, the spiral spring 28 exercises its potential energy to move the rods 27 and clamp board 26 into their original position. The board 26 presses against the double terminals of the needles 7 and moves them, in turn, to their normal position. The same sequence of operations is repeated for every pick of weft.

Fig. 261



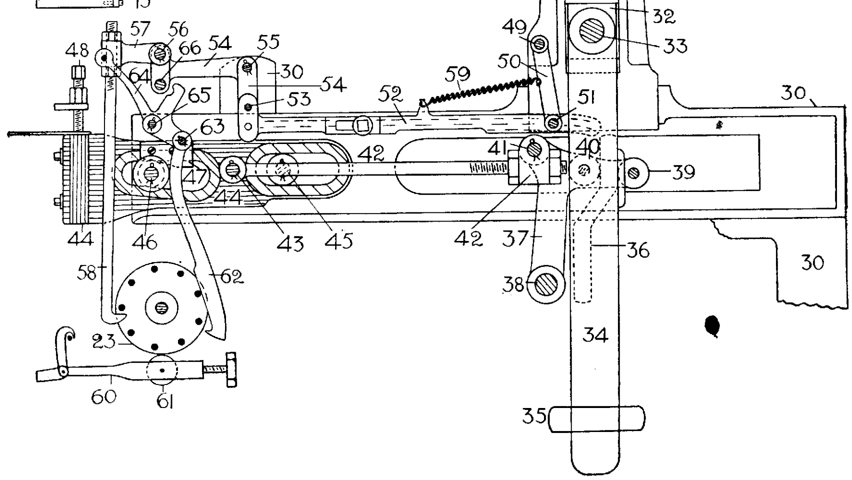


Fig. 262

Details of Mechanism and Driving the Needle Plates.

Fig. 260 is a front elevation of the card roller and needle driving plates.

Fig. 261 is a detached and side view of part of the needle driving plates, together with their distribution and compounding into one whole series.

Fig. 262 is a side elevation of the essential details of the operating mechanism, including the connections with the Jacquard head.

Similar numerals throughout the chapter refer to corresponding details of mechanism. 30 shows a portion of the Jacquard gable; 31 a fixed slide bracket; 32 a square steel block centred on a fixed stud 33 in turn compounded with a slide bar 34 the lower end of which passes through the fixed slide bracket 35. The parts 32, 33 and 34 are free to slide vertically in the brackets 31 and 35. On the remote side of the slide bar 34 a cam shaped projection is formed as indicated by the dotted lines 36. A bell crank form of lever 37 is pivoted at 38; its horizontal arm carries two studs and antifriction bowls 39 and 40, one or other of which is kept in rolling contact on opposite sides, with the cam plates 36. A stud 41, combines the lever 37 with a swivel link and rod 42 which is free to reciprocate. This rod combines through a pivot stud 43, a bracket 44 which is supported and free to slide obliquely on antifriction rollers 45 and 46; immediately over and in contact with the antifriction roller 46 a small cam plate 47 is adjusted to the bracket 44. Adjusted to the end of this same bracket by means of a set screw 48 and its duplicate on the opposite side of the Jacquard, is the set of driving plates 15. (See Fig. 261).

The parts which connect and operate the card roller 23 are as follows:—A pivot stud 49, fixed in the bracket 31, supports a link 50 which in turn combines with the pivot stud 51 to support the right end of a suspended rod 52, the opposite end of which is supported on a pivot stud 53 in the lower arm of the bell crank lever 54 which is fulcrumed on the fixed stud 55. The upper arm of lever 54 is ⊢ shaped, the top wing being combined through a link stud 56 to a link 57. The link 57 is adjusted and supports a vertical spindle 58, the bottom of which is hook shaped and normally rests immediately under one of the pins in the card roller 23. The free arm of the suspended rod 52 is rounded and kept in surface contact with the left face of the cam plate 36, through the medium of a spiral spring 59, which links the rod 52 to the fixed bracket 31 as shown. A small swing lever 60 supports an antifriction bowl 61 and these combine to prevent the card cylinder from rotating too far.

The parts 62 to 66 inclusive are introduced for the purpose of reversing the movement of the card cylinder by hand when necessity arises. 62 is a pawl catch suspended from the pivot stud 63 fixed in the lower arm of a small tri-armed lever 64 pivoted on the fixed stud 65. To the left arm of 64 a cord is attached and falls to within reach of the weaver. 66 is a fixed stud in the lower wing of the ⊢ arm of the bell crank lever 54, its object being to limit the amount of oscillation in the tri-armed lever 64.

Action of the Mechanism.

With each ascent of the Jacquard head, the block 32, stud 33, slide bracket 34 and cam plate 36, all rise in sympathy. The inclined face on the left side of cam plate 36 presses outwards to the left, the bowl and stud 40, stud 41 and rod 42 supported in lever 37 which oscillates in sympathy about the pivot stud 38. The outward movement of the rod 42 pushes, through the stud connection 43, the plate 44 together with the driving plates 15, also outwards to the left. Simultaneously with this outward movement, the projecting face of the cam plate 47 in passing over the bowl 46, is lifted together with the sliding bracket 44 and the driving plates 15, a distance sufficient to raise the ends of the needles 13 with the feeler wires 16 clear of the brass plate 24 and allow enough space for the pattern paper 25 to be moved forward between the plates 19 and 24 without interruption from the feeler wires (Fig. 253). The falling Jacquard head causes the projecting cam plate 36 to press on the antifriction roller 39 outwards to the right which through the details enumerated reverses the movements of the described parts and thereby places them into their normal position.

The rotation of the card roller 23 is accomplished from the same source. The cam plate 36, as it ascends, presses against the rounded end of the rod 52 which, through stud 53, partly rotates clockwise, the bell crank lever 54 about the stud 55. The upper arm of 54, the stud 56 and link 57 in turn, elevate the pawl catch 58 a distance sufficient to rotate the card roller 23 one ninth of a revolution and bring up the next card division. With the descent of the Jacquard head the spiral spring 54 is free to exercise its energy and so pulls the suspended rod 52 laterally to the right, which through the parts described depresses the pawl catch 58 into its normal position below the next cross wire in the cylinder 23 ready for a repetition of the operation on the next shed.

Mechanism and Driving of the Jacquard Head.

Fig. 263 is a sectional elevation of the chief parts designed to reciprocate the griffe 2 and the sinking board 3. Combined with the pivot stud 33 fixed in the griffe bar 2 is a swivel link 68 to which is adjusted a link 69 as shown. This link is coupled by a pivot stud 70 to the simple lever 71 which is keyed fast to a shaft 72 suitably supported by brackets bolted fast to the Jacquard gantries. Keyed fast to the same shaft 72 but on the remote side of lever 71 and the Jacquard machine is a second lever 73 to which is connected, through stud 74, swivel link 75 and stud 76 a reciprocating rod 77. A duplicate set of these parts similarly connects the lower or sinking board 3 with a second reciprocating rod 89. The parts represented from 69 to 77 agree respectively with those from 81 to 89 both inclusive. A swivel link 79 combines through stud 80 and bracket 78 with the head 3.

The reciprocating rods 77 and 89 are adjusted in the usual manner to a double eccentric which is keyed fast to the crank shaft of the loom. Then, as the crank shaft and double eccentric revolve, the rod 77 and lever 73 combine to oscillate the shaft 72 clockwise, and lift the lever 71, links 69 and 68 together with the Jacquard head and griffe knives 2 with the requisite uprights to form the top shed. Simultaneously the rod 89 ascends and through its connections produces a downward movement in the sinking board 3 and lowers those uprights which are to form the bottom shed. As the eccentric completes its rotation the foregoing motions are reversed preparatory to the next pick.

The principle of this Index and fine pitch Jacquard is also applied and used for double acting Jacquards with two sets of uprights, combined with one or two sets of needles, feelers and card rollers.

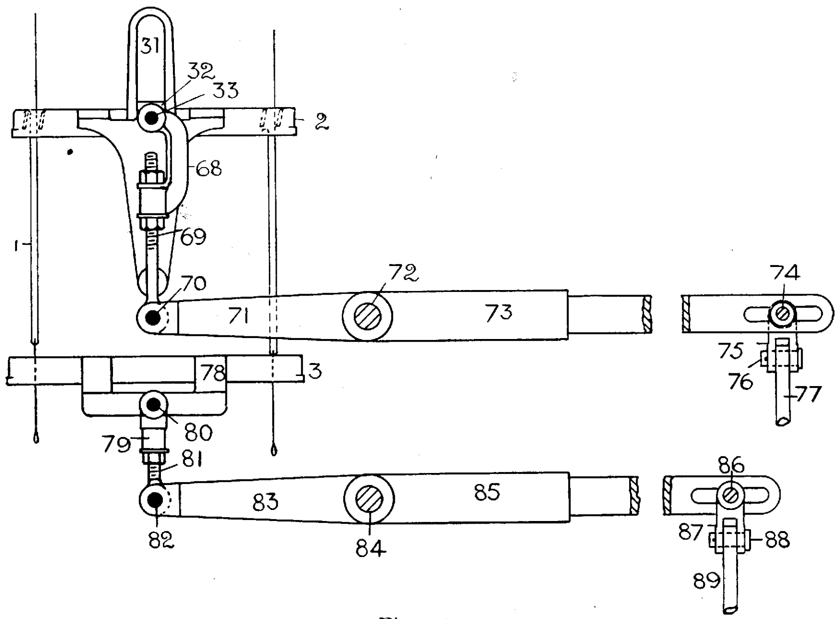


Fig. 263

The Centre Shed Jacquard.

As the title suggests, the centre shed Jacquard machine is built to produce a warp shed on the closed and centre shedding principle. It consequently merits all the advantages which characterise this principle of shedding, but it also inherits all its defects. See pages 27 and 28.

A centre shed Jacquard is very suitable for use in weaving figured gauzes where one or two doups is placed in front of the harness mounting.

The chief details of mechanism in the centre shed Jacquard are supplied in Fig. 264, which is a line diagram, showing one row of uprights and needles, together with a vertical section through the griffe blades and upper and lower reciprocating boards. A indicates the top and usual griffe bars; B the resting or suspension hook board, free to rise or fall. The griffe A is connected to the spindle C at the position D and the board B is similarly connected to the second spindle E at the position F. The uprights are shown at G and the cross wires or needles at H. The usual card cylinder, needle board and spring box are also indicated.

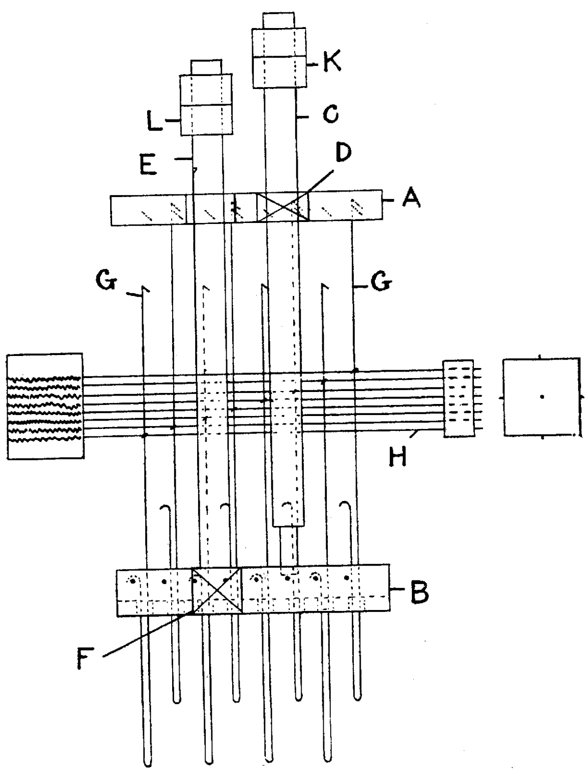


Fig. 264

The designs are painted and the cards cut in the usual way. There are two Jacquard cross heads K and L, and two head levers and reciprocating rods and a double throw eccentric as in double lift machines, but the eccentric is set screwed fast to the crank shaft, so that as the cross head K rises and falls, the cross head L falls and rises once for each pick of weft or revolution of the crank shaft.

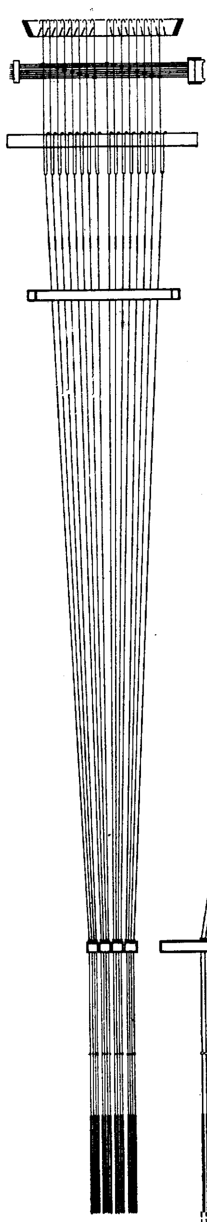


Fig. 265

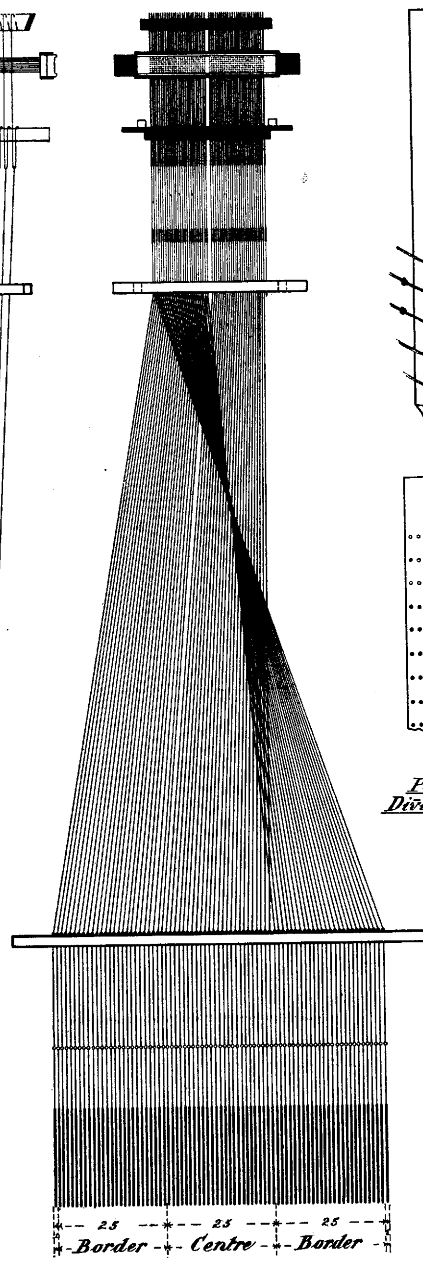
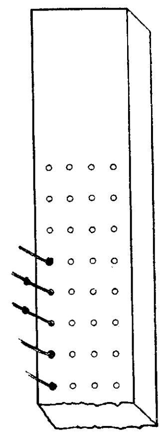
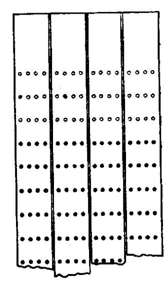


Fig. 266

Fig. 268





Part views of Divided Comber Brd

Fig. 267

Action of the Mechanism.

The crank shaft of the loom revolves as usual once, for every shot of weft. The cross head K rises with the spindle C and griffe A with all the hooks G that have been left over the griffe knives, according to pattern, to form the top warp shed. Simultaneously the cross head L with spindle E descends together with the bottom board B, supporting all the hooks G that have been left clear of the top knives in griffe A, according to pattern, to form the bottom shed. The weft is then inserted and the griffe A descends whilst B ascends until the uprights G meet in the centre, irrespective of the position which they are to occupy on the next and succeeding picks of weft. The operation is similarly repeated for each shot of weft.

In the given diagram the shed is fully open.

Brussels and Wilton Carpet Jacquard.

This machine is designed to control the coloured pile yarn and produce a figure effect of pattern in different colours on the surface of either Brussels or Wilton Pile Carpets.

The mechanism, harness mounting and operation of this machine is fully illustrated and described on pages 85 to 102 inclusive in *Carpet Manufacture*, for which reason it is unnecessary to repeat it in this treatise.

The Double Cloth and Ingrain Carpet Jacquard.

This Jacquard is constructed to produce an effect of figure in double and compound woven structures such as Tapestries, Roman, Scotch and Ingrain Carpets. Each cloth is composed of differently coloured yarns and the figured pattern is obtained by causing these cloths to interchange.

A description of the principle and Hutchinson and Hollingworth's Ingrain Loom is described and illustrated on pages 280 to 301 inclusive in *Carpet Manufacture*. A supplementary set of illustrations is supplied at Figs. 265 to 268 inclusive.

Fig. 265 is a side elevation of Jacquard harness, comber boards, mails and lingoes.

Fig. 266 is a front elevation of the same details.

Fig. 267 is a part plan of the four comber boards.

Fig. 268 is a part plan ($\frac{1}{3}$ scale) of one of the comber boards.