is, that the lay can work with a shorter traverse, and by so doing it is easier on the yarn; and the reason that this loom can work with a shorter traverse is, that the spike that stops the loom does not take effect on the handle till the lay is within three quarters of an inch off the fell of the cloth; whereas, with the other, it must strike the frog for stopping the loom when the lay wants about two and a half inches from the cloth.

It will be seen from the following what the patentees themselves say about this loom, and the drawings, as shown in Plate No. 5, will illustrate their inventions. The Specification is given in full so that the reader may see the legal form of such documents.

The loom with the fly reed has many advantages, and does its work well in weaving light or medium heavy cloth. But when the cloth is very heavy, and the weft difficult to put on, it does not answer so well. And to have the same advantage given to the loom for stout cloth, as the fly reed has given to the one for light cloth, something like the following plan would require to be adopted:—

The lay to be made in the old way, having the reed made fast, and to have the back roll (commonly called the whip roll), that the warp yarn comes over, movably by being hung upon two strong levers. When the shuttle is in the box these levers are locked, and kept firm in their position, to resist any strain that may be brought upon the warp to move the roll when the lay is in the act of knocking or striking up the weft. When the shuttle is not in the box the levers are unlocked, and the roll left at liberty to move towards the lay; being only restrained from doing so by springs being applied to the levers to keep the roll near its proper place when the shuttle is crossing the web. It will be evident that if the shuttle stops in the shed the levers will be unlocked, and the roll will yield to the pressure of the yarn brought to bear upon it, by the shuttle being pressed against the fell of the cloth. This yielding of the roll prevents (a smash) the warp yarn from being broken.

In weaving most kinds of heavy cloth the shed requires to be full open when the lay is in the act of striking up the weft, for the purpose of spreading the warp yarn, and this will bring a strain on the yarn, which will cause the roll to yield towards the lay; but the levers, when in the act of being locked, bring the yarn to its proper tension, by causing the roll to move back to its proper place. As there are many different plans for locking and unlocking the levers, they need not be explained, as they will suggest themselves to any party making the experiment.

## J. & A. BULLOUGH'S SPECIFICATION.

"To all to whom these presents shall come, we, James Bullough, of Blackburn, in the County of Lancaster, Machine Maker, and Adam Bullough, of the same, Overlooker, send greeting:

Whereas, Her present most Excellent Majesty Queen Victoria, by Her Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the First day of December, in the tenth year of Her reign, and in the year of our Lord one thousand eight hundred and forty-six, did, for Herself, Her heirs, and successors, give and grant unto us, the said James Bullough and Adam Bullough, Her especial license, full power, sole privilege, and authority, that we, the said James Bullough and Adam Bullough, our executors, administrators, and assigns, and such others as we, the said James Bullough and Adam Bullough, our executors, administrators, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England and Wales, and the Town of Berwick-upon-Tweed, our invention of "CERTAIN IMPROVEMENTS IN LOOMS FOR WEAVING;" in which said Letters Patent is contained a proviso that we, the said James Bullough and Adam Bullough, or one of us shall cause a particular description of the nature of our said invention, and in what manner the same is to be performed, to be enrolled in her Majesty's High Court of Chancery within six calendar months next, and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

Now know ye, that in compliance with the said proviso, I, the said James Bullough, do hereby declare that the nature of our said invention, and the manner in which the same is to be performed, is particularly described and ascertained in and by the drawings hereto annexed, and the following explanation thereof (that is to say):—

These Improvements in Looms for Weaving apply to power-looms (whether used for plain or fancy weaving), and consists,—

Firstly, in a certain novel arrangement of apparatus for the purpose of regulating the "letting off" of the yarn or warp from the yarn beam to (be used in connection with a positive "taking up" motion, whereby the "letting off" of the yarn is governed by the "taking up" of the cloth.

Secondly, in a modification of the above, in which arrangement the yarn beam is held fast by means of a friction break whilst the cloth is "beat up," and when being released, the tension of the yarn will cause the yarn beam to let off as much warp as required.

Thirdly, in an arrangement of mechanism connected with the ordinary "taking up" wheel for the purpose of "letting back" the cloth by hand when requisite, without lifting the taking-up catches.

Fourthly, in a modification of the above motion, which may be made either self-acting or otherwise.

Fifthly, in a swivelling "slay cap," for the purpose of allowing the reed to give way whenever the shuttle stops in the "shed," thereby preventing injury to the cloth, but which is held firm whilst beating up; and,

Sixthly, our invention consists in the application of a friction break, which is caused to act simultaneously upon the face of the spur wheels which connect the ordinary tappet and crank shaft (and are known as the tappet shaft wheel and the crank shaft wheel), for the purpose of stopping both shafts at one instant whenever the shuttle is absent from both boxes, instead of allowing the tappet shaft wheel to stop itself by concussion of its teeth against the teeth of the crank shaft wheel as heretofore.

These several improvements will be better explained and more readily understood by reference to the Drawing accompanying these Presents, which is of a scale of about two inches to a foot, and has figures and letters of reference marked upon it corresponding with the following description thereof, the new parts being shaded with colour for the sake of distinction, and the ordinary parts of the loom being drawn in outline, merely for the sake of illustrating the relative position of the various improvements.

Figure 1, is a side elevation of a loom with part of my improvements attached thereto, and Figure 2 is a section of a loom exhibiting other parts of the invention. A, A, is the main framing of the loom; B, B, is the yarn beam; C, C, the crank shaft; D, is the slay; E, the breast beam; and F, the cloth roller.

The first part of our improvements is seen best at Figure 2. Upon the ordinary tappet shaft G of the loom is a double tappet *a*, *a*, which, as it revolves, causes the lever *b*, *b*, to rise and fall. This lever *b* is connected by a rod *c* to a small lever *d*, which has its fulcrum upon cross shaft *e*. There is also another lever *f* attached to the same shaft, which has a catch *g* affixed to it. When the cam or tappet *a* lifts the lever *b*, the lever *d* comes in contact with the lever *f*, and causes the catch *g* to take up one tooth of the ratchet wheel *h*, which being connected to the yarn beam B by the worm and wheel *i*, *i*, lets off the yarn. The quantity of yarn let off is regulated in the following manner:—The yarn or warp is caused to pass over a rod or bearer *k*, which vibrates upon supports fixed at each end. This yarn bearer *k* is furnished with a weight and lever *l* at one end for the purpose of keeping the yarn at the proper tension, and at the other end of the same is a pin *m*, which vibrates between the stops *n* and *o*. When more yarn is let off than is taken up, pin *m* comes into contact with the stop *n* and projects a small lever *p*, underneath the lever *f*, and holds it up out of the reach of the lever *d*, and thus stops the letting off; but as soon as the tension of the yarn, consequent upon the taking up of the cloth, causes the pin *m*, to come into contact with the stop *o*, it will withdraw the lever *p*, and allows the "letting-off" to proceed as before. Figure 3 is a side view of the ratchet wheel and levers, and Figure 4 is a plan view of the apparatus.

The second part of our invention is shewn in Figure 5. A is part of the framing of the loom, and G is the tappet shaft. When the yarn beam is placed in the loom the boss at the end thereof is placed inside the pulley *a*, a pin upon the boss fitting between the two projections *b*, *b*, so that the yarn beam cannot turn without the pulley. Upon the tappet shaft G a tappet *c* is fixed in such a manner that the instant the reed is beating up the cloth, the tappet *c* causes the lever *d* to tighten the friction belt or break *e*, upon the pulley *a*, by means of the connecting links *f*, *f*, and thus prevent the yarn beam from "letting off" any warp whilst the reed is "beating up," but releases it the moment afterwards, the tension of the yarn causing the yarn beam to let off as much warp as is required. The same arrangement of detached pulley may be applied without the break in those looms where friction is applied to the warp beam by a rope coiled around the end of the same and carrying a weight, the principal feature of novelty consisting in having the pulley to which the friction is applied detached from the yarn beam, in order to afford more convenience in re-filling.

The third part of our invention is shewn in Figures 1 and 6. *Q* is the ordinary "taking-up" ratchet wheel which is loose upon its stud, and has a ring of leather let into its side. There is also a ring of leather let into the boss of the spur wheel *r*, which wheel slides upon a feather on its stud, and is held firmly against the wheel *q* by the spring *s*. The wheel *r* gears with a pinion *t* upon the shaft *u*, which is turned by a hand wheel fixed upon it near to the "setting-on rod," not shown in the Drawing Thus it will be evident, that by turning the hand wheel the cloth may be let back without lifting the catches from off the "taking-up wheel" *q*. If it be thought desirable to have the shaft *u* stationary while the loom is working, it may easily be accomplished by removing about four of the teeth of the pinion *t*.

The fourth part of our invention is shewn in Figure 7, which is a plan view of another arrangement of mechanism for letting back. The "taking-up wheel" *q* has a small pin or tooth *v*, which takes into the teeth on the face of the wheel *w*, which slides upon a feather and is held against the wheel *q* by the spiral spring *x*, but may be thrown out of gear by the lever *y* either by hand or by being connected to the weft motion. When the wheel *w* is thrown out of gear the tension of the cloth will pull the cloth roller back one tooth at a time, so that any required amount may be let back.

The fifth part of our invention is shewn in Figures 1 and 2. The "slay cap" 1, which holds the upper part of the reed 2 instead of being bolted to the "slay sword," as usual, swivels upon a pin or stud at each end, so that when the shuttle stops in the shed it allows the reed to give way, as shewn by dotted lines in Figure 2. The "slay cap" is held firm at the moment of "beating up" in the following manner. To one end of the same a small lever 3 is fixed, which lever is connected to the lever 4 by a link 5. The lever 4 at the moment of "beating up" passes above the projecting piece 6, and thus holds the slay cap firm.

The sixth and last part of our improvements is shewn in Figure 1. The ordinary "stop rod finger" connected to the swell in the shuttle box, is shewn at 7. Eight is a break which is supported by the levers 9 and 10. When the shuttle is absent from both boxes the finger 7 remains in the position shewn in the Drawing, and coming against the projection upon the lever 9, draws the break 8 into contact with the crank shaft wheel 11, and the tappet shaft wheel 12 simultaneously, thus stopping both shafts at once and with less concussion than heretofore. In those looms where the ordinary break is applied to the fly wheel, we propose to apply a fixed or stationary break attached to the framing of the loom at the opposite side of the wheel to the ordinary break, to prevent straining of the crank shaft, and also to gain additional friction power.

Having now described the nature and object of our several improvements in looms for weaving, and the manner of carrying the same into practical effect, I would remark, in conclusion, that we claim as our invention,—

Firstly, the novel arrangement of mechanism shewn in Figures 2, 3, 4, and 5, for "letting off" the yarn or warp (together with the application of the detached pulley to looms where friction is applied by a coiled rope and weight), and also the method of regulating the same, namely, by the tension of the yarn or warp threads.

Secondly, we claim the apparatus shewn in Figures 1, 6, and 7, for "letting back" the cloth when required without the necessity of lifting the catches from the "taking-up wheel," to be worked either by hand or by the weft motion when the weft breaks.

Thirdly, we claim the swivelling "slay cap" whereby the reed is allowed to give way whenever the shuttle stops in the shed, and also the apparatus shewn in the Figure 1 for holding the same firm whilst "beating up"; and,

Fourthly, we claim the employment or use of a break, as shewn in Figure 1, to act simultaneously upon both the "crank shaft wheel" and "tappet shaft wheel" for the purpose of stopping the loom when the shuttle is absent from both shuttle boxes at once; and also the application of a fixed or stationary break in addition to the ordinary one to those looms where a movable break is applied to the fly wheel for the purpose of stopping the loom.

In witness whereof, I, the said James Bullough, have hereunto set my hand and seal, this Thirty-first day of May, One thousand eight hundred and forty-seven.

JAMES (L.S.) BULLOUGH.

And be it remembered, that on the same Thirty-first day of May, in the year above mentioned, the aforesaid James Bullough came before our Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained, in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute in that case made and provided.

Enrolled the First day of June, in the year above written."

There has been many modifications of the Fly Reed, but the plan that is in general use is the one that allows the reed to go back from the bottom. It will be seen from the drawing of Mr. James Bullough's loom, that the reed flies back from the top; and it is very probable that some one may bring out a loom, the reed of which will go back both top and bottom, which may be easier on the rims of the reed.

The novel arrangement of mechanism, which the patentee claims for the letting off the yarn or warp, although it is his first claim in the Specification, has not yet come into much use, and is not likely to do, as better plans than his have been patented and tried before, and did not succeed. But those failures need not keep others from trying to get some novel arrangement of mechanism, whereby the present mode of pacing the beam may be done away with to advantage, for it is decidedly a defect in the power-loom, the pacing apparatus as it is in general applied at the present time. Neither has the second claim in this patent come into general use, but the third and fourth are almost in general use, and they were great improvements to the power-loom. Mr. Bullough gets great credit in the trade for his invention, and he well deserves it, for he has brought out some of the very best things in connection with power-loom weaving.

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## TODDS' PATENT LOOM.

More than twenty years ago, a loom for Plain Cloth was brought out, which was known by the name of Todds' Patent Loom; and although a great many of its movements were not new, yet it was a happy combination of working parts as a whole, and was then considered the best in the trade for light work.

The picking in this loom is accomplished by the picking stick coming up through the lay, and by this arrangement no spindles or shuttle cords are required, the end of the picking stick acting direct on the shuttle driver. The picking stick gets its motion from a small upright shaft fixed to the sword of the lay, and on the end of this upright shaft is a small projection like a finger, which comes in contact with another finger as the lay moves back. It is by this arrangement the shuttles are driven. The heddles are fixed to a roller below, in the same manner as they are fixed to the one above, and by moving one of these rollers, the sheds are formed.

The following is Messrs. Todds' own description:—

## TODDS' DESCRIPTION.

Our improvements relate, first, to that part of power-looms known as the tappet shaft, and used for actuating the tappets, which give motion to the heddles, and consists in a novel method of driving such shaft, which is accomplished by means of a second shaft, to which a rocking or reciprocating motion is imparted, and at each end of which shaft is a small pulley or drum, to which is attached an endless band or strap of metal, leather, or other suitable material. The strap also passes round and is attached to a loose pulley upon the tappet shaft. This pulley has upon the interior surface of its rim a spring pressing upon a pawl or catch, which acts against a plate secured upon the tappet shaft, and having two or more ratchets or teeth formed on its periphery. By this arrangement, when a rocking motion is given to the pulleys at the end of the rocking shaft it will be imparted to the loose pulley, which will cause the pawl to force round the ratchet, and give an intermittent motion to the tappet shaft as required. This arrangement is applied at each end of the loom, and both driven in the same direction by the straps, being one open and the other crossed, as the pawls are required to force the ratchets alternately on each side of the loom. The motion given to the "yarn bearer" for ensuring the equal tension of yarn is also actuated from the rocking shaft by means of an eccentric in connection with and through the medium of a suitable arrangement of levers.

The second part of this invention relates to the rocking or oscillating shaft above mentioned, and consists in imparting to the said shaft an uniform reciprocating motion, through the medium of which a positive dwell is given to the heddles. This motion is affected by means of a lever or arm, indirectly connected with the crank shaft (from which it receives motion) by an arrangement of levers. One end of this lever is secured to the framing, the other being enlarged to the required size, so as to form a segment of a circle. About the centre of this segment is situated the required number of teeth, leaving the two sides of the segment a plain surface; gearing into these teeth are the corresponding teeth of a disc fixed upon the rocking shaft, the remaining portion of such disc having a plain surface like the segment. Supposing motion to be given to the arm, the teeth thereupon would turn the toothed disc until the plain surfaces came into contact, which would cause a dwell; if, now, the arm moves back as the crank revolves, a plate secured upon the said arm will fit into a corresponding recess in the toothed pinion and bring the teeth again into gear, and so on, at every upward and downward throw of the crank, thus causing the required oscillation or reciprocating motion of the shaft, and positive dwell of the heddles while open.

Lastly, these improvements apply to the part called the "weft stopping motion," usually in connection with the "swell" of the shuttle box, and consists in the addition and application of a suitable formed spring, situated beneath one of the cranked levers, one of which presses against the swell of the shuttle box, the second being employed to strike the "frog." This spring is placed under the third, in order to assist in forcing the second on to the "frog," and, by being suitably curved, to release the "swell," and consequently the shuttle from pressure, as it is expelled from the box. A similar effect may also be gained by curving the third lever upwards, so as to come into contact with a stud upon the crank arm, and so fitted, that as the arm moves, the lever may touch the stud, and thus release the swell from pressure, and raise the second finger from the "frog" if the shuttle completes its course from box to box; but should any occurrence interfere to cause the absence of the shuttle, then the first lever would press the swell in, and allow the third one to be raised and struck by the advancing stud, and consequently force the second lever on to the "frog," and stop the loom.

It will be seen from the description given by the patentees, that the positive dwell of the heddles, when the shed is open, is one of the things they claim; but the same thing can be done, and *is* done, by the common wypers better than what it is in this loom. But their last claim for the contrivance that takes the pressure off the shuttle before it is picked, is a very good thing, although it has been applied to power-looms before.

## SCOB OR FLOAT PREVENTER.

When the weft passes over a portion of the warp without being interwoven with it, the defect is that the yarn hangs loose at that part, and it is called a Scob, Float, or Flow; and to have a contrivance that would really prevent floats without any other draw-back, would be a very good thing indeed for the power-loom; but all the plans hitherto tried have not as yet proved successful.

When a warp thread breaks, and the end of it gets entangled with the other warp threads, it prevents that part of the web from forming a shed, by holding both halves of the warp together in front of the reed. The shuttle must pass either above or below this part; if it passes below it will work a float, if it passes above it will do the same, but it is in general thrown out of the loom when it passes above. By putting the tips of the shuttle a little nearer the under side of the shuttle than the top of it, it will always pass under the part of the shed that is obstructed, and in doing so will receive a certain pressure on the top. After this explanation, the following plans for preventing scobs will be understood without much study.

The first plan was to have the shuttle made with its tips as described, and a small nob like part of a circle projecting a little above the top surface of the shuttle, and this was connected to a lever of the first kind which was placed in the inside of the shuttle, being in the same direction as the skewer. The end of this lever pressed upon a small pin that was placed between the tip and the eye of the shuttle in front, and this pin and lever were so shaped that when that part of the warp which would make a scob, pressed upon the nob, it caused the pin to project from the fore side of the shuttle, and thus prevented the shuttle from getting into the box, and the loom was stopped by the common protection.

Another plan (but this one requires to be put on a loom that has the weft motion on it) is to have the shuttle made in the same form as in the other plan, with a cutter that will cut the weft shot at or near the shuttle eye, and when this is done, the loom will be stopped by the action of the weft motion in the same manner as if the loom were working without weft. It will be obvious to those who know what a shuttle is, and its use, that in applying this apparatus to it, it must be in as compact a form as possible, and all to be inside of the shuttle except the small curved part of the nob that the yarn is to press upon, and to be so placed as not to weaken or destroy any other part of it; also, so arranged as not to be a drawback to the weaver when changing and filling the shuttle.

Some years ago a description was given of a shuttle in the following words:—"The said invention relates to shuttles, and consists in the addition of an improved apparatus for the twofold purpose of preventing the occurrance of what is technically termed 'float,' and of retaining the cop on the spindle and preventing its being shaken off by the vibration in the shuttle caused by the blows of the picker. The defect termed 'float' is caused by imperfect shedding, and in order to prevent it, we cause the twist or threads of the warp which obstruct the shuttle race from being insufficiently raised or depressed in the shedding, to press down a small hook or cutter near the eye of the shuttle; and this being done, the loom is stopped by the action of the weft motion, in the same manner as in an ordinary case of broken or exhausted weft. It is proper to mention here, that hooks or cutters of this kind have before been applied or attempted to be applied for this purpose; and therefore, we wish it to be understood that this part of our invention does not consist in the use merely of such hooks or cutters, but in the mode of applying and fixing them to the shuttle hereinafter described, the peculiarities of which are, the compact form of the apparatus and its capability of being affixed on the solid part of the shuttle, so as not to weaken the sides thereof—the entire absence of every part of the apparatus from the body of the shuttle, so that it is no longer liable to be interfered with or damaged by the weaver in the act of removing or replacing the cops, and the incorporation with it of the transverse plate hereinafter described, for the double purpose of retaining the cop on the spindle and masking the hook or cutter so that it may not catch the yarn in its passage from the skewer, except when depressed for that purpose, &c., &c."

But no more need be said about it, for it is clear that the party who wrote the description was not a practical weaver, and the principle is already described.

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## THE SHUTTLE CHANGER.

A few words in this place will suffice for a description of this contrivance, but we may have occasion to say more about it in another place. It is an apparatus for changing the shuttle when the weft cop is run done, or the weft thread broken in the working shuttle without the assistance of the weaver. The loom that this apparatus is applied to must have the weft stopper motion, and the brake and the west stopper fork should be on the side of the loom opposite to the driving pulley; it is also necessary it should have a crank shaft with fly-wheels upon it; the brake acts on the fly-wheel next the driving pulley. When the weft motion stops the loom, and the swell that is placed on the rim of the fly is so set that it allows the shuttle to be thrown to the driving pulley side of the loom, before it is entirely stopped, for although the weft motion pulls off the handle of the loom when the shuttle is at the opposite side of the lay, the loom has acquired as much force with its fly-wheels as carry the shuttle to the other side where the changing apparatus is placed. It will be obvious that the loom will stop always at the very same place, in consequence of the swell on the fly-wheel. Suppose the loom is stopped when the lay is about one inch from the fell of the cloth, and the shuttle with the cop in it is placed on a level with the race of the lay, two inches in front of the shuttle box; and suppose the front or fore box side moves down until the top of it is level with the race of the lay, then a pair of fingers from the back box side pushes the empty shuttle over the top of the front box side, and it falls into a keeper placed below the sole of the lay, to lie there till the weaver removes it. The shelf that holds the full shuttle now moves towards the lay, and at the instant it touches the front of it, the shuttle is pushed on to the lay, and the front box side rises up to its original position; when this is done, a small lever takes hold of the shuttle and puts it as far back into the box as the driver will allow, in the same way as it is done with the weaver's hand when changing the shuttle. The shuttle is now changed, and the loom ready to be put again in motion by pushing the handle into its proper position. This is done by a lever for the purpose, which is explained further on. It is already explained how the loom is stopped when the lay is within an inch of the cloth. The instant that the weft motion disengages the handle of the loom, it throws the belt on to the loose pulley, and at the same time puts into gear the shifting apparatus which is driven with the loose pulley. On the eye of the loose pulley is a pinion in the proportion of one to three of the wheel that it drives; the wheel is a solid one without arms, and has on its side cams or grooves for working the different levers, which are all compactly fitted into a framing that is bolted to the side of the loom right below the driving pulley.

The reader will observe from the foregoing description, that the first movement is the front box side, and one lever takes it down and puts it up; this first lever, as it is named, also pushes the shuttle over the edge of the lay into the keeper; the second lever moves the shelf with the full shuttle towards the lay, and a third lever puts the shuttle into the box and shifts it as far back in the box as the driver will allow. The fourth lever pushes the handle of the loom on, and throws the shifting apparatus out of gear, to stand until the next time the weft shot breaks.

From the time that the loom stops when the weft shot is broken, to the time it is put on again with the full shuttle, is three shots, but it might be managed by the loss of only two shots, and then the pinion on the loose pulley would require to have only one tooth for two that is in the apparatus wheel.

## ARTICLES ABOUT A LOOM.

It will be of advantage to the beginner to know the names of the principal things that compose a loom, as it will enable him to understand the various descriptions given in this work; and before proceeding further, a short explanation of some of them will be given.

## DRIVING PULLEYS

Are the pulleys that are fixed on the top shaft for giving motion to the loom; the loose pulley is the one the belt runs on when the loom is standing.

## CRANK SHAFT,

Sometimes called the top shaft, or driving shaft, is the main one in the loom, and has the pulleys on the one end, and a pinion on the other. It is from this shaft that the lay receives its motion by means of the connection rods.

## CONNECTION RODS.

The crank shaft has two connection rods which are attached to the lay or swords of the lay. In some looms a small rod for working the uptaking motion is known by this name.

## WYPER SHAFT

Is the shaft that works the shedding and picking motion, and is driven by the crank shaft with a pinion gearing with a wheel on the end of the wyper shaft; this shaft makes only one revolution for two of the crank one.

## YARN BEAM.

That cylindrical piece of wood or iron which is used for holding the warp yarn; on it are placed two flanges, which are set at a distance from each other to correspond with the breadth of the web. There is also on it an iron pulley at each end, which are called pace pulleys, because a rope or cord is passed round them for pacing the web. The end of the pace cord is tied to a lever which is called the pace lever, and the weight that is put on this lever is the pace weight. The iron pivots that the beam turns upon are called the gudgeons.

## CLOTH BEAM

Is the beam on the opposite side of the loom from the warp beam for winding up the cloth as it is woven; on the end of this beam is a spur wheel which is called the cloth beam wheel; in some looms this beam is covered with emery or card sheets, and then it is named the card or emery beam. When this is the case, a wood roll is used besides, and is called the cloth roll, because it receives the cloth as it is delivered from the card beam. In hand-looms the card beam is not used, and very seldom does the hand-loom weaver use flanges for their yarn beam, as they build the selvages of the web like a cone, by holding the ravel in an oblique position at an angle from the yarn beam, making the yarn build narrower as the beam increases in diameter.

## SWORDS, LAY, AND ROCKING SHAFT.

Swords are these parts of the loom that the lay is fixed to; for power-looms, they are made of cast-iron, and are fixed on the rocking shaft which stretches from one end of the loom to the other, near the floor. The lay is bolted on to the upper ends of the swords, and the connection rods are either fixed to them or the lay. The sole of the lay is that part of wood or iron where the race is fixed on, and the shuttle runs upon the race. The top shell is that part of the lay which holds the reed by the top rim, and the under rim of the reed is placed in the under shell, sometimes named flighter. The protecting rod is that round piece of iron, which is placed along the lay, either below it or at the back. The box sides are those parts made either of wood or iron, that keep the shuttles in their proper places at the end of the lay, after they have passed through the shed. The spindle heads are those pieces of iron that hold the ends of the spindles that are next to the web.

## BREAST BEAM

Is the rail in front of the loom that the cloth passes over as it is woven to the cloth beam. It is on this rail the self-acting temples are fixed; by hand-loom weavers it is sometimes called the slab-stock.

## PICKING ARM, PULLEY, AND CONE.

The picking arms are those levers that are keyed on the wyper shaft, with a slit in them for the purpose of receiving the studs that carry the picking pulleys; and the picking pulley strikes against the treadle, lever, or some other movable article that gives motion to the shuttles. Sometimes a bracket of a particular curve strikes against a cone or small pulley called a truck, which is made to pick the shuttle.

## CAMS OR WYPERS

Wypers are those pieces of cast iron of an eccentric shape that are fixed on the under shaft for moving the treadles that shed the web, and the small castings, with the pulleys in them, that are on the treadles, are named the shedding trucks; the curved plates used for moving the tweeling treadles are called wypers or cams. Sometimes the picking arms are named cams.

## PICKING STICK

Is the piece of wood that has the shuttle cords attached to it for pulling the picker that throws the shuttle; they are made of various lengths and thicknesses, some of them round and others flat.

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## UPTAKING MOTION

Is a term given to that piece of mechanism which winds up the cloth on the cloth beam when the loom is in the act of weaving; one kind is called the bell crank motion, which does not take up the cloth regularly, the quantity of shots being regulated by the weight of the pace or friction put upon the warp yarn; the other takes up the cloth uniformly, and the number of shots or picks is regulated by a pinion named the change pinion. This motion commonly consists of a connection rod attached to the end of a lever of the first kind, and at the other end of the lever is a catch for driving the ratchet wheel; and on the eye of this wheel is put the change pinion which drives the spur wheel on the end of the cloth beam. There is another catch that falls into the teeth of the ratchet wheel, which holds it from turning back.

## GEARING.

When speaking of gearing in connection with a power-loom factory, it is understood to consist of—first, the main gearing, and second, the small gearing. The main gearing are the shafts, wheels, brackets, bushes, and belts that are between the engine and the shafts in the flat or shed with the drums on them for driving the looms. And the shafts with the drums, grounds, hangers, bushes, and bolts, are what is called the small gearing, although the shafts may be both large and long.

# CHAPTER V.

## CHECK AND DAMASK POWER-LOOM.

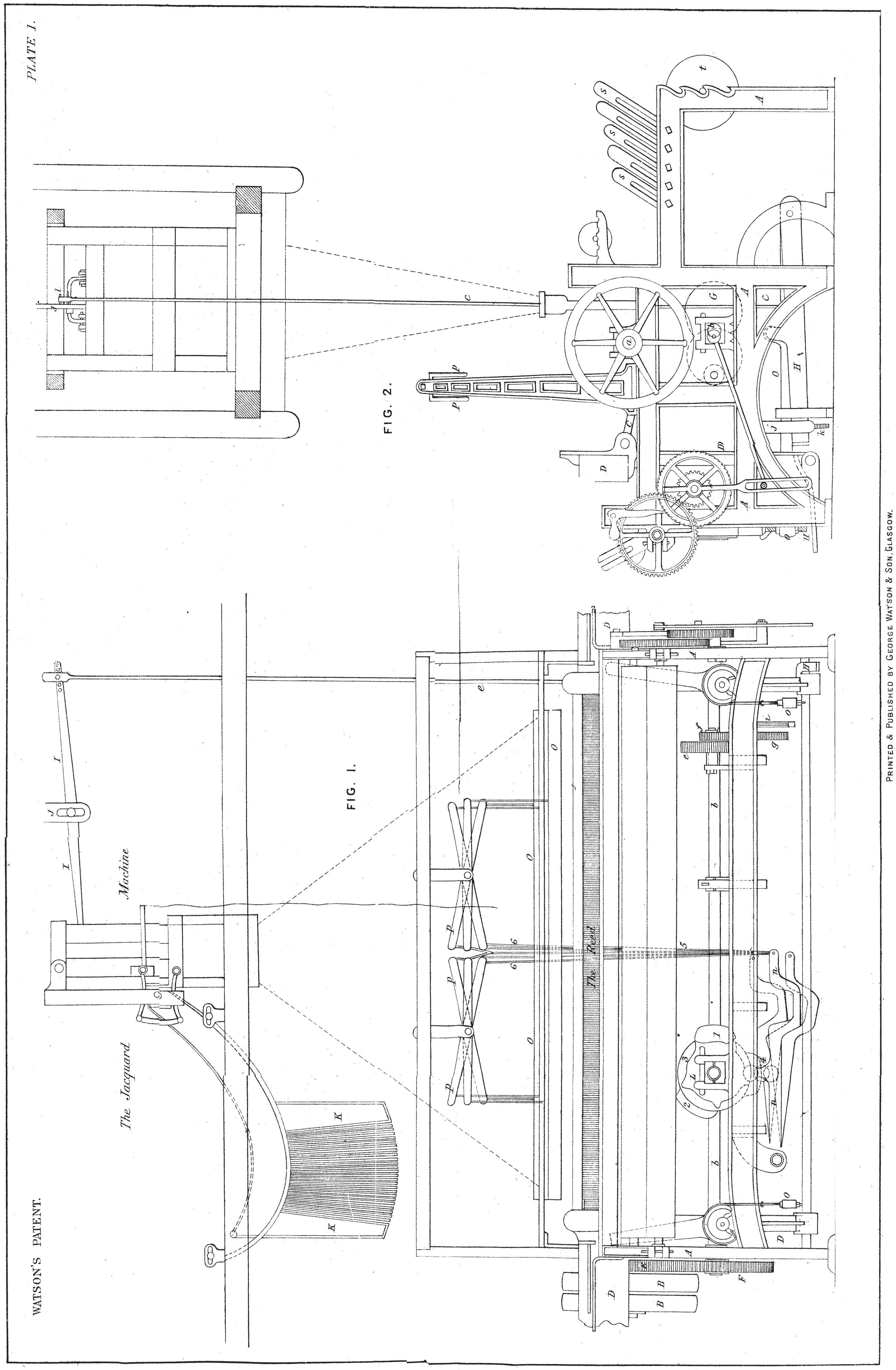
This is a loom which requires a considerable quantity of machinery and extra mounting, more than what is required in a common power-loom, as will be seen from the drawings given. It is the most complete loom that has yet been brought out for fancy work, when it is mounted for pressure harness, and for six or ten shuttles—as the reader will observe from the description, and drawings, that any number of shuttles can be used as far as the space in the loom will admit of. It is so planned that any shuttle can be taken that is required for the pattern, and the pattern is only limited by the number of cards the manufacturer chooses to use; and if the reader will pay attention to the descriptions which will be given with reference to the drawings, it will be easily understood. A patent was obtained for this loom at the time when it was brought out, so we shall first give the description as given by the patentee, and then explain its different parts in a manner that will enable the workman to mount the loom and work it.

The following is the specification, with a description of the drawings:—

## WATSON'S SPECIFICATION.

"To all whom these presents shall come, I, John Watson, of Glasgow, manager to Messieurs Gilmour and Kerr, power-loom cloth manufacturers, send greeting:

Whereas, Her present most Excellent Majesty Queen Victoria, by Her Royal Letters Patent under the Great Seal of the United Kingdom of Great Britain and Ireland, bearing date at Westminster, the twenty-first day of December, one thousand eight hundred and forty-six, in the tenth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said John Watson, my exors, admors, and assigns, Her especial license, full power, sole privilege and authority, that I, the said John Watson, my exors, admors, and assigns, or such others as I, the said John Watson, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England and Wales, and the town of Berwick-upon-Tweed, my Invention of "IMPROVEMENTS IN WEAVING BY JACQUARD LOOMS BY POWER,"

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in which said Letters Patent is contained a proviso, that I, the said John Watson, shall cause a particular description of the nature of my said Invention, and in what manner the same is to be performed, by an instrument, in writing, under my hand and seal, to be enrolled in Her said Majesty's High Court of Chancery, within six calendar months next, and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

Now know ye, that in compliance with the said proviso, I, the said John Watson, do hereby declare that the nature of my said Invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following statements thereof, reference being had to the Drawings hereunto annexed, and to the figures and letters marked thereon, that is to say:—

My invention consists of improvements in the mounting of power-looms and in the application of additional apparatus thereto, whereby certain varieties of pattern fabrics not hitherto produced in looms of that kind may be economically made; and in order that these improvements may be fully understood and really carried into effect, I will proceed to describe them in reference to the Drawings hereunto annexed, in the various figures of which the same letters are used to indicate the same parts wherever they occur.

## DESCRIPTION OF THE DRAWINGS.

"Plate I. In this Plate figure 1 is a front view of the loom, showing its connection with the Jacquard machine, also a front view of the apparatus for disengaging the connection of that machine when required, together with the cam barrel and levers for working the heddles in connection with the harness. Figure 2 shows an end view of the loom with the cam and lever for working the Jacquard machine, the supports for the "stenting rollers," and other parts.

Plate II. In this Plate figure 3 is a ground plan of the entire loom, of which figure 4 is a general section. Figure 5 is a side and end view of the disengaging apparatus detached.

Plate III. In this Plate figure 6 is a front view of the loom, in which are shown the shuttle box of the lay, and the details of the apparatus for working it. Figure 7 is an end elevation of the same.

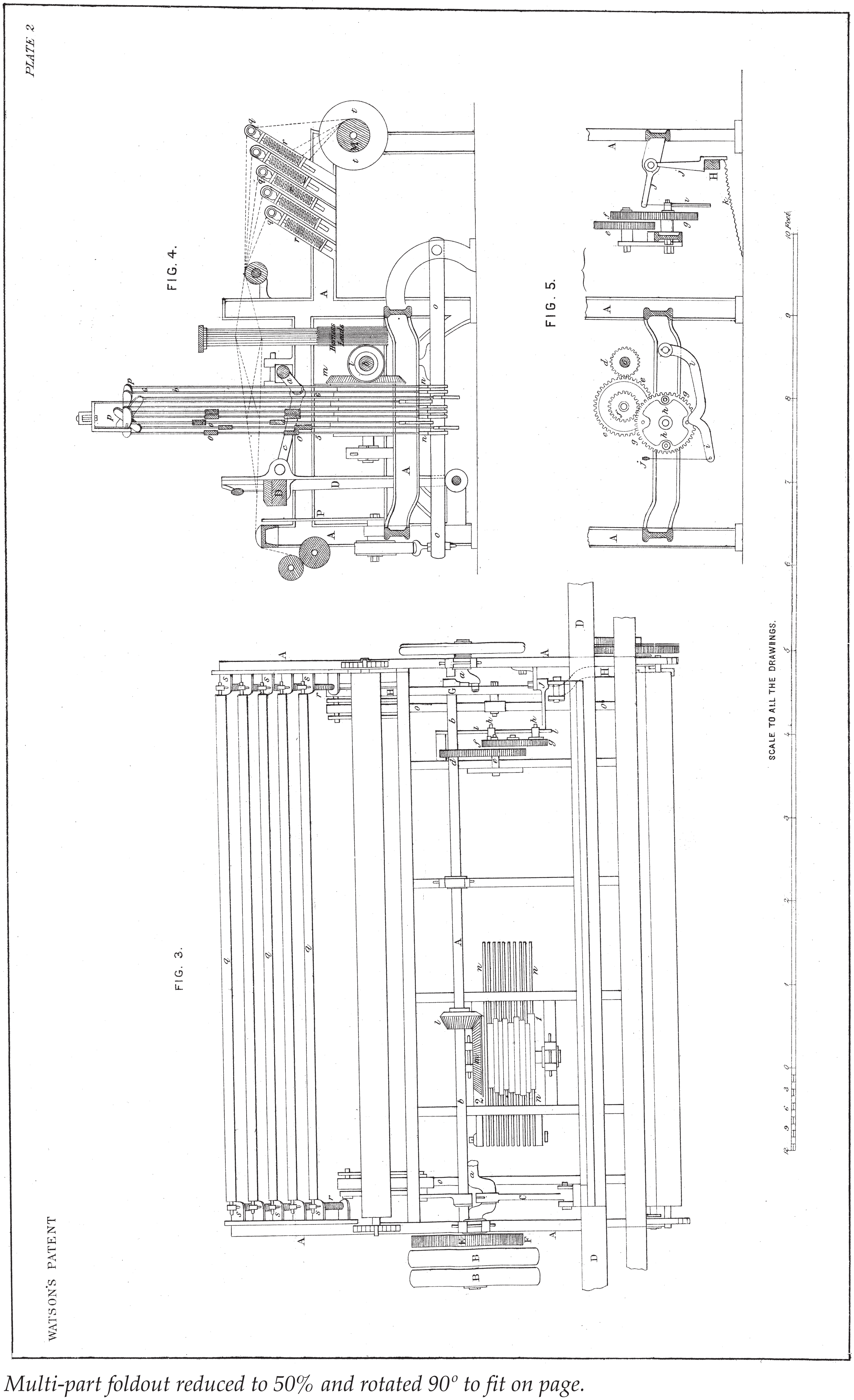
Plate IV. Figure 8 in this Plate represents an elevation of the loom, as seen from the back. Figure 9 is a general section showing the internal arrangement of the levers for working the shuttle box, &c. Figure 10 is a ground plan. Figure 11 is a vertical section through the shuttle box, showing the gearing by which it is shifted. Figure 12 exhibits the details of the weft protector detached.

The main frame of the loom marked A is similar to that of other power-looms in common use. The motive power is communicated to the working parts in the usual manner by a band from a drum on one of the leading shafts of the factory passing to the pulleys B, B, one of which is fast and the other loose upon their common axis (*a*) as in other power-looms. The reciprocating motion of the lay is derived from two cranks on the pulley shaft (*a*) by means of two connecting rods C, C, attached by pin joints to the lay swords D, D. On one extremity of the shaft (*a*) is fixed a wheel E, which is in gear with the wheel F, on the corresponding extremity of the second shaft (*b*). The ratio of the wheels E and F is as 1 to 2, so that the shaft (*b*) makes exactly one revolution for every two picks or shots thrown. On the same shaft (*b*) is fixed the cam or wyper G which works the Jacquard treadle H of the loom when employed in producing fabrics requiring the use of that apparatus. The motion of the cam G is transferred to the Jacquard lever I, which communicates with the treadle H by means of the small rod (*c*), and is supported by a stud on a bracket J, attached in any convenient manner over the loom. The action of these last-mentioned parts are as follows:—When the cam G revolves, it depresses the treadle H, and consequently the end of the lever I to which it is attached by the rod (*c*). This action necessarily raises the opposite end of the lever I in connection with the

Jacquard machine, but immediately on the treadle H being depressed by the cam it is brought under the control of the "disengaging apparatus" to be hereafter described, and which keeps it down, and consequently causes the Jacquard lever to maintain its elevated position, until the required number of picks or shots pertaining to the card of the machine at the time being passed is thrown, when the treadle rises, and the cam G comes again into action. The treadle H is made to project in front of the loom to enable the weaver to turn back the cards of the Jacquard machine when any derangement takes place, and it is required to open out any number of picks. By this arrangement the weaver avoids the inconvenience of working the loom empty, that is, without weft, for the purpose of bringing the proper card into position. The conditions necessary to be observed in forming the cam G are as follows:—First, the part of the periphery which comes first into contact with the treadle H ought to have a curvature of large radius so as to cause the Jacquard lever I to commence its rise slowly, and gradually to accelerate its motion until it has attained half the required elevation, when its motion ought gradually to decrease until it has risen to the highest point of elevation necessary. By thus regulating the motion of the lever, any undue vibration of the leads of the harness is avoided during their rise, and the cards are less liable to be deranged on the barrel of the Jacquard machine. When the lever has remained up during the time requisite, it is again slowly lowered by the action of the cam becoming gradually less, until it finally ceases to act upon the treadle H, in consequence of the hollow portion of its periphery being brought opposite to the point of contact with the treadle. The succeeding lift is regulated in the same manner as above described. To regulate the number of shots or picks on the cards of the Jacquard machine, the following arrangement is adopted :—A small pinion (*a*) on the shaft (*b*) gives motion to the wheel (*e*), formed with a hollow projecting boss on which is fixed a change pinion (*f*), gearing with the wheel (*g*), carrying one, two, three, or more small studs, as the pattern may require. On these studs are carried the small friction pulleys (*h*, *h*. . .) which, coming round on the under side act on the lever (*i*), causing one extremity of it to descend. In this extremity is a hole through which a cord is made fast, and which communicates with the bell crank lever (*j*). The purpose of this is to keep the treadle H depressed when the cam G has acted upon it; and again, when the lever (*i*) is pressed down, it necessarily pulls the cord attached to the bell crank lever, and takes this out of contact with the treadle H at the instant the cam G begins to act upon it, thereby letting down the needles of the Jacquard machine with the same kind of gradual motion as they were raised. When the machine is ready to take another lift, the small spring (*k*) by contracting pulls the bell crank lever (*j*) into contact with the treadle H, and the action proceeds as before described.

The mode of working the heddles may be understood from the following description in reference to the Drawings:—A shaft carrying a series of cam plates (marked L) is driven from the shaft (*b*) by a bevil pinion (*l*) gearing with the bevil wheel (*m*). The ratio of this pair of wheels is properly adjusted to the tweel which is required to be put upon the cloth at the time worked. The cams are so formed and set in relation to each other, that the heddle leaves all stand steadily in one position, except the two leaves in action at the particular time The projection marked 1 on the cams is for sinking the heddle leaves, and that marked 2 is for raising them, while the circular parts marked 3 are for keeping those leaves steady which are out of action. These cams are so pitched or set as to work in unison with each other, and with the Jacquard machine and the lay $D^1$ while the loom is in action. When the point 1 comes round to the part of the treadle at 4, it causes the treadle (*u*) to descend at the point, and the cord marked 5 being attached to the extremity of the treadle (*u*), and also to the heddles (marked *o*), it makes the shed downwards; and the treadle ($u^1$) being acted upon simultaneously with the treadle (*u*), and the cords marked 6 being attached to the contiguous extremities of the upper levers ($p$). these extremities are depressed by the action of the cords when pulled; but the levers being suspended on an axis at or near the middle of their length, the depression at one end is necessarily accompanied by the corresponding elevation of the contrary end, which being attached by cords to the heddle leaves, the effect is to cause those acted upon to shed upwards, and the other heddles being connected in the same manner, the cams to which they are respectively related retain them in a middle position, neither up nor down, until by the motion of the common axis of the cam barrel L they are brought into action, and those previously engaged thrown idle. This arrangement of parts, and the motions above described, are principally adapted to working two, three, four, five, or six thread harness more or less as may be required, and can be applied to work four, five, six, seven, eight, nine, or ten heddle leaves, and the advantage of it is that the cams keep the idle leaves steady when the others are shedding. The tweeling cams may be formed of simple plates cut to the required shape, or they may be formed with loose marginal pieces made to fit upon permanent centres. They may also be formed with rollers at the projections marked 1 and 2. The stenting rollers ($q$), shown in figures 2, 3, and 4, are carried in bearings acted upon by springs, to allow the yarn to yield, yet remain tight when the heddles or harness is acting, without sujecting it to unnecessary strain, which it would be were no such provision made for its stretch when the heddles are shedding. There is one of these rollers for every leaf in the set of heddles employed, and the springs marked (*r*) are so adjusted in tension as to keep the yarn at the degree of tightness required for putting on the requisite number of shots or picks on a given length of the warp yarn. In the figures referred to above, the arrangement of parts is adapted to a five-leaved set of heddles, but may be extended to any number, more or less, as may be required for the particular kind of fabric to be woven; the yarn passing through the eyes of the heddles of any particular leaf, passes over one of the rollers, and that particular roller yields to the yarn when the leaf of heddles through which it passes is forming a shed, producing a similar effect as if the yarn were elastic in itself. The brackets (*s*) carrying the rollers and springs are fixed on the two side frames of the loom in any convenient manner. The yarn beam M, the pace pulleys (*t*), the pace weights N, the picking treadle O, the picking stick P, are similar and similarly applied as in other power-looms.

I will now describe the selvage protector, the use of which is to prevent the warp yarn from being broken by the weft shot drawing it too tightly. The small pins (*u*) at each side of the web work up and down

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alternately, each being down for the shot on that side from which the shuttle is thrown. The two cams ($v$) on the shaft ($b$) (see figures 8, 9, and 10) are formed with recesses to allow the levers ($w$) to fall. These last are fixed in brackets at the back rail of the loom, and the small pulleys marked 6 in the levers ($w$) lift the levers ($x$) which are suspended on axes at ($y$), so that when the recesses in the cams successively come round, they allow the pins ($u$) to fall into position at the selvage, taking hold of the selvage threads, and the weft of the successive picks turns upon them, thus preventing all unnecessary strain on the selvage yarn. The cams are so made and set in relation to the movements of the loom, that whenever the shuttle is in the box of the lay at the contrary side, the pins ($u$) rise out of contact with the yarn, and move slightly back to allow the lay to drive up the weft shot to the fell of the cloth without touching the pins.

I will now describe the apparatus for working the shuttle box Q, when three or more shuttles are employed for the purpose of putting in different kinds of weft into the web. The Drawings marked Plates III. and IV. show an arrangement for six shuttles, and the mechanism is so constructed and adapted that any number of shots of one kind of weft from two upwards, may be thrown in any order whatever of the shuttles answering to the particular pattern to be woven. When the box Q is to be shifted to change the shuttle, one of the cords marked 7 attached to a spring marked 8 is pulled up by the Jacquard machine, and this cord being attached to one of the bell crank levers (*z*) provided with a toothed segment at one extremity, makes the small tumbler ($a^1$) to rise in its place in the lever or treadle R, and this tumbler ($a^1$) being movable on a centre in the treadle when the cam S on the shaft (*b*) comes round and depresses the treadle, the two chains at its extremity are so adjusted as to act upon the pulleys ($b^1$) to which they are attached on the rod T. On this rod are also two wheels ($c^1$. $c^1$), gearing with the racks ($d^1$, $d^1$) (see figure 11), which cause the box to shift to the position required. Immediately on this being effected, the cam S passes over the tumbler ($a^1$), and touching the bell crank (*z*), throws it back, thereby causing the tumbler to fall into its place in the lever R, and so on for every subsequent shift of the shuttle box. Every shuttle has its own lever, tumbler, and pulley; and the cam S making one revolution for every two shots thrown, it is always ready to shift the box Q to whatever position the Jacquard machine shall indicate. To this end the pattern must previously be all completely arranged upon the cards of the Jacquard machine. The shaft T is supported in bearing, attached to the swords of the lay, and therefore partakes of their reciprocating motion. I wish it also to be observed that the treadles or leavers being each attached by two chains, one on each side of the pulley ($b^1$) of that treadle, they can every one act independently of the others. That the box Q may shift freely, the cam U on the shaft ($b$) is so pitched as to allow the small pulleys marked 9 to come out of the notches in the racks ($d^1$, $d^1$). When the box has been shifted to its proper position, the cam U turns its full side to the pulley and the lever W, and pulling the connecting rod ($e^1$), which is flexibly attached to the small horizontal lever ($f^1$) at the bottom of the lay sword, it causes the upright lever ($g^1$), centred on or near the middle of its length, to act upon the spiral spring ($h^1$), which, pulling the frame carrying the small pulleys marked 9 into the notches of the racks ($d^1$, $d^1$), holds the box firmly in its proper place until the instant for shifting again arrives. The reason for having all the leavers working at the rocking-tree shaft X is, that at that point there is the least motion of the lay. The weight of the shuttle box is counterpoised by the weight Y, to render it more easily shifted. The weight is suspended by a cord or chain from the top of the box passing over the pulley Z; and to prevent the motion of the lay from communicating to it a swinging motion, it is controlled by a small guide rod attached to the contiguous sword of the lay. The protecting rod ($i^1$) shown at the back of the lay in figure 8, is similar to that in other power-looms.

I will now describe the mode of stopping the loom, when it happens from any cause during its working, that the shuttle driver is not taken back to its proper position, it being understood that the driver or picker ($k^1$) ought always to be back when the box is shifted, to touch the small curved lever ($j^1$) shown in front of the shuttle box Q, and send that end of it back also. The effect of this is to raise the other end of the lever, and consequently the lifter ($l$) clear of the frog; but when any derangement occurs to prevent the driver from getting back, the lifter is not raised, but striking on the frog or movable catch ($m^1$), this last is brought into action upon the upright lever ($n^1$), and pushing it forward transfers the motion along the rod $A^1$ in front of the loom to the opposite end, at which is the lever ($o^1$) connected with the handle $B^1$ for stopping the loom. To secure the correct shifting of the shuttle box, before picking the first shot of the shuttle shifted to, an apparatus called the protector is provided, the character and action of which may be understood from the following description with reference to the Drawings. The small pulleys marked 9 on the brackets V, enter the notches of the racks ($d^1$, $d^1$) when the box Q is in its proper position, and the bracket V pressing on one end of the lever ($p^1$) at the back of the shuttle box, causes the other end to press on the rod descending from the back tongue of the protector, and lifts it over the notch of the frog ($m^1$) (see figure 7); but if not lifted, the tongue ($l^{11}$) strikes the frog when the lay is going back, and a pin in the frog pushes the lever ($q^1$) back, and this being in connection with the lever ($n^1$) and the rod or shaft $A^1$, pulls the handle $B^1$, and stops the loom.

The weft protector, which I now proceed to describe, is similar to that in common use on the side of the loom contiguous to the driving pulleys B, B; but it is also applied at the side of this loom where the shifting shuttle box is situated, to allow the loom being stopped whenever any of the weft shots fail. To accomplish this, I employ an apparatus of the kind depicted in the Drawings, and which may be understood from the following description:—A frame ($r^1$) is fixed to the sword of the lay on that side at which the protector is to be applied, and in this frame is a lever ($s^1$) carrying a small fork at its extremity for lifting the weft of the idle shuttles out of the way of the weft stopper forks ($t^1$). The lever $S^1$ is lifted by a wyper or cam $C^1$, on the shaft ($b$), and allows the shuttle to pass below it from the single side of the lay. After it has passed into the box Q, the wyper $E^1$ acts upon the hanging lever ($v^1$), which pulls the lever ($w^1$) hung upon the frame ($r^1$) or sword of the lay. This lever is provided with a friction pulley, and being pulled back disengages the small wires holding up the threads of weft, and allows them to fall to the race of the lay, when the wyper $C^1$ acting upon the lever ($v^1$) allows the lever $S^1$ to fall to the bottom of the slit provided for it in the race of the lay. This done, the wyper

$E^1$ allows the spring or weight ($x^1$) to pull the lever ($s^1$) with its fork under the weft shots, when the shuttle has passed to the single side of the lay, and thus lifts all the weft shots by the wyper $C^1$ acting on the lever ($u^1$), as before described. When the weft of any shuttle is run out or breaks, the fork ($t^1$) is not lifted, and the arm $F^1$ on the shaft ($b$) acts in consequence upon the lever ($y^1$), and thereby communicates motion to the hauling catch ($z^1$), which pulling the lever $G^1$ pushes forward the upright lever ($n^1$), and this acting upon the handle of the loom stops it in the same manner as the other protectors before described.

Having thus described the nature of my Invention, and the means employed by me for carrying the same into effect, I would have it understood that I do not confine myself to the details shown and described, so long as the peculiar character of any part or parts of my Invention is retained. But what I claim is,—

Firstly, the particular shape or form of the cam or wyper G on the shaft ($b$) for working the Jacquard machine.

Secondly, the form and position of the treadle H, whereby it is made to project in front of the loom, for the purpose of enabling the weaver to work the Jacquard machine independently of the loom.

Thirdly, the peculiar apparatus for disengaging the Jacquard machine.

Fourthly, the application of a series of cams or other like mechanism for steadying the idle heddle leaves when the other leaves are working or in action.

Fifthly, the application of what I have called stenting rollers for keeping the yarn at proper tension, at the same time that it is allowed to yield to the working heddle leaves.

Sixthly, the apparatus depicted and described under the name of selvage protector.

Seventhly, the mode of working the shuttle box when three or more shuttles are employed.

Eighthly, the mode of applying apparatus to stop the loom from the double box side of the lay when the weft fails.

Ninthly, the mode of stopping the loom when the shuttle driver is not taken sufficiently back. And,

Tenthly, the mode of stopping the loom when the shuttle box is not properly shifted.

In witness whereof, I, the said John Watson, have hereunto set my hand and seal, this seventeenth day of June, one thousand eight hundred and forty-seven.

JOHN WATSON.

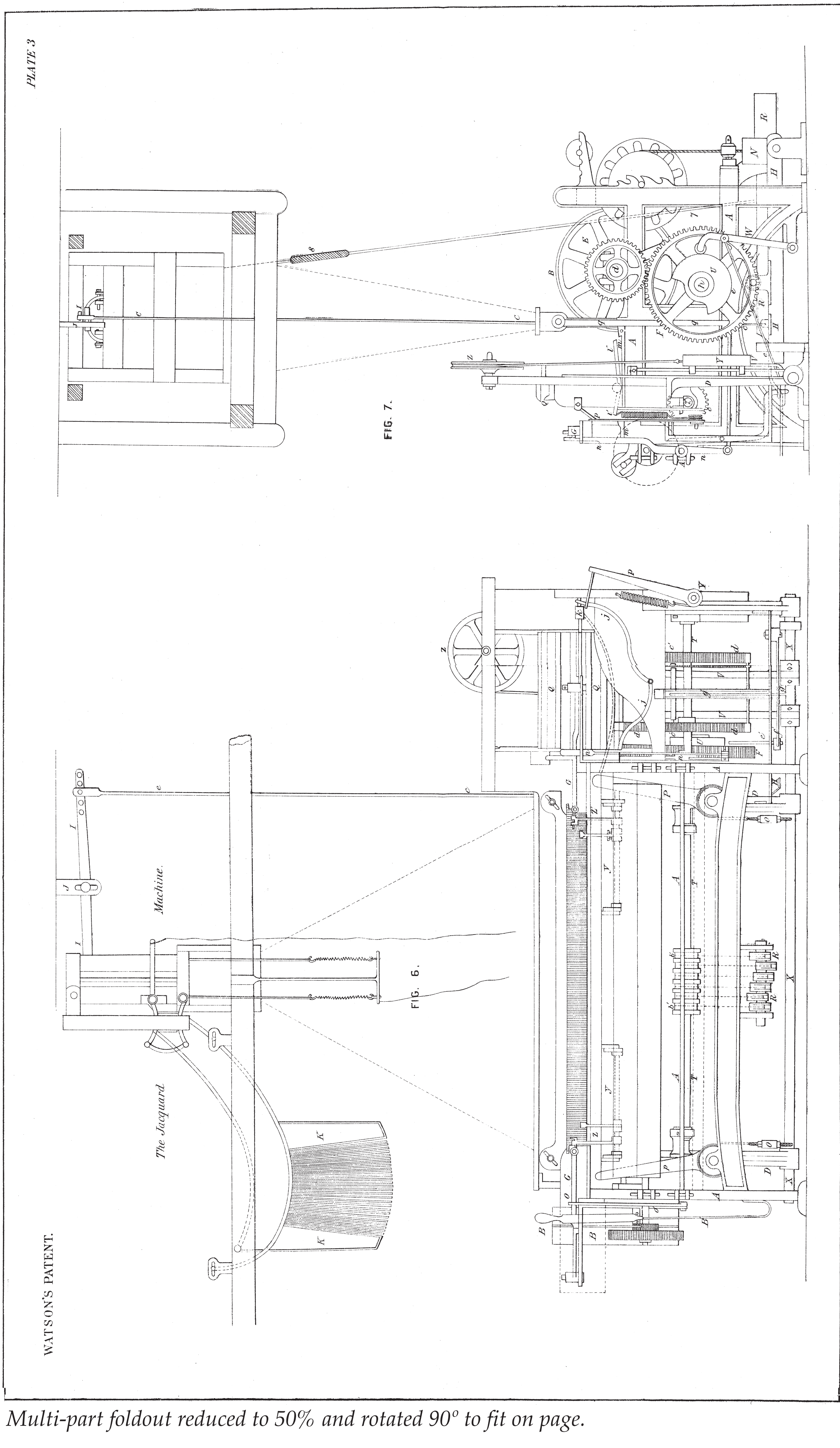
"And be it remembered, that on the seventeenth day of June, in the year of our Lord, one thousand eight hundred and forty-seven, the aforesaid John Watson came before our said Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified in form above written. And also the Specification aforesaid was stamped according to the tenor of the statute made for that purpose.

Enrolled the twenty-first day of June, in the year of our Lord, one thousand eight hundred and forty-seven."

## TO MOUNT A HARNESS LOOM.

The first thing that should be learned about Damask Weaving is designing the patterns; indeed, this is required for all kinds of figured weaving, and a great deal depends upon the selection of the patterns, but more will be said about this under another head—the remarks here will be confined to what is required for the mounting and starting of a Harness Loom.

The figure to be woven is first painted on design paper (see design paper), which must be of the proper proportion for the warp and weft, and the card-cutter cuts the cards from this painting; also the weaver or harness tyer, finds the number of tail cords that will be required for the pattern from this paper. After the quantity of tails are found that will make the harness, the workman will require the following articles before he proceeds to mount it.

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## MAILS

Are in general made out of sheet copper of an oblong shape, with three holes in them, and they answer the same purpose as the eyes of heddles, the warp of the web being drawn through the centre hole. They are made in a variety of shapes and sizes to suit the kind of work they are used for.

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## LEADS

Are from seven to twelve inches long, and may be made by casting small rods, and then drawing them in the same manner as iron wire, through holes of different diameters, until the proper size is got; they are used as weights in the harness, and are connected with twine to the mails. The weight of the leads to be employed will depend upon the weight of the work they have to do; for a full harness and light work, they may be made as light as to have about one hundred of them in the pound, but the weight of them must be increased in proportion to the weight of cloth. For a split or four thread (if not a pressure one) harness, about thirty in the pound will do; but if it be a four or five thread pressure harness, such as is used for table-covers, &c., &c., then they will require to be as heavy as to have only ten to sixteen in the pound. The leads in the centre of a web may be lighter than those at the border, as their action is more direct, and with gathered ties, the leads can always be used lighter than in those that are not gathered.

## HARNESS TWINE.

This twine is used for tying the leads to the mails, and forming what are called the sleepers and neck of the harness. It should be made from some substance that has little or no elasticity in it, at the same time flexible; it is generally made from flax yarn, with as many threads twisted together as will make the twine up to the strength that will be required for the kind of work that is to be woven. For full harnesses with light work there is no use in putting in twine heavier than six ply of eighteens, as it would be adding expense to the mounting for no purpose; but when the harness is a pressure one, with four or five threads in the mail, and with leads, that each one will weigh two ounces; then the twine requires to be very strong, and this strength can only be got by putting in more plies of yarn. At the sides of broad webs, the harness twine undergoes a great deal more friction than in the centre, and it might be profitable to use two sizes of twine, putting the lightest in the centre. However, much of this must be left to the discretion of the manager or workman.

## SLABSTOCK.

The slabstock is a piece of wood about six inches longer than the loom is broad; it is five or six inches broad, and one inch thick, with a groove made on the edge of it, for the purpose of holding the ends of the mails when the harness is being tied. The use of the slabstock will appear in the explanation given for mounting the loom.

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## HARNESS OR HOLE BOARD.

The hole board is made of plane-tree wood, or some other hard, smooth material, and is made as long as the loom is broad. For a full harness, the hole board must have at least as many holes in it as there are threads in the web that is to be woven; but they are scarcely ever made so as just to be the same set as the reed, because each part in the harness should begin with a full row in the board. Suppose the tye to be 360, and the board bored with eight holes in the row, this tye would fill exactly 45 rows, and the reed and hole board might be the same set; but if the tye was 350, it would fill forty-three rows and six holes; this would leave two holes empty in each part; consequently, it would require the hole board to be finer than the reed. In fancy work there are always many changes, and manufacturers find it better to have the hole boards made fine in the set, and when a coarser set is required than what the hole board is, they order so many holes to be left empty in the same manner as heddles are set when they are finer than the reed. The rows of holes run in oblique lines across the board, and that obliqueness depends upon the fineness of the set. In fine boards each row of holes embosom each other, to keep them from being too much crowded, and that the mails may stand as near as possible opposite to their respective intervals of the reed. In a full harness where two threads are put in one split of the reed, the two mails should just take the same space as one split, and when four threads are in one mail, it should take up the space of two splits, and so on, in proportion to the quantity of threads in one mail.

Hole boards used to be made by dividing them off with a pair of compasses, and was a matter of taste as to the number of holes in the rows across the board; but now they are made by machinery, and in general have eight holes in the row, and can be divided to have holes to suit any reed, as the apparatus for dividing the board is almost the same as what is used by the reed makers for regulating the set of the reed.

## STANDERS

Are articles which are required for holding the slabstock in its proper place in the loom, when the harness is being tied up. They are either made of iron or wood, about three or four inches broad, with a slit in the side of them, as wide as to allow the slabstock to get in.

## TO PREPARE THE HARNESS.

The first thing is Stringing the Leads (the name given to this operation), and it is in general done by children. The flax yarn used for this purpose is cut into pieces called hangers, in lengths about twelve or fourteen inches long, and laid on a small bench or table opposite the operator; the mails and leads are also put on this bench. The person takes one lead with the left hand, and with the right hand puts the hanger through the hole in the end of it, and then through the under hole in the mail; the two ends of the twine are then tied together, and hung on a rod with the mail uppermost; this operation is repeated until there is a sufficient quantity of leads and mails strung to make the harness. They are now taken off the rods in handfuls, by slipping the hand between the legs of the hangers, and allowing the leads to hang down, and are in this position put on the slabstock, and spread along it.

The next thing that is required is a piece of flat wire, a little longer than the harness is broad, which may be got from any reed maker, and on which the mails are placed one by one; the mails will now be all right above the groove in the slabstock, with their top eyes above the flat wire. The slabstock with the leads and mails are now put into a frame like the letter H, which is made of wood, the ends of it going into slits that are made in the sides of the frame for that purpose. The slabstock is moved up towards the cross bar in the frame, and when it and the cross bar are about fourteen inches apart, and parallel with each other, it is fixed in that place, for the harness to be what some weavers denominate "cast," which is, connecting the mails to the sleepers. Sleepers are made from the same kind of yarn as the hangers, in the following manner:—The yarn is first wound on bobbins, and one of these bobbins with the yarn on it is placed at the side of the frame upon a wire or spindle. The boy or girl, or whoever is to cast the harness, takes the end of the yarn that is on the bobbin and puts it through the eye of a common needle, and goes to the opposite end of the frame where the casting should begin; the needle is now put through the top eyes of fifty or sixty of the mails and the twine drawn along with it. After this is done, the end of the twine is taken out of the needle, and fixed to a nail or wire that is in the cross bar of the frame. These nails should be arranged along the cross bar, not more than four or five inches from each other, to prevent unnecessary loss of twine.

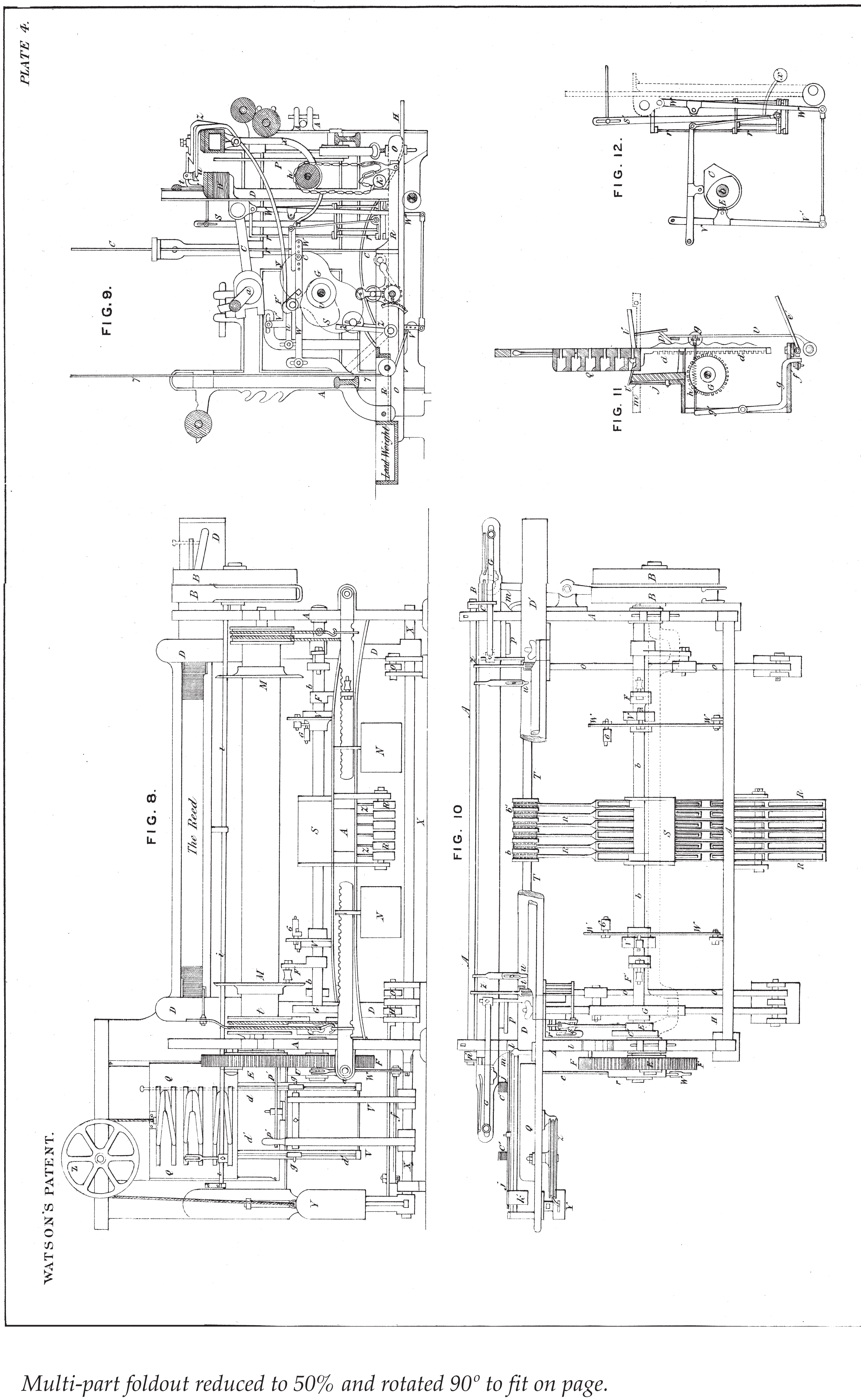
The caster now takes a piece of small wire or draw-point, and inserts it in between the end mail and the one next it, below the harness twine, and lifts the harness twine up to the nail in the cross bar. The draw-point is next inserted in between the second and third mail, and the twine put upon the nail as before, and so on with the remainder of the mails that the sleeper twine has been put through till finished. The foregoing operation is continued until the harness is all cast. It will be evident that in winding the yarn on the bobbins, it will not do to have any knots on the twine, as they would not pass through the eyes of the mails. The next thing is to take the sleepers off the wires, and cut them in the exact place where the wires were in.

Now that the harness is cast, the next process is to draw the sleepers through the holes in the harness board; and for illustration, we will suppose the tye to be a 400, the web to be put in a $12^{00}$ reed, and the yarn to fill as near as possible 38 inches of the reed. It will be seen from the table of splits in a web, that there are 1232·43 splits in a $12^{00}$ 38 inch, which will make, with 2 threads in the split, 2464 ends (keeping out the fraction) in the warp of the web; take off 36 ends for selvages, and the number will be 2428, which is divided by the tye, namely,—

400)2428(6 times over.
2400
———
28

This six times over means that the tye in this web is repeated 6 times, and there are 28 ends over, which must be left out, unless the pattern be very small, but in this instance, the whole 400 are required to complete the pattern; therefore, the 28 ends are left out, which will make the web about three-eighths of an inch narrower. This quantity, 2400, represents the number of sleepers that are to be taken through the harness board, and the holes in the board must be divided off, so as the harness will occupy exactly $37\frac{5}{8}$ inches, the space that will be filled in the reed by the warp of the web. After the holes in the board have been marked that are to be filled, it is hung up a little above the slabstock. If the person who is to draw the sleepers into the board be standing in front, the drawing must begin at the left hand side, with the back hole in the board; there being 8 holes in each cross row of the board, the tye will fill 50 rows, and it being 6 times repeated, as stated before, the harness will fill 300 rows exactly; but if the tye had not divided by the number of holes in a row (viz. 8), but left a few holes in the last row of the repeat, these holes must remain empty, as every repeat of the tye must begin with a full row.

The harness board, with slabstock, mails, leads, and sleepers, are now taken to the loom and placed in the position as seen at (*c*), in Plate III., Figure 7, which is an end view of a power-loom with a full harness;

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(figure 6 being the front view of the same), as will be observed, it is very near the front of the loom; indeed, a common full harness should be as near to the back of the lay as just to be clear of it when it is full back. If the harness is to be put up in a loom that has got no arrangements in it for allowing the harness board and Jacquard machine to be shifted after the harness is tied, the harness board in this case must be firmly fixed in its place, not to be shifted after the harness is tied, in any direction whatever. And, although there are arrangements made in power-looms for shifting the Jacquard machine and harness board to any position that may be required, still it is better to have them as near as possible fixed in their place where they are to remain when the loom is at work. To find the proper height for the mails, the lay is placed half way back, and a small straight edge put across the race, with the end of it projecting as far back as to reach the slabstock; the under edge of the straight edge where it crosses the top of the slabstock is the proper height for the mails, the slabstock being fixed in brackets which are bolted to the sides of the loom; the mails can be brought to their position by shifting these brackets up or down. After the slabstock is secured in its proper place, the hole board is next fixed in its place, which is about seven inches above the top edge of the slabstock, thus allowing the sleepers to be about eight inches above the hole board, and about seven below. The harness tyer now takes pieces of cord and ties them round the slabstock, at a distance of three or four inches from each other, for the purpose of keeping the flat wire with the mails on it close down to the slabstock during the time that the harness is being tied. When this is done, the sleepers are gathered into bunches, with four hundred in each bunch, and a piece of string put round them to keep each four hundred distinct. The Jacquard machine is now set in its proper position, which is right above the centre of the harness board. The usual method for placing the Jacquard machine is, to take one of the leads and attach a piece of harness twine to it, and hang it to one of the cords in the centre of the machine, which is then shifted till once the lead is exactly above the centre of the harness board.

The harness is now ready for beating and tying up, and the most expeditious way to do it is to have two or three persons to beat the harness, and one to tie it, which is done in the following manner:—Having ascertained the length of the neck twine (which is the twine that connects the sleeper to the tail cords in the Jacquard machine), and supposing them to be five feet long, a piece of wood, such as a heddle shaft, is taken, and two pins put into it, two-and-a-half feet apart, and the twine is reeled on to the pins for the neck, which will give the length required, by cutting it in the centre. Each person who is to beat the harness, gets a quantity of this twine and knots it to the sleepers, beginning with the back hole in the row on each part; and suppose there are only two beaters, each will hand up three ends to the harness tyer, who will tie them to the cord that is next the Jacquard machine barrel in front of the machine; this is what is called the first cord, and attention must be paid to the design to see that the flower is drawn to answer this; the tail cord next to this one in the cross row of the machine is the second, which the harness tyer takes next, and so on with all the four hundred tail cords, taking them in regular rotation. The knot used here is a matter of choice; if the snitch knot is employed at all, it should be between the neck twines and the sleepers, for the purpose of adjusting any of the mails that may be too high or too low, but the harness tyer should be very careful to have all the neck twines equally tight and the knots on the tail cords all the same distance from the Jacquard machine, for if the knots be not all in the same horizontal line, the heck for guiding the neck twines cannot be properly set.

When the harness is brought forward to this stage, the workman proceeds to take away the brackets that are bolted on to the sides of the loom for holding the slabstock, and for the purpose of keeping a lease in the harness, he ties a cord to the end of the slabstock, which is drawn through the legs of the sleepers when the slabstock is pulled out. This lease is to preserve the order of the harness, so that the person who is to draw the warp into the mails may get them in regular succession. The slabstock and brackets having been removed, a boy commences with the first lead at the side of the harness and brings the knot on the hanger down to the eye of it, proceeding from one to another until he goes over the whole of the hangers. The brackets for holding the harness board are now put on in the same place where the brackets were that held the slabstock, and the harness board fixed in its place. The harness is now ready for dressing; that is putting a sort of varnish on to the hangers and sleepers, and that part of the neck twine that will rub on the heck when the harness is working, but care must be taken that the varnish is thoroughly dry before the drawing of the warp into the mails commences. The drawing of the warp into the mails of a full harness is the same as drawing a plain web, which is explained at page 83.

The web being now in the loom, and the harness board fixed in its proper place, the tenter's next duty is to see that the yarn is in its proper position, which is just to be touching the race when the lay is half way back; if it be too high or too low, he moves the Jacquard machine up or down, as the case may be, till once the mails of the harness are at their proper place. The rod (*c*), as shown in Plate III., Figure 7, also in Plate IV., Figure 9, is now to be connected to the lever I, which works the Jacquard machine, and in doing so, care must be taken not to have the shed too large. It will be seen from the drawing that there are a number of holes on the lever for the purpose of regulating the size of the sheds. After this is done, he puts his foot upon the treadle H, and depresses it, and by doing so, the brander of the Jacquard machine, along with the whole harness and warp of the web is raised, and it is kept in this position until the workman puts four cards on the barrel, which cards have been previously cut for making plain cloth. The brander and harness are now lowered, and the plain cards coming in contact with the needles of the Jacquard machine, one half of them will be pressed back, and the next time the brander is raised a plain shed will be formed, when the first lease rod may be put into it. The next tread will make the other plain shed, when the second lease rod can be put in, then the loom will be ready for making plain cloth; and to make good plain cloth with the Jacquard machine, the different articles about it require to be nicely adjusted, which will now be explained.

## JACQUARD MACHINE.

The position that the Jacquard machine occupies in regard to the loom will be seen in Plate III., which is right above the loom, and it should be as near to the ceiling as it can be got, for the purpose of giving the harness twine as little angle as possible. If the machine is properly made, the upright needles should stand perpendicular when the brander is down, if they are not pressed back by the cross ones. The hooks on the upper end of the upright needles should be $\frac{3}{8}$ of an inch above the blades of the brander. If the needles press too much on the blades of the brander, the trap board is shifted a little towards the front or barrel side of the machine, if they are not near enough to the blades, the trap board is shifted back. As very much depends on the setting of the trap board to have a good going machine, the workman should be very particular to have it right done. The box at the back of the machine which contains the small spiral brass springs, should be so set as not to press too hard on the cross needles; this can be adjusted by putting a small slip of wood or paste-board between the spring box and the standers of the machine, for if they are allowed to press too much, the points of the needles will have a great tendency to pierce holes in the cards.

To get the barrel properly set also requires great care, and in doing this, the workman takes a card which has been previously cut, and places it on one of the sides of the barrel, when he will see if the pegs will suit to keep the card in its proper place; if the holes in the card are all opposite the holes in the barrel, it is right, but if not, he shifts the pegs till once the card is brought to the position required. After he has examined all the four sides of the barrel, and made them right, the cards for working plain cloth are again tied on the barrel, and put into the machine, when the brander is allowed to come down. He next sets the bracket that moves the lay of the Jacquard machine, so as it will bring the barrel as close on the needles as to make all the upright ones stand clear of the brander blades, except those that are to be lifted. It does not do to have the barrel coming too close to the machine, because it puts unnecessary strain on the cards, and that must be avoided.

The rod (*c*) that connects the lever I (that lifts the brander) to the treadle H, should have a screw upon it, for the purpose of making it short or long at pleasure; by this screw the tenter adjusts the fall of the brander. If the brander be allowed to come down and rest on the machine every shot, when the loom is in full motion, it will have the same effect as if it was struck with a hammer, which makes a disagreeable noise, and has a very bad effect upon the whole of the harness, such as turning and bending the needles, causing the leads to have a swinging motion, and destroying the regularity of the shedding; and to avoid this, the rod (*c*) is screwed up to that extent, that the weight of the brander will always hang upon the cams G, as shown at Figure 9, Plate IV.

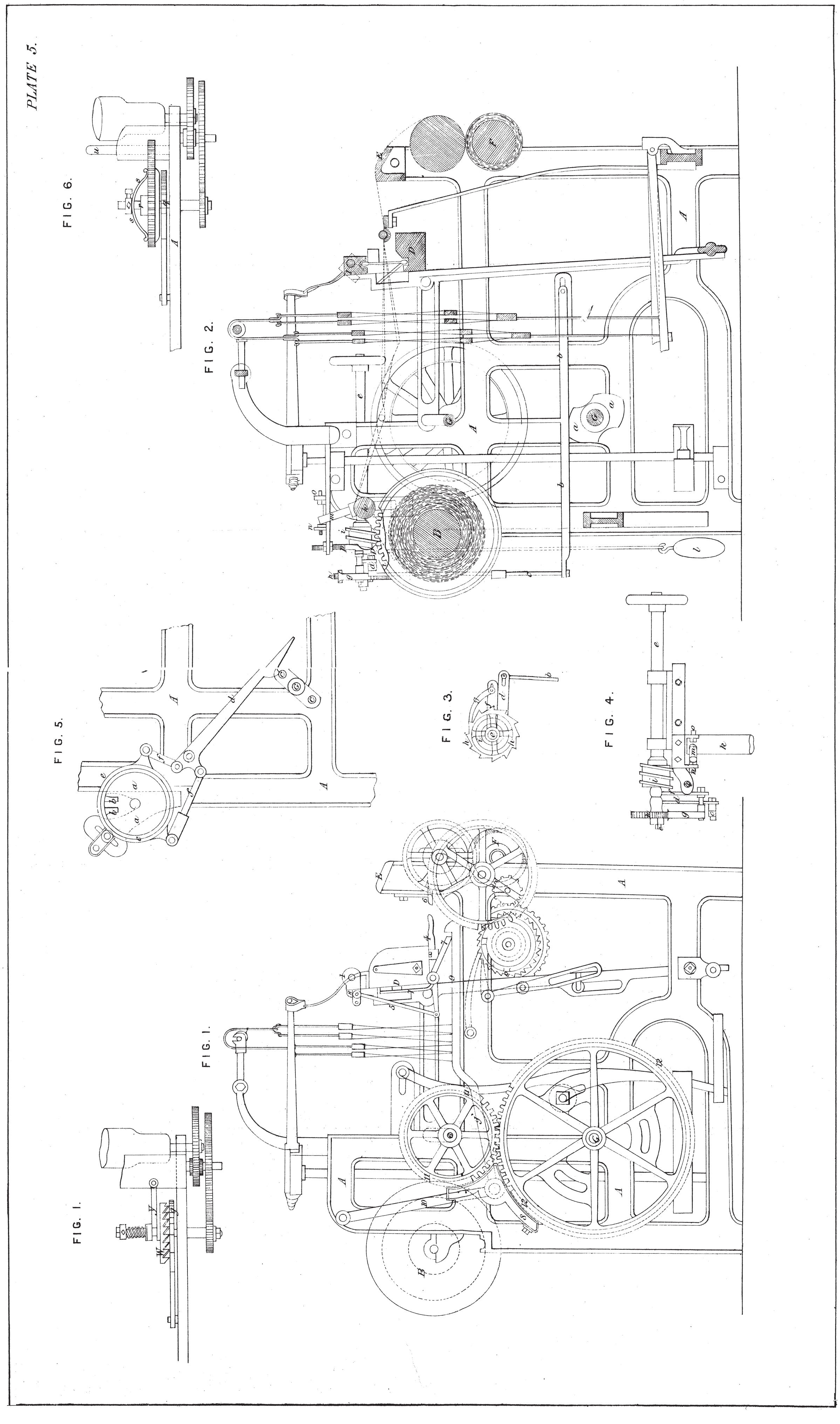
## MAKING CLOTH.

When all the little parts about the Jacquard machine are properly adjusted, and the harness brought forward, as has been explained, the loom is ready for weaving; and as plain cloth will show the working of the harness better than any other, a few inches of it should be woven before the flowering cards are put on.

In Plate III., Figure 6, the cards are shown at K, and it will be observed that they are hung on two curved iron rods, the curves of them being made so as they will be suitable to hold either a small or large set of cards.

After having woven a few inches of plain cloth, the set of cards that is to work the pattern wanted is hung upon these curved rods, the cards having been all previously laced and arranged on wires for supporting them on the rods. The four plain cards are now taken off the barrel, and the flowering cards put on, which completes the mounting of a full harness power-loom. The method for regulating the quantity of shots to be put on the cloth has been explained in Chapter III.

When the weaver is obliged to turn back the cards to find the suitable one, from any cause that may happen, such as taking out a quantity of shots, that cord which is attached to the upper catch for turning the barrel, which will be seen in Figure 6, Plate III., is

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taken hold of, and pulled downward; and as both catches are connected at their points, it is evident that when the top one is taken out of gear, the under one will be raised and come into contact with the barrel, which will turn the barrel backwards along with the cards when the weaver depresses the treadle H. The treadle H is depressed by the weaver's foot, and to prevent the harness from being lifted too high, a guide is placed on the under edge of the treadle for that purpose, which enables the weaver to work the Jacquard machine with the greatest ease.

To keep the wooden frame that guides the upright needles steady, there are four small spiral springs used; two of them are shown in Plate III. (right above the word, Figure 6, and below the Jacquard machine), the other two are placed at the opposite end of the machine, and not shown in the drawings. These springs are in general made of brass wire, or some other material that will not be effected by dampness.

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## PRESSURE HARNESS LOOM.

Those harnesses that work in conjunction with the heddle leaves, which leaves force the warp of the web into a shed, are denominated Pressure Harnesses. In a pressure harness the warp threads in each mail vary from two to seven, and sometimes more; but for many kinds of cloth, it is not necessary to have an equal quantity of threads in each mail, although it is better to have them as nearly equal as possible, as it makes the turnings in the figure more regular.

This mode of weaving has been applied to the making of many different kinds of goods, such as shawls, ladies' dresses, table-cloths and covers, napkins, bedmats, &c.; and to make the principle of this plan of weaving understood, the reader is requested to look at Plate II., Figure 4, where an end view of a loom with a pressure harness mounting will be seen. It will be observed that the warp threads cross each other between the heddles and the harness. For illustration, suppose the warp of the web to be white, and the weft red, and that none of the warp is lifted by the harness, the heddle leaves in this case would make tweeled cloth, according to the quantity of leaves employed, which in this loom are five; and as there are never more than two leaves working at the one time in a pressure harness, the consequence will be, that only a fifth-part of the warp is lifted each shot, and the upper side of the cloth will be red, and the under side white, or nearly so. If the loom be allowed to work two inches of cloth in this way, and then work two inches with the whole harness lifted, only a fifth part of the warp will be sunk, and the colours will be reversed. It will be obvious that if the loom were to work for some time in this manner, a red and white stripe would be woven, each stripe two inches broad; but suppose that cards cut for plain cloth were to be put on the machine barrel, every alternate mail would be raised, and along with them half the warp; and if the heddles were allowed to stand idle for a short time, and the machine to work every shot, this would make plain cloth the same as a full harness, if each mail had only one thread of warp in it; but in this harness each mail has four warp threads in it, so the shuttle will pass above and below four threads alternately. Suppose now that the harness is kept up for four shots at a time, and the heddles put in motion, and the loom allowed to work for a little, the cloth produced will have the appearance of a four-and-four red and white check; because the heddles will press up and down a fifth-part of the warp threads from each half of the harness, every shot.

The reader will understand from the foregoing explanation, how any flower or figure that is within the compass of the tye can be woven. As already stated, the number of threads in each mail will vary, a harness with six threads in each mail will make a figure double the size of one with only three, if both harnesses have the same tye; also half the quantity of cards will do, for in general the same number of shots are woven for each shift of the card, as there are threads in the mail. For example,—A three thread harness will have three shots for each lift of the harness; a four thread, four shots, and so on for every thread in the mail, one shot more for each card.

A description of how a harness should be prepared is given under the head, "Full Harness," so it need not be repeated here, the only difference being, that the mails and leads are larger, and the twine stronger than what is required for a full harness.

The mounting now to be described was for working linen damask table-cloths, and was applied to the loom from which the drawings were taken that are given in Plates I. and II. For these table-cloths a gathered tye of 612 was employed, and the space occupied in the harness board was nearly 76 inches. What is meant by a gathered tye is, in tying the harness the operator takes two ends, one from each half-part, and tyes them to the tail cord, and whatever the figure is on the one half, it is the same on the other, reversed. In some figures it is necessary to take only one end from the centre of each part for the first tail cord; this is to make the centre of the figure neater, by having only one mail for the figure to turn on. But all the other tail cords, as stated before, must have two ends, one from each half-part. However, the tye for this table-cloth had only one whole part on it, which will be apparent as we proceed with the description.

The harness being prepared and ready for the loom, the slabstock with it is fixed in its proper position, which is shown at the words, "Harness Leads," Plate

II., Figure 4. In this loom the distance between the harness and fell of the cloth was 22 inches, but this may be different in other looms. The proper distance for the mails to be from the fell of the cloth in a pressure harness, can be found from the traverse of the lay. Let the heddles be kept as close to the lay as just to allow them to work clear of it; and suppose the distance from the fell of the cloth to the centre leaf to be about ten inches, then from the centre leaf to the centre mail in the harness should be ten inches also.

The Jacquard machine having been fixed right above the centre of the slabstock, the harness tyer begins his operations by taking the two ends, forming the neck twines of the two mails that are in the centre of the harness, and the first tail cord in the machine, and tyes them together. He goes on tying two of the neck twines to each of the tail cords in regular rotation, until the whole 612 are tyed. Of course the last tail cord will have tyed to it the two outside mails, one from each selvage. It will now appear that this tye can work any figure that will come within the range of 1225 mails, or $612 \times 2 = 1224$, the number of mails in the harness; but the figure must be so drawn, that when the two halves are put together they will join without any defect, and make one complete figure.

Suppose the harness is now ready for the warp of the web to be drawn into it, divide the whole number of ends in the web by the mails in the harness, and this will give the number of ends or threads for each mail. The web being a $12^{00}$, with 4920 ends in it, (which makes it nearly 76 inches wide), the threads in each mail will be four, as will be seen from the example, after allowing 12 ends for each selvage.

EXAMPLE.

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1224)4920(4 Threads in Mail.
     4896
     ----
       24 for Selvages.
```

When the web is to be drawn through the harness, it must at the same time be drawn through the heddles, and the heddles are placed in the loom in front of the harness. The drawer begins by taking the first end through the mail and heddle next the selvage; the second end is taken through the same mail, and through the second heddle; the third and fourth ends are taken through the same first mail, and through the third and fourth heddles, and so on with all the rest—four ends in each mail—taking the heddles in regular succession, until all the web is drawn. This will take all the warp in the web, except 24 ends, which are allowed for the selvages, and two or three mails are hung at each side of the harness board, for the selvage ends that are not lifted by the harness. If all the 12 ends for the selvage are put in one mail, a lead sufficiently heavy must be hung to the hanger to keep them down, so that the pressure of the heddles will not be able to lift the lead.

After the web is drawn into the harness and heddles, it is knotted up in the same manner as a common web, but the mounting of the heddles is rather different. The eyes of common heddles are about $\frac{3}{8}$ of an inch long, but for a pressure harness the eyes must be at least three inches long, to allow the yarn in the harness to form a shed independent of the heddles; as three of the leaves out of the five will be at all times in a mid position, neither up nor down, while the other two are forcing the tweel shed, one of the two will take down the fifth part of the warp that is lifted by the harness, and the other will raise a fifth part of the warp that is not lifted. So when tying up the heddles the under end of the eyes are to be brought nearly on a level with the race of the lay; and when this is done, a piece of wood is put on the top of the jacks at P.P.P., Figure 1, Plate I, and firmly tied down upon them, to keep them parallel with the heddle shafts, for the time being, when the workman is connecting the heddle shafts to the jacks and treadles with cords, which cords are represented at 5 and 6, Figure 1, Plate I.

When the heddles are mounted, the piece of wood is taken off the jacks, and two or three inches of cloth are woven with the heddles, the harness being allowed to stand idle. By doing this, the workman will see if the sheds are properly formed, better than if both the harness and heddles were working. If the Jacquard machine and harness board have been adjusted, according to the direction given under "Full Harness," the loom will be ready for the flowering cards; and if the web is to be woven with the same quantity of weft as warp, then the set of cards will contain 1224 flowering cards, and six blank or uncut ones, making in all 1230; but to this should be added other ten tweeling or blank cards, to allow room for a hem on each end of the table-cloth. It will be seen from the position of the heddles in the loom that the harness requires to make a shed double the size of what is made by the heddles, (see dotted lines, Figure 4, Plate II.), so as to have the sheds that are made by the harness and heddles both the same size in front of the reed where the shuttle runs. The shed made by the harness is regulated in this loom in the same manner as in the full harness one.

In the same Plate, at Figure 5, will be seen a drawing of the disengaging apparatus, which apparatus is for regulating the quantity of shots the loom works for every change of card.

It is common in the trade to say so many shots on the card, as four shots on the card, five shots on the card, &c., which means that the loom works that number of shots for each card, and for this table-cloth there were four shots on the card, and as the set contains in all 1240, including the blank and tweeling ones, that number multiplied by four will give 4960 shots for one table-cloth. The reader will understand from this that any figure or pattern can be woven up to that quantity of shots.

To save expense in cards, manufacturers in designing for table-cloths, very often make the pattern of the one end of the cloth the same as the other; when this way is adopted, half the cards will do, by working them back for the second half of the cloth.

Suppose that it is wanted to have 15 shots on the cloth instead of 12, and to keep the table-cloth the same length, and to have no more cards in the set, the disengaging apparatus is made to put five shots on the card instead of four; because if four give twelve, five will give fifteen. This is accomplished by changing the pinion S on the boss of the wheel, *c*, *c*, at Figure 5. If the wheels and pinions in this apparatus are properly proportionated, any degree of wefting can be put upon the cloth with far more accuracy than with the hand-loom weaver, because it will not forget, as a weaver might do, the number of shots for each card. For example, if the weft that is wanted on the cloth be equal to $4\frac{3}{4}$ shots on the card, then three cards would require to have five shots, and one four, which will make 19 shots for one revolution of the stud wheel in the disengaging apparatus. It will be observed that there are four studs in the wheel shown in the figure, but they are set to work only four shots on each card, and four times four being 16, a pinion will be required to be put on, so as the wheel will make one turn for 19 shots. Suppose again, that the cloth wanted is to be equal to $3\frac{1}{8}$ shots on the card, this example will show how any nicety can be attained by this apparatus. To find the pinion required for the different shifts, first find how many shots will be required for one revolution of the stud-wheel, and it will be found by multiplying the number of shots on the card by the denominator of the fraction.

EXAMPLE.

$3\frac{1}{8}$ Shots on Card.
8

25 Shots for one turn of the Wheel.

It will be evident that the wheel will require to have eight studs in it for the $3\frac{1}{8}$ shots on the card, which will be equal to seven cards with three shots on each, making 21, and one card with four shots, which makes up the 25. After this explanation, with the description given at page 173, it will be easily understood how the apparatus should act.

## STENTING ROLLERS.

At page 175 there is given a short description of the use of these rollers, and it will be as well for the reader to look at the drawings again, and the description there given.

The little or no elasticity in linen yarn has always been a drawback to the weaving of it in a pressure harness, because the heddles have to force the yarn from the harness shed to form the tweeling sheds; therefore, that part of the warp which is pressed sustains the whole strain or weight of the pace, and the consequence is, that the rest of the warp in the harness does not form a proper shed by it becoming slack. When experimenting with the pressure harness in the power-loom, the greatest difficulty we had to contend with was to keep the warp yarn at its proper tension, and this led to the introduction of these rollers, which are represented in Plate II., Figure 4. The dotted lines at *q*, *q*, *q*, show the position of the different portions of the warp yarn for each respective leaf; that portion of the warp which passes over the roller nearest the yarn beam, is taken through the back leaf of the heddles, the yarn passing over the next roller, through the next leaf, and so on with the others in regular rotation. When any of the leaves begin to force the shed, the spiral springs of the roller yield to the strain put upon them, and by this means the warp yarn in the harness that is not pressed is kept at a proper tightness by the pace on the yarn beam not yielding to the pressure of the heddles. To keep the different parts of the warp distinct, it is necessary to have each roll placed a little below the one immediately behind it, as shown in the drawing; which also shows, that the whole of the warp yarn is brought to the same level with the common warp roll, which is placed behind the harness.

By using these rollers, the following advantages are obtained:—The web can be woven with a lighter pace, and consequently will be easier on the yarn; the cloth is made more perfect, by being free from what is called skipped warp, caused by the warp yarn being slack; the weaver's time is economised by being able to work with larger shuttles and pirns; and there is a saving of power in driving the loom, because the warp yarn does not press so much upon the shuttle, being enabled to work with larger sheds, which allows the shuttle to be driven with a lighter pick.

It is essential to have the rollers strong, at the same time light, and small in diameter. They must have as much strength as not to bend in the centre when the pressure of the yarn comes upon them, for that would destroy the regularity of the shed; they must be small in diameter, so as to take up as little room as possible; and they must be light, so as the springs will not be too much burdened with their weight. To have these three requisites, the rollers should be made of sheet-iron tinned, similar to a cylinder of a throstle frame, but on a much smaller scale.

## SHEDDING.

It has been explained how a common web is shedded, and a few words will show the difference for the shedding in this loom. As will have been noticed, the eyes of the heddles for a pressure harness are at least three inches long; and as the heddles must move the length of the eye besides the depth of the shed, it will be necessary to take this into calculation in making the patterns for the tweeling barrel and treadles; for if the shed wanted be three inches deep, and the eye of the heddle be three inches, then the traverse of the points of the tweeling treadles must be six inches, to make up for the length of the eye. But the shed must not be so large as the eye of the heddle, or the warp yarn will press upon the eyes of those that are not in the act of shedding, and put unnecessary strain on the web.

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## CHECK POWER-LOOM, WITH SIX SHUTTLES.

Checked Cloth is made by having stripes in the warp and weft; and these stripes may be formed by putting in so much coarse and so much fine yarn alternately, in the warp of the web, and the same way with the weft, which will make a check. But checks are mostly made by having the warp and weft striped with different colours, which stripes form the checks, according to their arrangement.

It is an easy matter to have the warp striped with as many colours as may be chosen, the warping of which has been explained at pages 66, 67, and 68. But it is a very different matter with the striping to be made in the wefting, which will be apparent from the description given at page 177, about the working cf the shuttle boxes.

We may also state here how patterns are got up at first. A pattern drawer may paint on paper from his own imagination, or from the suggestion of the manufacturer, as many as will make a pattern web; and if the checks are small, there may be ten or twelve of them put in it. The use of the pattern web is to show the effect the different colours have when woven into cloth; for very often the patterns that look best on paper have very little appearance on cloth. Suppose that a web is warped four or five yards long, with ten of these patterns in it, the weaver works over each pattern with wefting the same as the warp, which will give each pattern in the warp nine different weftings besides it own. And when all the ten patterns are woven over, there will be ten of them regular, and ninety irregular, or what are called chance patterns. All the 100 patterns are cut separate, and put in some convenient place to be examined; those that are considered fair are put aside for a second examination, the others are thrown into the waste basket; on the second examination, if any one is found good it is given to the warper. The pattern web being still in the loom, any little alteration can be made in the different patterns that may be suggested, until the whole length of the web be consumed in trials.

Having fixed upon a pattern that requires six different colours in the wefting, it will require a lay with a six shuttle box to make it; and our object here is to explain how these can be made to work in the power-loom, and to make the description more readily comprehended; also, for the benefit of those who wish to try their inventive faculties at making a complete power-loom for check work, the following hints are given. The number of plans that have been tried in connection with check-looms are astonishing, and by far the largest number of them did not succeed; so the remarks given here may be of use to the inventor and loom-maker.

When the hand-loom weaver requires to use more shuttles than five, he in general works with a single shuttle lay, and has the number of shuttles lying on a board at the side of the loom, which he picks up with his hand, as they are required to be changed according to the pattern; but in the power-loom this has all to be done by machinery.

To have a complete power-loom for making the various kinds of checks used in tartans and fancy dresses, the apparatus used as an index for the pattern must have an extensive range, such as what may be obtained by using the Jacquard machine for that purpose.

It should have a weft stopper motion that will stop the loom the first shot, and this will cause the use of a fork at each side of the web, or some other thing that will act upon the loom whenever the weft is away, not allowing it to run one shot afterwards, as is the case with the common weft motion.

The mechanism for shifting the shuttle-box should be so made that any shuttle can be brought into play so as to make any pattern that can be imagined. A contrivance for stopping the loom when the shuttle driver is not properly taken back at the double-box side of the lay; for if the driver happens to be in the box at the time it should he shifted, either the box or the driver will be broken, perhaps both.

If the box is not brought to its proper position when shifted, there should be a protector to stop the loom, to prevent damage being done to the picking or shuttle-box.

As mistakes sometimes occur by putting in the wrong colour, and thus spoiling the pattern, some mechanism should be applied that will prevent the loom from working, if the proper coloured pirn be not in the shuttle; and as it would be difficult to make the loom distinguish colours, the pirns that the weft is wound upon could be made with different shaped heads, each colour having its own kind of pirn; and if the shuttle is filled with a wrong pirn, the loom will not work, because the proper pirn is not in the right shuttle.

As stated at page 177 the drawings marked Plates III. and IV., show an arrangement for six shuttles, which will answer for the pattern fixed upon; and the pattern given at page 68 will do for an example in the arrangement of shuttles, supposing the slate colour is understood to be wefted with white.

It will be seen at page 68 that the first of the pattern is 60 of Brown; and suppose, for the sake of reference, that the shuttles are numbered 1, 2, 3, 4, 5, and 6, No. 1 being the shuttle in the top box, the others to be in regular rotation to No. 6 (the shuttle in the bottom box). To work this pattern, the box will require to be shifted as under:—

| | | | | |
|---|---|---|---|---|
| 60 | of Brown, | ... | 1st | Shuttle. |
| 2 | ,, Red, | ... | 2nd | ,, |
| 2 | ,, Orange, | ... | 3rd | ,, |
| 2 | ,, Yellow, | ... | 4th | ,, |
| 8 | ,, Green, | ... | 5th | ,, |
| 2 | ,, Brown, | ... | 1st | ,, |
| 20 | ,, White, | ... | 6th | ,, |
| 2 | ,, Brown, | ... | 1st | ,, |
| 8 | ,, Green, | ... | 5th | ,, |
| 2 | ,, Yellow, | ... | 4th | ,, |
| 2 | ,, Orange, | ... | 3rd | ,, |
| 2 | ,, Red, | ... | 2nd | ,, |
| 10 | ,, White, | ... | 6th | ,, |
| 10 | ,, Brown, | ... | 1st | ,, |
| 10 | ,, White, | ... | 6th | ,, |
| 4 | ,, Red, | ... | 2nd | ,, |

| | | | | |
|---|---|---|---|---|
| 14 | of | White, | ... | 6th Shuttle. |
| 14 | ,, | Brown, | ... | 1st ,, |
| 4 | ,, | Green, | ... | 5th ,, |
| 2 | ,, | Orange, | ... | 3rd ,, |
| 20 | ,, | Brown, | ... | 1st ,, |
| 20 | ,, | White, | ... | 6th ,, |

On examination of this pattern, it will be observed that the shuttles cannot be taken in regular succession, by working the box up or down, without missing some of the shuttles; and to obtain this, each shuttle must be at the control of the index for the pattern, which in this case is the set of cards working on the Jacquard machine. But other things may be applied to the same loom for an index instead of the Jacquard machine, such as the Dobie machine for working the heddle leaves, or a single barrel with cards for the purpose of working the shuttle box, something the same as what is used on Mr. Whitesmith's check-loom. Or it may be done by a barrel without the use of cards. However, we will go on with our explanation as done by the Jacquard machine.

What is called a 400 Jacquard machine has, in general, 51 rows of needles, with eight in each row, which in all makes 408; and the tye of the "Full Harness" which has been described is 400, which leaves eight needles not required for the harness; six of these eight are taken for regulating the movements of the shuttle box; as the wefting was one shot above, even with the warp, the set of cards were 440, for the complete pattern of the flowering; the checking pattern, being just half the size, it is twice repeated on the set of cards, as it only required 220 shots to complete the check pattern. The ends of the cards right opposite the needles, set aside for the checking, are not cut, except when the shuttle box is to be shifted, and then one hole is punched in the card, to correspond with the shuttle, which is to be brought into play. It will be seen from this pattern, that only 22 cards will require to be cut for one repeat of the checking, the remainder being all left blank at their ends.

After the pattern is arranged on the cards, the workman will require to adjust each shuttle box to its respective lever or treadle; and this is done by turning the cam S, Figure 9, round, until the full part of it presses upon the tumbler, then screwing up the chains at X, to have both of them the same tightness, when the shuttle box belonging to that lever is in its proper place. After this has been repeated upon all the six levers, the six needles in the Jacquard machine are connected with cords to the bell cranks that work the tumblers in the levers; and care must be taken to have the proper needle attached to the lever that is to work the shuttle corresponding to the pattern. It will be observed in Plate III., Figure 7, that there is a spiral spring (marked 8) for each of the six cords, but only one is shown in the drawing; and as the Jacquard machine may be lifted higher at one time than another, these springs yield to the over-lift, which saves the cords from being broken, and the needles from receiving any undue strain.

It will also be observed at the back of the rack ($d^1$ $d^1$) Figure II., that there is a projecting casting, with six hollow curves, one for each shuttle box ; these curves are used for keeping the shuttle box steady at the instant the shuttles are being picked. As the cam S makes one revolution for every two shots, the shuttle box is relieved every second shot from the strain put upon the rack, so that the box can be shifted every second shot if required. Another thing that these curves are used for is, that if the chains do not bring the sole of the box exactly level with the race of the lay, the small pulley ($g$) being pressed into the curve by the cam S makes them exactly level. But if one of the chains breaks, and the box stops when the small pulley ($g$) is opposite one of the projections, then the protector for stopping the loom, when the shuttle box is not properly shifted, takes effect and stops the loom.

The shuttle cord at that side of the loom where the shifting box is placed, must be so adjusted as to allow the driver, when taken back, to touch the lever, J J, shown at Figure 6, Plate III., or the loom will not work, because this lever acts upon the apparatus for stopping the loom when the driver is not taken back to its proper position. When the weft stoppers and other parts about the loom are all properly set, the loom will be ready for making cloth. And although this check-loom that we have been describing has also a harness, the description given will answer for any kind of checked work; for if the harness be not required for the kind of work to be woven, a small machine, made on the principle of the Jacquard machine, will do for an index for the pattern. But if the manufacturer has already got Jacquard machines, he can use them for that purpose with an old set of cards that may have the number in it for the pattern, which will save the expense of getting new ones.

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## SIX-SHUTTLE CHECK LOOM,
BY THE
## ANDERSTON FOUNDRY COMPANY, GLASGOW.

This loom would have been taken notice of in a former edition, had I been as conversant with the details of it as I now am. There it is explained how the loom is stopped when the shuttle box is not properly shifted; also, how the loom is stopped when the driver is not sufficiently taken back at the shifting box side of the loom. It is also described how any shuttle can be brought into action to suit the pattern required; some instructions are also given regarding check fabrics, beginning at page 213, under the heading "Check Power-Loom, with Six Shuttles."

The Anderston Foundry Company's six shuttle loom has got very popular in the trade, and many hundreds of them are at work at present. Instead of it having a separate mechanism for stopping the loom when the driver is not sufficiently taken back, and another for stopping it when the box is not properly shifted, it has a pair of springs attached to the bell crank levers, and the springs yield when any obstruction takes place in the shifting of the box. These bell crank levers are kept moving every second shot by a cam on the under shaft of the loom, and each lever has a pall or catch that gives motion to a horizontal lever that shifts the shuttle box up or down at the instant the pattern barrel indicates a change of shuttle. It will be observed by any one acquainted with check power-looms that these spring levers are of great advantage for power-loom weaving, they are so simple in their action, and yet answer the purpose so well.

This loom has been taken by many manufacturers who know well when they see a loom whether it is a good thing or not, which is a very good proof of this loom's superiority over many others. Indeed, this company has been going on improving the check power-loom for the last twenty years, and although it is not yet brought to perfection in many points, they deserve praise for what they have done for the trade already, and I have no doubt but many more improvements will still be made on their check power-loom.

The barrel used for arranging the pattern on in their loom has been in use for a long time, and is well known in the trade. It answers the purpose for an index very well, and can take in a large range of pattern. Besides answering for the pattern mechanism for the various checkings, it can be taken advantage of for varying the working of the heddle leaves on the principle explained under the heading "Plain and Tweel, with Weft Cords."

Taking the check mechanism of this loom as a whole, there is nothing out yet as good.

## CHAPTER VI.

## WOOL WEAVING.

As the making of cloth from woollen yarns is a very important branch in the Weaving Trade, and one to which many of our manufacturers exclusively confine themselves, we will devote this chapter to the explanation of its peculiarities. What is meant by the word wool, as used here, is the yarn which is spun from the fleece of the sheep, and some other animals, and the quality and variety of these yarns depend upon the selection of the fleece and how it is spun. Like all other yarns it must have its standard of measurement, and that measurement is found in different ways, but the principle is the same in all kinds of yarns, namely, a certain given weight for a certain given length. To a casual observer, the fineness of yarn would be found by its smallness in diameter compared with other yarns, and so it is in one sense but not in another. The yarns that are smallest in diameter would be the finest, if the substances they were spun from were all of the same specific gravity, but they are not of the same weight or specific gravity. For example, ten thousand yards of linen yarn, the weight of which is one pound avoirdupois, and ten thousand yards of woollen yarn, the weight of it also one pound avoirdupois, although they are both the same length and the same weight, their diameters are very different, the linen yarn being very much smaller, so that each class of yarns is compared with its own class, when they are measured (or what is called sized).

The most common standard for wool yarn is as follows:—The reel upon which it is wound is fifty-four inches in circumference, and eighty rounds of the reel is one skein, which is one hundred and twenty yards, and seven of these skeins make one hank or number, which is eight hundred and forty yards, and eighteen of these hanks make one spyndle, which is fifteen thousand one hundred and twenty yards, which will stand thus:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 120 | yards | 1 | skein. | | | | |
| 840 | ,, | 7 | ,, | 1 | hank. | | |
| 15,120 | ,, | 126 | ,, | 18 | ,, | 1 | spyndle. |

It will be observed that this is the same length as the cotton spyndle, but it is found one third heavier than cotton. For example, one pound of 18's wool yarn has only 12 hanks in it (840 yards long), and one pound of 18's cotton has 18 hanks in it. Some of the heavier yarns are differently designated; such as, two pound yarn, three, four, or five pound yarn, which means that there is that number of pounds in one spyndle.

When the yarn comes from the spinning machine it contains a large per centage of extraneous matter, principally oil, which it loses after it is properly washed and cleansed, which washing and cleansing goes by the name of scouring. After it is scoured it is much lighter, and allowance must be made for this in sizing cleansed yarn. If more oil and dirt is spun up with the yarn than what is necessary, it may appear to the buyer that it is just so much profit to the spinner; but that is not the case, because it is soon found out by the buyer, and a lower price is given for it, so that any deception of that kind is no profit to the spinner, whatever it may be to others whose hands it may pass through before it comes to the weaver; and the weaver can find out to a nicety what amount of real wool he gets for each pound weight he pays for, by weighing the yarn after it has been properly cleansed.

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## WINDING AND WARPING.

After the warp yarn is got in from the dyer or scourer, it is wound on bobbins either by hand with a common wheel, or by a bobbin winding machine driven by power. The best kind are those where the bobbin is driven by a small drum or pulley. The bobbin lies in a horizontal position on the drum, and is driven by the friction of its own weight on the drum. But wool yarn being very soft, it builds slack on the bobbins; so to get a greater quantity of yarn on them, small weights or springs can be applied to the ends of the arbor, that goes through the bobbins, to put a greater pressure on the drum, consequently a greater pressure on the yarn, and this pressure can be regulated to suit the kind of yarn that is being wound. It will be evident that the reels (or swifts) will always run at the same speed when the bobbins are driven in this way. But when they are driven from the arbor (like many of the machines), the reels increase in speed as the bobbins increase in diameter when in the act of filling, and this is an objection, because the winding must be either far too slow when the bobbins are nearly empty, or far too quick when they are nearly full.

The winder should be very particular, in winding the warp yarn, to have all the knots properly tied and not to leave long ends at the knots, and that no double ends be allowed to go on the bobbins when in the act of winding; and before the yarn is put on the reels, it should be shaken to take off any dust or other loose substance that may be adhering to it. And attention should also be paid to the quantity that is put on the bobbins, so that they may all have an equal length of yarn. This is more essential when only a short web is wanted. The number of the winder should be put on each bobbin, so that the warper may know when any fault is in the winding, to whom it belongs, and have the fault pointed out to the person who gives out the yarn for winding.

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## WARPING.

The bobbins after they are wound are given to the warper, with the number of splits that is to be in the web, and as the warping of a wool web is in many respects the same as other kinds of webs, the reader is referred to that part of the first chapter of this work, under the head "Calculations of Warps;" also under the head "Warp in a Web," where it is explained how to find the proper quantity of warp for a web; and in the second chapter, under the head "Warping," it is explained how the warping should proceed. An explanation is also given there of a number of different kinds of warping machines; but there is one machine used for warping wool which is not taken notice of in that place, which I shall now do. It goes by the name

## HORIZONTAL MILL.

This machine is very much liked by some manufacturers for warping woollen yarn, and in some respects it is superior to the common four or five ell mill. It is in general made twenty-seven feet, or nine yards in circumference, and nine or ten feet broad, with spokes similar to the common warping mill. The advantage to be gained by using this machine we will now explain. The common way of warping is to run a given number of ends in a spiral form up and down the mill, until the requisite number of splits is warped to make the cloth the breadth wanted. By doing this, it is obvious that each layer of yarn will go on the top of the one that was warped before it, and the consequence is, that the last layer will be wound on a larger diameter than the first, and that that part of the web will be longer than the first layers, and that when the web comes to the weaver, one part of the yarn will be tight, and another part slack; but in the horizontal mill this is obviated in a great measure by it being so much larger in circumference and broader, and by the method of warping.

The horizontal mill is very like a large reel, and can be driven either by the steam engine or by the hand. The bank for holding the bobbins is placed at a convenient distance from the reel, and as many bobbins put into it as make the pattern. If the pattern be small, it is repeated with the bobbins in the bank, until there are as many runners (or ends) as may be desirable to work with. The ends are then taken through a reed for guiding them on to the reel, and as much warped as make the length of the web (not the width of the web as with the common mill). The next space is then warped, and so on until there are as many splits warped as make up the number that is wanted for the breadth of the cloth. By this mode of warping, all the different parts of the web are the same length, and will be equal in tightness when in the loom, if it is properly measured.

It has another advantage over the common warping mill, as it is not necessary to take the web off the mill in a chain, because it can be put on to a beam direct from the reel by the beaming machine; and if the yarn is not to be dressed (and it beamed on the weaver's beam), it is ready for the twister. If it is to be dressed or sized, it is better to warp the web so as it will be suitable to be beamed on two or four beams for the dressing machine.

If large quantities of one pattern are to be woven (such as two or three thousand yards and upwards), and the warps require to be dressed in the dressing machine, then it is better to warp the yarn on to two or four beams with the warping machine, which is already explained in the second chapter. In the same chapter, under the head "To Warp Striped Work," it will be seen how any pattern can be made with the beam warping machine. In our remarks in that place it is stated that it is a common practice for the warper to take out the bobbins before they have run nearly empty, and that sometimes a considerable quantity of yarn is left on them. To avoid this as much as possible, the barrel of the bobbin should be at least one inch and a quarter in diameter, for if these be less in diameter, the bobbin will not run till it is empty without the risk of the yarn breaking frequently. Now, although this is the common practice in warping cotton and linen yarns, it should, for various reasons, never be allowed to be done with wool, and one reason is, that wool yarn is more apt to spoil by keeping; another is, that there should be as few knots on the warp as possible: so the barrel of the bobbins ought to be made sufficiently large so as to allow them to run empty without the risk of breaking the yarn. After the number of beams has been warped, they are then ready for dressing or sizing.

## DRESSING OR SIZING.

Having explained sizing and dressing, and the different ways in which they are done, also the different kinds of machines used for that purpose, it only remains for us, in this place, to point out what is applicable to woollen yarns. When it does not deteriorate the quality of the cloth to have the fibres laid in the warp yarn, the best machine to be used is the crank or cylinder machine; but if the fibres are not to be laid, it is better to use the tape-leg dressing machine. But whatever machine is used, the size, glue, or other substance, should be used hot. The substances that have been taken for the purpose of dressing wool yarn are the following:—Wheat flour, sago, Irish moss, common size, common glue, Russian glue, and scraps of leather and buffalo are sometimes boiled, and the gummy substance used. The Russian glue is considered about the best thing to use, if the price is not too high.

If the manufacturer is going to use common or Russian glue for dressing the yarns, the glue requires to be melted in warm water before it is put into the dressing box, and warm water added until it is reduced to the proper strength that is required for the kind of work. If the webs are to be dressed in the crank machine (which is the best for wool), the box for holding the glue will require to be made larger than what is used for dressing cotton yarn with cold dressing; but it need not be any larger than just to admit of a small roll to submerge the yarn into the boiling liquid, before it goes through between the other two rollers that are used for pressing out the superfluous starch or glue. The pressure of these rollers can be regulated by weights and levers, to any degree of nicety that may be required, for putting on the yarn the proper quantity of starch or glue.

Some yarn will require more brushing than others, and this can be done by altering the speed of the brushes, which is taken notice of under the head "Dressing," in the second chapter, and as the working of the crank dressing machine is explained there, no further notice need be taken of it here. As wool yarns are of a soft spongy nature, they are apt to build soft on the weaver's beam. To prevent this, and to make the yarn firm on the beam, a pressure roll should be used. The pressure roll is so made that it can answer any width of beam. The roll should have its journals on the ends of levers, to enable the workman to lift with ease the roll off the weaver's beam at any time it may be required; such as changing the weaver's beam, when full, to replace it with an empty one.

After the web has been dressed, or beamed without being dressed, it is ready for being drawn or twisted, that is putting the warp yarn into the heddles and reed. The manner in which it is done is explained in another place, but it may be observed here, that for woollen warps the heddles and reeds are made different from what they are for cotton yarns. For the common kind of wool work, such as wool shirting, the heddles and reeds are made a little deeper, and the splits of the reeds are rather thinner, to allow more room for the warp than what is allowed in the common reed. But the thinness of the splits depends upon the opinion of the manufacturer.

Some make the splits lighter than what others do; but I would recommend that the splits of a reed for wool weaving, should be about twenty-five per cent.

lighter than the splits used in reeds for weaving cotton yarns, and about one inch deeper, and the heddles about two inches deeper, and made of worsted yarn.

In weaving the heavy kinds of woollen goods, such as tweeds and blankets, the heddles are made very much deeper, some of them being sixteen and eighteen inches deep, and in general are varnished at the eyes, which makes them last longer. They are made of yarn to correspond to the weight of the web. The reeds for this class of work are made specially for the purpose, both deep and strong; but in drawing the web, three or four threads are put in the split. Of course, if four threads are put in the split, the reed is made just double coarser than when there is only to be two threads in the split. By putting four threads in the split, the sheds are more easily formed, as the threads of the warp are enabled to pass each other better, there being less friction on the warp.

## LOOMING THE WEB.

Looming the web is a term used by hand-loom weavers; it signifies the putting the web into the loom, and connecting the heddles to the jacks (or coupers) above, and to the marches and treadles below, and otherwise adjusting the different things about the loom for the purpose of making cloth. As the principle is the same both in hand and power-looms, we refer the reader to the third chapter, where a full explanation is given of how to start the looms, and also how to mount the webs. I shall only notice in this place what is peculiar to the weaving of woollen webs.

When the weft is coarse, it is advantageous to have larger shuttles, so as to be able to work with larger copes or pirns than what are commonly used for finer wefts. The large shuttle will require a deeper shed. To accomplish this, the wypers must be made to give a greater traverse to the treadles, and in some cases the lay will require a longer traverse, so as to give the shuttle sufficient room to work. The shuttle being larger, the protector for stopping the loom when the shuttle stops in the shed, will require to act sooner than with a smaller shuttle. The fibres of wool yarn stand more out from the body of the thread than either linen or cotton, and this makes it more difficult to get a clear shed. The consequence, is that the loom has to be driven slower, to allow time for the threads of the warp to pass each other. Some weavers, instead of putting the lease rods into the shed, for the weaver's lease, put one rod below the warp, and another above, for the weaver's guidance. These rods are tied together, about seven or eight inches back from the heddles.

The principal objection to this way of working with the rods is, that when a number of threads is broken in one place, the weaver has more difficulty in finding the proper place for the respective ends or threads. The advantage gained is, that the yarn is not so much chaffed in passing the rods in the act of weaving.

We have given in another place an explanation of both plain and fancy tweels, which may be used in weaving fabrics made of woollen yarn; but before pointing out those that are more applicable to this kind of work, we will give some remarks about designing and colours, which are very essential things in making such goods as carpets, table covers, and many other kinds of goods made of woollen yarns.

## REMARKS ON DESIGNING.

It has been frequently said that the British are far behind both in drawing, designing, and also in the arrangement of colours. But as I do not pretend to be a judge in this matter, I will merely state the opinions that have been given by others, in as few words as possible, not to abridge them too much.

The following is an abridgement of evidence given in the House of Commons in connection with our manufactures. One of the witnesses, after giving a long statement about the Jacquard machine and the draw-loom, says—"The rest of the process is mechanical, consisting of punching holes in the cards, according to the number required, and applying the cards to the machine. I have seen 200 boys employed in weaving the richest figures in the loom. To so simple a process is the principle of weaving now reduced, that even boys of *sixteen* years of age are set to weave the figures of so complicated a nature as formerly would have required men of *thirty years'* experience.

"In some departments of this process, the manufacture is superior in *England*, in others in *France*. Plain silks, if manufactured with the same materials, the production will be equal in England as in France; figured silks are equal, as respects the mere manufacture; and there are two points of inferiority, the designing and the *mise en carte* (that is putting on rule paper). One particular reason for inferiority in England, which has much struck me, is the exhorbitant *price of cards*. In the woollen manufacture, the cards which have been used for woollen goods have been returned to the excise. A return of duty has been obtained. I think that if the same thing were done with the Jacquard cards, it would have a tendency to diminish the price. Though, generally speaking, the price is about equal in the two countries, yet in the reading the designs there is this enormous difference: the average price in France is three francs, or half-a-crown sterling; in England the price was a long time fifteen shillings; and I now charge eight shillings per hundred. I attribute that to two causes, the presence of silk manufacturers, which has created a greater competition and a greater necessity for activity. The consequence of this competition has been also the introduction of a great many French designers to settle here. The French designer understands the *mise en carte better than the English designer;* and the French *metteur en carte* understands design better than the English *metteur en carte.* The reason that occasions this great difference between the *metteur en cartes* and designers of England and France is, that the designers themselves are *obliged* to put it on the rule-paper, and *previous* to that go through *every branch* of the business (including the *weaving*), and this is undoubtedly the cause that they are more perfect. I do not mean to say that they design *better* in France than here; but there is a much greater number of designers of the same capabilities in France than here. In consequence of the *encouragement* the French designers receive, they are both more numerous and more talented, although there are individuals in England equally as clever, and with a profound knowledge of their art. The artist who draws the designs at Lyons is the artist generally employed to transfer them to the rule-paper. This person, whom I consider the *metteur en carte,* is only employed in that; he is inferior here. In Lyons, in a great number of instances, there is never a design drawn at all; but the first production of the design is on the rule-paper. The *metteur en carte* is himself an artist. It is in the connection between the arts and the manufactures that we are inferior. In France a manufacturer employs from three to four artists, and in England one artist supplies from eight to ten manufacturers. An indifferent artist employed in painting the patterns on the ruled paper may be obtained for fifty pounds per year, but there are men whose services are worth four hundred pounds per year, or even a share of the manufacture. The sale of the fancy trade entirely depends upon the *taste* and *abilities* of the *designer*. In France there are often only one or two artists who are paid, and who get from one hundred and eighty to two hundred pounds a year, but there are several who give their services for the instruction they receive. The *metteur en carte* should be well instructed in designing. He should also be acquainted with manufactures in theory and in principle. They are so at Lyons, but they are not so in Great Britain."

After some further remarks about the Jacquard machine, the witness says,—"When France possessed the *monopoly* of the Jacquard machine, it gave her great advantage in other countries. France has only by great exertions produced better and cheaper than they. There is a school of design at Lyons. The young artists have, since the discovery of M. Jacquard, particularly turned their attention to the *mise en carte*. There has been a great augmentation of such young artists; indeed, there were no such artists before; for it was found requisite to set up Jacquard machines in the school of design. This lasted two or three years only; they now obtain the required knowledge of the loom out of the school. The discovery of the Jacquard loom infinitely multiplied the number of young artists who devoted themselves to the *mise en carte.* The great advantage of Jacquard machinery is this: that it enables that to be done in a few weeks, which before occupied months; and that the change of a pattern formerly was a long, laborious, and costly affair, and now it is a very simple one, and may be done in a few minutes, after the completion of the reading and the stamping or cutting of the cards. The English copy the good French patterns, and the French copy the good English patterns. The best English designs are those on cotton goods; but the English do *not understand the mise en carte.* We sometimes make good copies from English patterns for the Spitalfields looms from the English printed muslins, but it requires taste and knowledge to arrange them. The French manufacturer can come with patterns every year to England, bringing with him samples of them on the cloth, whilst the English manufacturer only brings it on the paper. The cause of that is, the French manufacturer employs weavers who are solely engaged in the production of patterns, and as the pattern on the cloth shows more distinctly the effect than the drawing on paper, it gives them an *advantage* in the *market.* There are individuals who are engaged, and who collect at Paris the patterns in vogue there, which they bring and dispose of in England, and they also carry to the continent such patterns as they can collect here for the purpose of sale. These only serve as mere ideas; in the execution of the working drawings, the French improve upon us. If there were a school of design established in London, its effects in three years would be so to equalize the manufactures of the two countries, that the country in which they were produced would not be recognizable.

"With respect to colours, I think, in a great many cases, where there is an apparently greater beauty in the French dyes, they are *much less permanent* than those of England; and I have seen many examples where, after a few weeks wearing, the French colours have wholly faded."

The witness adds,—"I take the liberty of making the following remarks about designing and *mise en carte;* for, as this is the very head-part of all that belongs to the weaving department, and, at the same time, is the very *least* cultivated in this country; *it is before anything else the most worthy of your attention and consideration.* For, as long as this branch of the business is not highly improved, and proper schools for design and *mise en carte* erected, and children, who already have acquired the practical and theoretical part of weaving, are engaged and trained up in this art, France will always have to boast over England of the honour of sending *more fancy patterns, and finer and more beautiful workmanship*, and, in fact, brought to the *highest state of perfection*."

Another witness states—"We have not been able to find persons in this country who are capable of giving proper designs; the principal difficulty arises from the circumstance of men not having been brought up in this country to design for silk: *it is very different to designing for printers, from the circumstance that it is necessary a man should be conversant with the principle of weaving, before he can make a proper design for silk.* If we could only get designs in this country, we should be able to find parties that could put them on ruled paper for weaving. There is nothing but what we could make, provided we had a proper designer for the purpose of drawing patterns for weaving; and I think the principal difficulty arises from the circumstance of not having any school of arts in this country, where young men would be enabled to pursue their studies, for the purpose of perfecting themselves in drawing for that particular branch of the manufacture. There is no want of talent in the country, because there are a great many persons engaged exclusively in the production of designs for printed cottons, challies, and bandannas; we have in the trade individuals who can draw patterns, but are not conversant with the principle of weaving, and therefore we have been *unable to put those patterns to work.* We have now many patterns by us which are perfectly useless, because the drawing is not adaptcd to weaving. We would willingly, *at the present time, engage a man at a handsome salary, conversant with the principle of weaving as a designer, and also able to put the pattern upon paper.* Foreigners are not superior to us in their colours; there is a brightness in their colours we certainly do not possess, but I think our colours are more permanent. The dyeing of colours has certainly improved within the last few years, and in many cases, the permanency of colours decidedly is more than the French. It has occurred to me, if we had a school of arts established in this country, that a great many young men would be willing to make themselves conversant with the principle of weaving, for the purpose of procuring that particular study, and ultimately to become designers and drawers upon ruled paper for the silk trade. It would be a lucrative profession."

The following statements were given by the Secretary to the Board of Trustees for the Encouragement of Manufactures in Scotland; also Secretary to the Royal Institution for the Encouragement of the Fine Arts in Scotland. After explaining how the Institutions were founded and supported, he states—"The principal means which the Board have followed for extending the knowledge of the arts among the people of Scotland, has now been in operation for about seventy years. About seventy years ago they established a school for drawing, being aware of the advantages which *foreigners* possessed over this country as teachers of design *at that period.* They got a person of the name of De La Croix, a Frenchman of considerable skill, who set that institution agoing: it was for the accommodation of forty pupils taught by one master, and the pupils are admitted gratis. They offer specimens of their capacity, and certificates as to character, to the Board of Trustees, and the judge of those who are to be admitted, giving the preference to those who seem the most deserving of it. It is an establishment which very soon rose into great repute in the country, and has continued exceedingly successful ever since. The number of pupils has remained stationary, with only one master. It has been managed since its first establishment by a series of very eminent teachers. The person who now holds it, Mr. William Allen, is the first artist in Scotland. The board contemplates extending it, and they are at present taking measures for that purpose. Hitherto it remains on the same footing, only forty pupils; but so great is the demand of the public for the extension of it, and so high it stands in their estimation, that although there are about four or five elections in the course of the year, there generally are at least ten candidates for every single vacancy that occurs, and it comes to be a matter of very disagreeable administration to the Board to reject so many young men from having instruction in the art of design, when they seem desirous to obtain it. The pupils are principally engravers and statuaries, also artists, coach painters, house painters, and manufacturers; persons of that kind. Mr. Wilkie (Sir David) was educated there, Mr. Barnet, Mr. Wilson, Mr. Allen himself. I believe there is not an eminent name in the history of art connected with Scotland, where the individual has not been educated at that academy. It has produced the most eminent men, either as artists, engravers, or as connected with any of the corresponding professions; *in fact, it has done a world of good to the country.* The candidates produce specimens of their talents for drawing; they produce certificates of their good character, the Board is very particular upon that subject; also if they are apprentices, they produce certificates from their masters that they will give them the means of attending, and then all these are examined by the Board of Trustees; and that young man whose name perhaps they are ignorant of, but that young man whose qualifications seem best, is the person elected. The only preference they seem disposed to give is to the younger classes of them in preference to older ones. The Board of Trustees also established a branch school for the express purpose of teaching the pattern drawing for *table-cloths*, *diaper*, and matters of that description, at the town of *Dunfermline;* it was upon a particular system, and the Board engaged to give

£50 a year to a master, provided the manufacturers of Dunfermline would contribute an equal sum. They did so, and that school was in operation for a good many years,—I do not exactly recollect the number of years, but for a good many years,—and was exceedingly beneficial, and in fact, was one of the great causes, in conjunction with the encouragement of premiums for the best articles of manufacture given annually by the Board, of raising the establishment of linen manufactures in the town of Dunfermline." The manufacturers of Dunfermline declined to contribute their portion, and that school has fallen.

"One of the great defects in the mode of instruction in this country is, that the first branch of art, namely, the fundamental one, is that which is neglected, that is, what is called *drawing from the round;* it is, in fact, the rudiments of design, the *most indispensable,* although the *most neglected.* Except the Royal Academy and that Academy of the Board of Trustees, I am not aware any other teacher of drawing does really adhere to that system, which I know in French academies to be the only system that is taught, because they conceive; and it has been the opinion, I believe, of artists for many generations, as well as the old masters, that this is the only species of study which is requisite to form an artist. If he has once acquired a knowledge of drawing from the round, or drawing from objects of beautiful outline, and containing means of light and shade, that he is enabled then to turn his talent to any of the branches that he may require without any further instruction. In this country we seem to take a secondary part of it; to take instruction in a more advanced part, and neglect the rudimental part. In correctness of drawing the human figure, and in the knowledge of proportions, we are very deficient; and on that account I would make it a rule of that establishment, that the first class should be that one in which instruction is given in chalk drawing on a large scale from the round, having a series of second classes where the different branches connected with the useful arts were taught, which covers very many; architecture and all other branches connected with the useful arts, ornamenting, decorative, house-painters, and so on. I would not only make the fundamental principle (correctness of design) the object, but also what may be termed the perspective in botany, and those parts which are connected with certain sciences which may be called positive parts of art. It appears to me, a very little instruction, perhaps a few lectures, on this, as far as it is applicable to the useful arts, would be sufficient,—that is on anatomy, chemistry, optics, with reference to colours and botany. It appears to me there is a very great defect in general in our patterns, in botanical accuracy, where flowers are introduced; *the foreign pattern-drawers are uniformly correct*; our *pattern-drawers very seldom so.* I would have a third class for the higher branches, and for the purpose of artists, but that confined alone to men whose object in life was to be artists. I would have a certain subdivision of instruction, so that pupils coming there, and wishing to devote themselves to the study of casting in bronze or in iron, or studying modelling silver, or turning themselves towards pattern-drawing on cotton or on silk fabrics, might have the means, after a certain time, of devoting their undivided attention to any particular branch of that kind, comprehending the requisite acquaintance with the manufacture itself; so that they might go out from the institution, having chosen that division of the subject most suited to their capabilities: they might go out as manufacturing artists, to accomplish the particular object which they felt themselves most particularly qualified for. And the purpose I should have in dividing it into classes, would be this: to, in fact, repress an error which those academies are exceedingly liable to fall into, and which the academy of the Board of Trustees in Scotland has already fallen into, that is *of neglecting those parts of the study which apply to the useful arts*, and dedicating their attention alone to the higher branches; in fact, making all the pupils study as artists, and not as men to pursue useful branches of occupation. It is an exceedingly dangerous thing to pursue, in such institutions, those portions of art which may be said to be connected with individual taste or individual genius, since the tendency of so pursuing them *must be to neglect those portions of art which are positive and true*, and founded upon invariable principles of art. I consider that the division into classes might prevent this tendency; because, if the first class is imperative that no pupil could enter the academy without going through a course of the first class, then he would be enabled to turn his talent to any branch of design he might choose; he may then quit the academy. If he chooses to follow out the pursuit to the highest branches by the recommendation of the master, he may be permitted to do so; but it has been experienced in those academies in Scotland, that many pupils who come there with a view towards the useful arts, have quitted it and become artists themselves. The Board established prizes for pattern-drawing in their academy, and a good many very creditable specimens have been, within two or three years, produced; but there is one deficiency there, which shows the necessity of teaching for that matter, which is this: *that many of those patterns which were exceedingly beautiful, were not altogether adapted to the operative part of the manufacture; the persons were not conversant with looms*, not conversant with manufactures in fact, and, therefore, they require the means to be provided of having recourse to a master, who can instruct them in the working of the fabric, whatever it may be, to which their pattern has been employed. *In France*, the workman is *more an artist than in this country.* The system in France is very different, because there the artists of the first eminence employ themselves, and make it the most profitable part of their time in pattern-drawing, and they are paid a very high price by the manufacturers."

He recommends protection for patterns and designs, and then says,—"It appears to me that one thing in which the British manufacturer is most deficient, is that of a knowledge of colours. At present, as far as my acquaintance with manufactures goes, *I believe they copy entirely their patterns from France:* in doing so, *if they introduce any alteration into them, they often spoil them;* and it is a matter which is not a very difficult one to obtain a knowledge of, the theory of colour, but it is one which appears to me a very singular circumstance that it is not sufficiently attended to, because we know quite well that any deviation from the regular established and fixed rules of harmony of colours, produces the same effect to the eye as any deviation in music from the harmony of notes. It produces an equally bad effect; and in placing our manufactures or fancy goods along with French fancy goods, it has often struck me as a remarkable circumstance, to see how very little those rules, which are exceedingly simple, are attended to in the English copies. That was my reason for suggesting a lecture on that part of the subject, on optics, in fact, on colours, at those schools; for the rules are simple, but quite necessary to be known to any person who has occasion to place colours in juxtaposition. I think the improvement in matters of taste in general, has been very remarkable in Scotland within a few years, and in dyes there has been a very great improvement; since the Board of Trustees have given premiums for that special purpose, there has been a very conspicuous improvement. In patterns, the improvement has also been obvious, but not so very great as yet, because there is no instruction given in it; the young men who present these specimens of drawing, are left to themselves, and they frequently go wrong in many particulars; it appears to me there is a great deficiency in the want of instruction. The Board of Trustees give £24 a-year to be divided into prizes for the young men. There are six prizes for ornamental drawings, and six prizes for drawings from the round. The young men produce the first and the last of their performances during the season, in order that the Board may be able to compare their progress; and these are kept in the possession of the Board, not returned to the young men. They are also exhibited to the public. The prizes given by the Board of Trustees for improving manufacturers' patterns, are very numerous, and vary from year to year, according as the state of manufactures and the state of the demand for manufactures seem to require, also according as it appears to the Board that there are particular branches of manufacture which might be conveniently and advantageously introduced into this country; therefore the premiums which they have offered have varied from year to year. Their principle is, that they shall not continue to give premiums for a longer period for the same purpose than what is quite sufficient to introduce it; when once it is introduced they suspend the premium, *because they consider that if it cannot maintain itself after that, it is not worth encouraging.* Formerly, there were a great many premiums given for the purpose of the linen manufacture; these have now been suspended. There are many premiums given for the woollen manufacture, for all the branches of that manufacture. Within these two or three years, the Board have particularly turned their attention to matters connected with woollen manufactures, to the branch of carpet manufacture; and they have been the means of very much extending that branch in Scotland by the introduction of three or four new descriptions in the branches of manufacture which never were known in the country before, never practiced in Scotland at least, and which have been most successfully introduced, and are now rising into great reputation.

"Exhibitions of works of art, such as ingenious patterns and manufactures, or ingenious specimens of weaving, were, at one time, contemplated, but never put in practice. I understand that there exists an indisposition on the part of persons who have made inventions or improvements to exhibit them, from the circumstance that they are aware that they have no protection: that their invention and the property of their improvement is *not protected.* The Trustees, for the encouragement of the manufactures of Scotland, offer annually a series of premiums for improvements in different manufactures, also for inventions, should any take place. Those are annually exhibited to the public, and judges are appointed from among the manufacturers, who examine the goods and award the premiums. The circumstance that induces the manufacturers to attend very much to this is, that by obtaining the premium for their manufacture, they may obtain the means of publishing, very much to their own advantage, the species of trade that they carry on; otherwise the premium is a very small one, and scarcely worth the while of manufacturers to work for it. The French Exposition is highly advantageous. Where it enjoys a very great advantage over any attempt in this country, is, that the improvements of the year, and the inventions of the year, are by the French manufacturers expressly reserved for that exhibition, because they know that they are safe in producing their new design, whatever it may be."

It will be seen from these statements, how very important it is for the manufacturer to be able to get proper patterns for the cloth he intends to make, and we consider that a few hints on that subject are requisite in this place.

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## DRAWING AND DESIGNING.

Design paper is the paper for putting the figures upon that are to be woven upon the cloth. It is ruled with lines crossing each other at right angles, and may be bought from the stationer ready for use. The lines on the design paper represent the warp and weft of the cloth, and these lines are made so as to be in proportion to the threads of the warp and weft. It does not matter as to the set of the reed, for the same design paper will answer for either a coarse or fine reed; the principal thing requiring attention is the proportion of the wefting to the warp.

To put the figures that are to be woven on this paper is the work of the designer, and the designer takes it from the sketch or drawing. It very often happens that the sketches, the drawing, and the design, are all done by the same person; and that person, to be good at it, must have a knowledge of weaving and colours, besides drawing, and a general idea of the style of patterns fashionable at the time;

although the manufacturer should be the best judge of what style will sell best.

If proficiency in these things be desired, they must be studied, and the first thing with which to begin is sketching. We quote the following, as it may be of use to the beginner:—

"To the uninitiated I therefore address myself, and let them not be dissuaded from beginning by having no predilection for the study—the more they persevere, the more they will love it.

"In the first place, your attempts ought to be of the most simple nature, and on as large a scale as you can conveniently adopt: therefore begin by procuring a black painted board or slate, of from two to three feet square, and with white chalk practice the drawing of squares, circles, and ovals, without any guide to your hand. You may make yourself copies of these figures by the ordinary rules. When you are tolerably perfect at these, upon the proper combination of which depends all linear harmony, you may practice in the same way triangles, hexagons, octagons, and such other figures as arise from the various combinations of the straight line. Next, by your circular and oval lines you may form crescents, circular and flattened volutes, regular undulations, and other figures, which arise out of their various combinations, first making an accurate copy to yourself of each figure by measurement, and continuing to practice until you can form it by the eye with perfect ease. Avoid forming your figures by little bits at a time; do each line as much as possible by one sweep of the hand. When you find yourself pretty perfect in this kind of practice, I would recommend you at once to draw from nature. You may take for your first subject a cabbage leaf, the larger the better, and persevere in copying it, full size, until you can represent it accurately in outline, with its principal fibres. You may then vary your practice by other simple subjects of a similar kind, until you find you can do them all with ease.

"Before endeavouring to draw more than one leaf at a time, you must know a little of perspective. The most simple mode by which you will attain such knowledge of this art as will be most useful for your present purpose, is to hang a circular object, such as a hoop, between you and the window; set it amoving gently round, recede a little from it, and you will find that, as one side of it retires and the other comes forward, the circle which it describes becomes narrower and narrower, until it disappears altogether, and leaves nothing but a dark line, as if a stick instead of a hoop were hanging before you. I recommend you to do this between you and the window, because the hoop will appear like a dark line, and you will thereby be better able to mark the change that takes place in the shape of the circle. Fix it in various positions and draw from it, and observe that it is a different figure from an oval. You may now hang up your cabbage leaf, or that of any other large and well-developed vegetable, and you will observe the same change in its figure as it turns round. Make an outline of its shape while its front is half-turned from you, then bring it from between you and the light, and place it where the light will fall upon it, with its face half-turned from you, as when it hung before the window. Take your outline, and within it draw the principal fibres as you see them. To do this properly will require a great deal of practice, but it will pave the way to your being able to draw the most complete groups of flowers and foliage that can be placed before you. You may now hang before you a small branch of any tree or plant, with two or more leaves upon it —the larger the leaves are the better—and endeavour to make outlines of them, varying their shape according to their perspective, as already described; be particular on this point, for a great deal depends upon it.

"When a considerable advance has been made in the elementary department of drawing, it will be proper to go on to the higher stages."

It will be requisite to provide a drawing board, about thirty inches long, and about the same broad. The drawing paper is damped, and fixed upon the board with a little gum or glue round its edges. It will also be requisite to have a set of mathematical drawing instruments, with pencils, brushes, India-rubber, and other things required in drawing. The colours used, and how to make them, is given in another place. (*See index.*)

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## SELECTING PATTERNS.

The selection of proper patterns is one of the most difficult things in connection with weaving, and one that requires peculiar taste to be able to fix upon successful ones. A writer on the subject of taste says:—"Nothing that belongs to human nature is more general than the relish of beauty of one kind or other, of what is orderly, proportioned, grand, harmonious, new, or sprightly." "But although none be wholly devoid of this faculty, yet the degrees in which it is possessed are widely different. In some men only the feeble glimmerings of taste appear, the beauties which they relish are of the coarsest kind, and of these they have but a weak and confused impression; while in others, taste rises to an acute discernment, and a lively enjoyment of the most refined beauties. In general we may observe, that in the powers and pleasures of taste, there is more remarkable inequality among men than is usually found in point of common sense, reason, and judgment.

"The characters of taste when brought to its most improved state, are all reduceable to two—delicacy and correctness."

"Delicacy of taste respects principally the perfection of that natural sensibility on which taste is founded. It implies those finer organs or powers which enable us to discover beauties that lie hid from a vulgar eye. One may have a strong sensibility, and yet be deficient in delicate taste. He may be deeply impressed by such beauties as he perceives; but he perceives only what is in some degree coarse, what is bold and palpable, while chaster and simpler ornaments escape his notice. In this state, taste generally exists among rude and unrefined nations. But a person of delicate taste both feels strongly and accurately. He sees distinctions and differences where others see none; the most latent beauty does not escape him, and he is sensible of the smallest blemish. Delicacy of taste is judged of by the same marks that we use in judging of the delicacy of an external sense. As the goodness of the palate is not tried by strong flavours, but by a mixture of the ingredients, where, notwithstanding the confusion, we remain sensible of each; in like manner, delicacy of taste appears, by a quick and lively sensibility, to its finest, most compounded, or most latent objects."

"Correctness of taste respects chiefly the improvement which that faculty receives through its connection with the understanding. A man of correct taste is one who is never imposed on by counterfeit beauties; who carries always in his mind that standard of good sense which he employs in judging of every thing. He estimates with propriety the comparative merit of the several beauties which he meets with in any work of genius; refers them to their proper classes; assigns the principles, as far as they can be traced, whence their power of pleasing flows, and is pleased himself precisely in that degree in which he ought, and no more."

"It is true that these two qualities of taste, delicacy and correctness, mutually imply each other. No taste can be exquisitely delicate without being correct, nor can be thoroughly correct without being delicate. But still, a predominancy of one or other quality in the mixture is often visible. The power of delicacy is chiefly seen in discerning the true merit of a work; the power of correctness in rejecting false pretensions to merit. Delicacy leans more to feeling; correctness more to reason and judgment. The former, is more the gift of nature; the latter, more the product of culture and art."

The pattern that should be selected for drawing, for the purpose of being afterwards woven, should be distinct, and of a flowing nature; so as it will not appear in the cloth to be cramped, unless it be spots, sprigs, or distinct small patterns. After the pattern is decided upon, it will require to be drawn to answer the tye, or the tye will require to be made to suit the pattern. It is the most economical way to draw the pattern to suit the tye, and the tyes are in general made to take the full advantage of the Jacquard machines, with which the manufacturer is working. By making the pattern to suit the tyes, the manufacturer has it in his power to change the different sets of cards, from one loom to another. For example: if he has four different flowers, and he wishes so many pieces from each flower in four different kinds of cloth, such as six-fourth, seven-fourth, eight-fourth, and nine-fourth (or it may be four different qualities of cloth), by changing the cards from one loom to another, he gets all the four different kinds from the one set of cards, and consequently saves the expense of twelve sets of cards by this arrangement.

For illustration, we will suppose that the cloth intended to be woven is for ladies' dresses, and the Jacquard machine is one with six hundred and twelve needles, or cords, as the case may be (this machine would be called a six hundred machine); and suppose it to be a full harness (that is a harness where no heddle leaves are used for the tweeling), the harness being made to work both the figuring and the tweeling, or plain cloth, or all three if desired, it will be evident that the largest tye that can be got for an all-over is six hundred, setting aside the twelve needles to work the selvages; and although the full advantage is taken of the machine for the largest flower that can be got, it does not necessitate the drawing of the flower that size if it is not wanted; because any smaller size of figure may be drawn that comes within the compass of the number by which six hundred will divide;—namely, three hundred, two hundred, one hundred and fifty, one hundred and twenty, one hundred, seventy-five, sixty and fifty; so that in designing the pattern it must first be fixed what number of cords, or needles, the tye is to occupy. If the tye fixed upon be one hundred and fifty, the person that cuts the cards repeats the same pattern in cutting, four times over, so as to make up the whole six hundred on the cards. The designer, in putting the pattern on design paper, will require to be very particular that each part will join with its neighbouring parts, without causing any discord in the look of the cloth (or what weavers call barred). To prevent this, it is better to divide the object that is to be drawn into two; it does not matter although it is not divided into two equal parts, so be it that it is divided, and the one part of it put on the right hand side, at the extreme edge of the design paper, and the other part on the left hand side; so that when the two sides are brought together, the figures will be complete. The same must be done at the beginning of the design and at the end of it, that is at top or bottom; any part of the figure that comes in the centre is drawn in full. The tye being one hundred and fifty, and the flower requiring the full quantity of both warp and weft: namely, one hundred and fifty threads of warp and weft, then the design will require to be as long as give one hundred and fifty shots of weft. Another thing to be considered, is the tweel that is to be used on the cloth, where no part of the flowers covers. If it is a five-leaf tweel, then one hundred and fifty will divide by five, and one hundred and fifty ends will do; but if it is an eight-leaf tweel that is to be used, one hundred and fifty will not divide by eight, and the designer will require to make the drawing to suit some number that will divide by eight, so that the number of cards must either be one hundred and fifty-two, or one hundred and forty-four; because it spoils the appearance of the cloth to have broken tweels in it, which would be if the tyes and the cards were not made to answer some number that will divide by the number of the tweel.

It frequently happens (such as in dresses) that the flower is wanted to be well brought out on the cloth, and this is done by giving that part of the cloth which forms the flower a much heavier tweel than what is used for the ground of the cloth. The ground of the cloth may be a five-leaf tweel, and the flower may be a ten, twelve, or sixteen-leaf tweel; or the ground may be plain cloth, and the flower a large tweel; or some part of the flower may be more flushed than another part, and not forming any regular tweel; but this can only be done with the full harness.

The foregoing description gives an idea of how any all-over flower may be put on the design paper, such as are generally used for dress goods, carpets, and other kinds of cloth that do not require a border; but when a border or centre is required, it is different. In weaving woollen table-covers, that are to have different kinds of figures for the border and centre, the first thing to do is to fix upon the number of ends that are to be put in the border, and also the number for the centre. (We are still supposing it is a full harness), suppose we take a six hundred machine, and that we take three hundred for the body, and the other three hundred for the border, and the border to be a gathered tye, the border then will have six hundred ends in it, with the two borders twelve hundred ends of the web will be taken up; and if the cover is a $10^{00}$ with ten shots, seventy-two inches broad in the reed and the same length to make it square, the whole warp in the web will be, say 3890 ends, and by taking the twelve hundred off for the borders, will leave 2690 for the body, which, divided by 300 (the other half of the machine), will give eight repeats and two hundred and ninety over for a broken part.

EXAMPLE.

When the fraction is so near making another repeat, more ends can be added to make up another repeat, so by putting 3920 ends in the whole web, it will stand thus:—

| | |
|---|---|
| 3920 | ends for the whole warp. |
| 1200 | „ „ „ two borders. |
| 2720 | |
| 20 | „ „ „ two selvages. |
| 2700 | „ „ „ body. |

This will make nine repeats in the body, without any broken part. The designer will first require to draw the cross border and the corner part. The corner part will require to be confined to the three hundred needles that are to make the running border, and the cross border confined to the three hundred needles that are to work the body of the table-cover. The running border being gathered, the cross border pattern must be made to correspond with it in the kind of figure and in the size; consequently it will require six hundred cards to work the cross border. In drawing the body part, the running border is drawn along with it, and although the designer must keep to the three hundred needles for each, it is not necessary for him to confine himself to three hundred cards in the length of the figure; but whatever number he adopts, he will require to bear in mind (as stated before) to have a number, so as there will be no broken tweels at the joinings. The foregoing explains how the designer puts upon the paper any figures that are repeated upon the cloth; but if the table-cover is to have a large centre, and a figure for itself, the drawer will have a larger scope, and can introduce more variety.

To weave a proper table-cover, with a border all round in a full harness, three six hundred Jacquard machines can be employed; and by making it a gathered tye, both for the body and the border, you can easily take in all the 3920 ends of warp, and have some needles over that can be taken advantage of, to increase the size of the border, if that is considered necessary. The designer for a cover of this kind will require to draw half the pattern, and to design it so that when the two halves are joined together, they will make a complete whole. For table-covers it is common just to draw one-fourth of the pattern, and the card cutter cuts two cards for each line on the design paper, and the cards, when being laced, are placed in their proper place. For the hand-loom only one card is cut for each line on the design paper; but when the weaver has woven once over the cards, he works them backwards, and this makes the other half of the pattern. But suppose the centre piece is a vase, with flowers, then the pattern has to be drawn for the whole length of the table-cover, because the first half is different from the second. It will be evident that any kind of figures can be drawn from the one end of the cover to the other, but in the breadth the designer is confined to one half.

Another kind of designing for table-covers, or any kind of cloth requiring large figures, with little expense for harness and cards, is to work the ground of the cloth with heddle leaves, and only use harness for the flowering. This harness is designated a split harness—a three, a four, a five, or a six thread harness. The tweeling being done by the heddles, the designer does not require to trouble himself about that part. In putting the figures on the design paper, all he requires to do, is to draw the figures on the design paper in the same manner as he would draw them on common paper, with flat colour; and no shading is used except the breaking up of the figures to show their parts. Suppose it is a six thread harness with which the web is to be woven, then every small square in the design paper will represent six threads in the warp, so that the designer requires to make the turns in the figures as neat as possible. It will be obvious that a harness of this kind, with a four-hundred Jacquard machine, will be equal to one (for extent of flower) with six four-hundred machines, making a great saving in machines and cording; and as it is common to put six shots of weft on the cloth for each card with a six thread harness, there is a great saving in cards also, but the neatness in the curves and small objects are not so good as in the full or one thread harness.

Designs drawn for a harness, when heddle leaves are used for the ground of the cloth, will answer either for a split harness or any other number of threads that may be put into the mail; and if the looms have all the same tye, it will answer for either broad or narrow cloth, the narrow cloth having fewer ends in each mail. It also suits for any set of reed, as the number of ends in the mails can be regulated according to the number of ends in the web. For further explanation, read the article "Pressure Harness," which will be found in the fifth chapter.

But before leaving the subject of designing, we will make a few simple remarks upon it. Many people think it is only some kind of figures, or flowers, that can be woven into cloth, but this is a mistake, for any thing that can be painted on paper can be woven. No matter how many the colours, or extent of the patterns; it is just a matter of expense (or money). When the painting is once on paper, then the warp threads are to be imagined running up and down the paper, and the weft threads running across it. These imaginary lines are put on paper with all the different colours, and this paper is what is called the design. The painting or figure on the paper may be exactly the same size as what it is on the cloth, or it may be smaller, or it may be larger, that will depend on circumstances. When designing is understood (that is transferring the painting to the ruled paper), it becomes very simple, and does not require much talent; the talent is required in making the original drawing (not copying).

The many different kinds of woollen goods that are made with all the different shades of colour in them, require that the person whose duty it is to get up the patterns should have a knowledge of the harmonious arrangement of colours, which will be treated of in another place.

Goods with prominent stripes in the weft can be made by weaving tweel and plain cloth alternately, and the larger the tweel is, the stripe will be the brighter. When not more than six leaves are used for these stripes, a very simple motion can be applied to the check power-looms for working the tweel and plain cloth, which may be explained here. The barrel, or cards, or whatever the apparatus is, that regulates the shifting of the shuttle boxes, can be taken advantage of for regulating the working of the tweel and plain. It is done in the following manner:—For illustration, take a pattern that has eighty shots of plain cloth and twenty-four of tweel, and suppose the tweel is three leaves down and one up, which makes four leaves in all, and suppose the plain cloth has at the rate of fifty-four shots per inch, and the tweeled at the rate of one hundred and eight shots per inch, which gives for the tweel double the quantity of shots for the same space. In setting the pattern on the barrel for the change of the shuttles, it is set at the same time for the tweel. From each leaf there is a small rod of iron, with a projection on it, near the end, for taking hold of the shedding treadles; only the common wypers and two treadles are required, and as the two treadles go up and down alternately to make the shed, the heddle leaves are sunk or raised according to the arrangement of the barrel, which is for the plain cloth two up and two down, and for the tweel three down and one up. But it will be evident that some provision will require to be made on the up-taking motion, so as to put on the double quantity of shots on the tweeled part. This is done by the barrel also, by lifting the hauling catch each alternate shot, and allowing it to miss a tooth every second shot. Those who understand the working of the Dobie machine, will also understand this simple mode of tweel and plain, for the principle is just the same, the common treadles being used instead of the blades of the Dobie, and the barrel or other index for regulating the shifting of the shuttle boxes, is instead of the cards employed on the Dobie machine; so that it will be obvious that its advantage is chiefly confined to check-looms.

In calculating the quantity of weft required for a piece of cloth of the foregoing description, it will be necessary to ascertain the number of shots in a given quantity of inches. This can be done by multiplying the number of stripes by the shots in the stripe, in the given number of inches. For example, take nine inches, the pattern being repeated four times in the nine inches of cloth, and each repeat having 164 shots, then

164 by 4
4

9)656($72\frac{8}{9}$ shots.
63

26
18

$\frac{8}{9}$ or nearly 73 shots per inch.

So that by looking at the weft table, under 73 shots per inch, the quantity of weft required will be found.

The clan patterns, and the many different kinds of tartans made for dresses, and also the different patterns for wool shirtings which are made of woollen yarn, need not be further treated upon here, as they are taken notice of in another place. But we may refer the reader to page 66, where it is explained how the most difficult patterns can be warped with the beam warping machine.

CHAPTER VII.

## LAPPET AND GAUZE WEAVING, &c.

To represent flowers and figures on the surface of woven cloth has been a work or an amusement to females in every age, generally known by the name embroidery, which was commonly done by sewing; using, for the sewing thread, a different kind of yarn from what the cloth was woven with. This difference might either consist in the sewing thread or yarn being coarser, or in the colour of it; so lappet weaving is just to make representations of different kinds of flowers, birds, and other things, on the surface of woven cloth, although this is not sewing, but a mere imitation of it.

Articles of dress, ornamented with sewed work, have long been held in esteem; and the prices paid for some of them were astonishing, which may have been the reason for so many different inventions for the purpose of making sewed work cheaper, and the introduction of machinery for imitating needle work, which enables the manufacturer to bring that class of goods to the market at a low price. Among those machines may be classed the tambouring frames, the embroidering machines, and the different kinds of looms that have been used for that purpose; the lappet loom is one of them which will now be explained. But before doing so, we will give a short description of the embroidering machine, which is now being used more in this country than heretofore. The writer saw a number of these machines at work in Glasgow, a few weeks ago (April, 1872); they were driven by manual power, but they can also be driven by steam power. But which of the two ways will be the most profitable, is a question which has not yet been decided, although they had some machines being driven by a steam engine at the time of my visit, and to all appearance working well; but the labour saved is so trifling, it will not pay the expense of the new system, unless a boy or girl is put to work the pantograph instead of a man.

The cloth to be sewed or embroidered upon, is stretched upon a frame in a perpendicular position, and the frame may be made to take in five or six yards of the cloth which is to be sewed upon. This frame is made so as it can be moved up or down, or end ways, at the pleasure of the operator; it is inside another frame which is fixed to the floor. The needles are made about three inches long, with the eyes in their centre. We will take one needle for illustration:—The thread is put through its eye, and a pair of pincers holds it by one end; it is put through the cloth, and on the opposite side of the cloth is another pair of pincers standing open to receive the needle, and after the pincers have got hold of the needle, it recedes from the cloth the length of the thread that is in the needle; after that, the needle returns to the cloth, and the pincers would put it through the cloth the same place as before, if the cloth remained in the same position; but as the frame that has the cloth stretched upon it has been moved from its former position, the needle goes through another part of the cloth and forms the first part of the flower. The flower that is to be sewed on the cloth is drawn either upon a paper or board, and is in general drawn five or six times larger than the flower will be on the cloth. This drawing is placed in a vertical position at one end of the frame, and at a convenient height for the person who works the pantograph, and it is by shifting the point of the pantograph from one part of the drawing to another that moves the cloth, and this movement of the cloth forms the figure, as the needle is always in the same horizontal line.

The foregoing is how one needle acts, and there are hundreds of these needles for each frame; and on each side of the cloth there is a carriage with the pincers for carrying the needles to and from the cloth, something like the carriage of a mule Jenny. When one carriage moves towards the cloth with all its needles, and pushes them through the cloth, the carriage on the other side is standing with all its pincers, and their jaws ready to receive the needles as they come through the cloth; and after the pincers have closed upon the needles, it recedes from the cloth far enough to draw all the threads tight to form the flower. This operation is continued until the flower is finished. Each needle sews one flower only, and every one is just a repeat of the other. It is the multitude of needles that makes this kind of sewing cheap. It would never be able to compete with some other kinds of machinery for flowering, but for the quantity of needles that are used. To understand the machine thoroughly, it would require to be seen and studied for some time. The principles of it are simple, but there are many ingenious contrivances to give the different movements that are required to perform the work.

We have given this short sketch of the embroidering machine, knowing that it does not properly belong to the Art of Weaving; but as lappet weaving is just putting figures on cloth of a similar nature, some hints might be taken from it. The lappet loom has the advantage of being able to work with three or four different kinds of flowers at the same time, as will be seen as we proceed with our explanation of lappet weaving.

The ground of lappet cloth may be either plain texture, or gauze, or it may be both, by having stripes of gauze work interspersed with the plain cloth. But the descriptions given in this place will be to show how the "whip" is put upon the surface of the cloth to form the figures.

Whip is the name given to that kind of yarn which is used for making the figures in lappet weaving, and it is made by twisting together so many ends of common yarn, in the same manner as sewing thread is made. The twist put upon it depends entirely upon the kind of work it is to be used for. A very large quantity of the whip used in lappet weaving, is made from 40s and 50s; but the following list will show some of the varieties that are used:—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | Ply of | No. | 18s, | White, | Red, | Blue, | Orange, & other | Colours. |
| 3 | " | " | 18s, | " | " | " | " | " |
| 2 | " | " | 20s, | " | " | " | " | " |
| 3 | " | " | 20s, | " | " | " | " | " |
| 2 | " | " | 24s, | " | " | " | " | " |
| 3 | " | " | 24s, | " | " | " | " | " |
| 2 | " | " | 30s, | " | " | " | " | " |
| 3 | " | " | 30s, | " | " | " | " | " |
| 2 | " | " | 40s, | " | " | " | " | " |
| 3 | " | " | 40s, | " | " | " | " | " |
| 4 | " | " | 40s, | " | " | " | " | " |
| 2 | " | " | 50s, | " | " | " | " | " |
| 3 | " | " | 50s, | " | " | " | " | " |
| 4 | " | " | 50s, | " | " | " | " | " |
| 3 | " | " | 60s, | " | " | " | " | " |
| 4 | " | " | 60s, | " | " | " | " | " |

Besides the preceding, there are many other sizes used, and the twist put upon them varies according to circumstances; however, the whip must always have as much twist put upon it, as to make it stand the strain it has to undergo in the process of weaving. When the merchant wishes his goods made with very soft whip, it is very difficult to hit upon the exact twist, as a great deal depends upon the quality of yarn the whip is made from, and the twist must be found out by experiment.

It is important that the manufacturer should have his whip made from good yarn; many make great mistakes in buying low-priced whip, considering it cheap; but it is a delusion, for some of the trashy stuff that is sold for whip is dear at any price to use it for lappets; because the weaver can neither make quantity nor quality to remunerate the manufacturer if the whip is not good.

## CALCULATIONS FOR WHIP.

To find the quantity of whip that is required for a piece of cloth, before the cloth is woven: take the design for the figure, and count the splits that the whip will occupy at each traverse of the needle frame, for one repeat of the figure; multiply this by the number of needles in the frame, and this product by the number of repeats in one yard of cloth. From this will be found the quantity of whip for one yard of cloth for one frame, and if there be two or more frames making different figures, each must be counted by itself, and added altogether for one yard, and then multiplied by the number of yards in the piece of cloth. We will take for example a piece that is to be woven with three frames, each frame making a different figure. The first and second frame to have thirty needles each, and the third frame to have fifteen needles, and the reed the cloth is to be woven with to be a $10^{00}$.

| | 1st Frame. | 2nd Frame. | 3rd Frame. |
|---|---|---|---|
| 1st Shift, | 3 Splits. | 2 Splits. | 4 Splits. |
| 2nd ,, | 3 ,, | 2 ,, | 4 ,, |
| 3rd ,, | 2 ,, | 3 ,, | 5 ,, |
| 4th ,, | 2 ,, | 3 ,, | 5 ,, |
| 5th ,, | 3 ,, | 4 ,, | 6 ,, |
| 6th ,, | 3 ,, | 4 ,, | 6 ,, |
| 7th ,, | 4 ,, | 5 ,, | 7 ,, |
| 8th ,, | 4 ,, | 5 ,, | 7 ,, |
| 9th ,, | 5 ,, | 6 ,, | 8 ,, |
| 10th ,, | 5 ,, | 6 ,, | 8 ,, |
| 11th ,, | 3 ,, | 8 ,, | 9 ,, |
| 12th ,, | 3 ,, | 8 ,, | 9 ,, |
| 13th ,, | 2 ,, | 6 ,, | 4 ,, |
| 14th ,, | 2 ,, | 6 ,, | 4 ,, |
| 15th ,, | 3 ,, | 5 ,, | 5 ,, |
| 16th ,, | 3 ,, | 5 ,, | 5 ,, |
| 17th ,, | 4 ,, | 4 ,, | 6 ,, |
| 18th ,, | 4 ,, | 4 ,, | 6 ,, |
| 19th ,, | 5 ,, | 3 ,, | 7 ,, |
| 20th ,, | 5 ,, | 3 ,, | 7 ,, |
| | 68 ,, | 92 ,, | 122 ,, |

The foregoing imaginary figures have 20 shifts for one repeat, and say 65 repeats in one yard of cloth; then it will stand thus:—

| | |
|---|---|
| 1st Frame, - - 68 splits × 65 = | 4420 splits. |
| The first Frame has 30 needles, | 30 |
| | 132600 |
| 2nd Frame, - - 92 splits × 65 = | 5980 splits. |
| The second Frame has 30 needles, | 30 |
| | 179400 |
| 3rd Frame, - - 122 splits × 65 = | 7930 splits. |
| The third Frame has 15 needles, | 15 |
| | 39650 |
| | 7930 |
| | 118950 |

| | |
|---|---|
| 1st Frame, - - - - | 132600 |
| 2nd ,, - - - - | 179400 |
| 3rd ,, - - - - | 118950 |
| | 430950 |

Splits in all for one yard of cloth in a $10^{00}$ reed. There are as nearly as possible 27 splits in one inch, so we will divide by 27 to find the number of inches.

```
                27)430950(15961 inches.
                   27
                   --
                   160
                   135
                   ---
                    259
                    243
                    ---
                     165
                     162
                     ---
                       30
                       27
                       --
                        3
                       --
                       27

36 for Yards— 36)15961(443⅓, say 444 yards.
                 144
                 ---
                  156
                  144
                  ---
                   121
                   108
                   ---
                    13
                   ---
                    36
```

Suppose the piece of cloth is 20 yards long, then,

```
                          444 × 20
                           20
                          ---
yards in 1 hank, 840)8880(10½ hanks full per piece.
                     840
                     ---
                      480
                      ---
                      840
```

This shows that there are fully $10\frac{1}{2}$ hanks in the piece of 20 yards, and the weight of the whip in ounces will depend upon the number of hanks that are in one lb. of the yarn that is used for it.

The foregoing gives the method for finding the quantity of whip required for a piece of cloth before it is woven, but sometimes it is found after the piece is woven, that more whip has been put on the piece than what the calculation gives. This may be caused by different things, such as the peck not being the proper thickness, or by the whip being too slack woven. So it is better for the manufacturer to know the exact weight of the piece without the whip, and then weigh the piece after it is woven with the whip, and the difference in the weight will be the quantity of whip it has taken.

If a pattern piece of cloth be sent to the manufacturer to rate, a common way to find out the quantity of whip that will be required for it, is to pull out the whip a number of inches and measure it, then multiply by the number of needles, and that will give the length of whip for the number of inches pulled out, and from this the quantity of whip required for the piece will be ascertained.

EXAMPLE.

The cloth from which the thread of whip is taken we will suppose measures 6 inches, and the thread itself measures 25 inches, and that there are 42 needles in the breadth of the cloth. As there are 36 inches in one yard, the 25 inches will require to be multiplied by 6.

```
              25
               6
            ----
             150
              42 needles.
            ----
             300
            600
            ----
         36)6300(175 yards of whip.
            36
           ----
            270
            252
            ----
             180
             180
             ----
                 175 × 20 yards in a piece.
                  20
                 ----
yards in 1 hank, 840)3500(4¼ hanks nearly.
                 3360
                 ----
                  140
                  ----
                  840
```

The foregoing gives rather more than $4\frac{1}{4}$ hanks of whip for the piece of cloth 20 yards long.

## LAPPET LOOM.

The framing of a power-loom for weaving lappets is nearly the same as the framing of one for plain cloth, the stretch being rather longer to allow room for the whip rolls and the extra traverse of the lay; the shedding, picking, and a number of other things, are similar to those in the common loom, and will not be taken notice of here; but before beginning to explain the different articles that are required extra for the lappet loom, it may be stated that the crank and wyper shafts should be so placed as to give ample room for the lappet mounting to work without coming in contact with any other parts about the loom, and the cranks should be made with a throw sufficiently large to give the lay nearly seven inches of a traverse. The space that the needle frames take up in the lay is the cause of this large traverse. It will also be necessary, when putting up the gearing for driving the looms, to take into consideration the extra space they will occupy, compared to what is required for common looms.

---

## LAPPET WHEEL.

The pattern to be woven is drawn upon design paper, from which the wheel-cutter works. The wheels for lappets are in general made of plane-tree, being previously well seasoned, but they may be made from any other kind of hard wood that is close in the grain, and not liable to cast by change of the atmosphere.

The diameter of the wheel will depend upon the size of the pattern, although for very small patterns, such as the honey-comb, it is not advisable to have the wheel so small as just to have the pattern once on its circumference, because the grooves are very soon worn with the peck, and this will spoil the neatness of the figure; therefore, for small figures it is better to have the pattern repeated three or four times. After the diameter of the wheel has been fixed upon, and the number of teeth that will be required for the pattern, the piece of wood from which the wheel is to be made, is put into a lathe, for the purpose of being turned to its proper size. On the side of the wheel where the groove or grooves, as the case may be, are to be cut, a number of circular lines are made for the guidance of the workman when cutting the pattern; these lines may either represent the space of one, two, or three splits of the reed of the intended web, and the workman will cut accordingly. Steel combs can be got at any pitch required for making the circular lines on the wheel all at once; there is also a small groove cut in the wheel, near its circumference, for the pace cord.

After the wheel is turned, the next process is to divide its circumference into as many divisions as will make up the number of teeth required; this is done by an index which is fixed on the spindle of the lathe, or by a dividing machine, the number of teeth having been ascertained from the pattern on the design paper. When these divisions have been marked for the teeth, a straight line is drawn from each mark to the centre of the wheel. The circular lines represent the warp of the web, and the straight ones the weft; for each straight line there will be two shots of weft, and for each circular line there may be two, four, or six threads of warp, according to the fineness of the comb.

The workman will now draw on the face of the wheel those parts that are to be cut for the groove, and the design paper will show him how many threads of the warp will require to be traversed by the lappet needle to form the pattern at each tooth of the wheel; and to this space must be added the space that the peck will occupy. When he has got the piece cut out for the first tooth to correspond with the first line on the design paper, he takes the next line for the second tooth, and so on for the round of the wheel.

Suppose, for illustration, that before the wheel was taken out of the turning lathe, a groove had been cut in it half-an-inch wide, and suppose the peck to be a quarter of an inch, then it would follow that a straight stripe of whip, a quarter of an inch broad, would be woven on the face of the cloth. Now it will be evident that if the groove be made wider at any part of the wheel, the stripe will be made broader in proportion at that part. It is upon this principle of widening and contracting the groove, and changing its position on the face of the wheel, that any figure which will come within the range of the lappet loom may be woven.

Every new pattern requires a new wheel, and although not very expensive, at the end of a year the wheel-cutter's account amounts to a considerable sum, which has caused some manufacturers to consider whether some plan could not be devised, so that one wheel would answer for any pattern; but as yet no such wheel has been constructed, although a near approach to it was made a number of years ago. This wheel was made of sheet iron, was fully 22 inches in diameter, and had 180 teeth of $\frac{3}{8}$ pitch. On the face of it the circular lines were marked to correspond to the splits of a $10^{00}$ reed, and opposite each tooth there was a slit about 6 inches long, into which a pair of small bolts with thin flat heads were placed, the heads projecting from the face of the plate about a quarter of an inch, to form the sides of the grooves for the pecks. These small bolts being movable, they were shifted to any place in the slits of the wheel to form the pattern wanted.

The wheel having 180 teeth, would have a range for a pattern containing 360 shots of weft, but it will be obvious that this wheel would not answer for any pattern; for the number of weft shots contained in the given pattern must be a number that 360 will divide by; perhaps this was one of the principal reasons manufacturers had for not adopting this wheel.

## LAPPET NEEDLES AND PINS.

Lappet needles are made from brass or iron wire; iron ones are the best and cheapest, but sometimes it is necessary to use brass where the iron has a tendency to rust. The length of the needles is about $3\frac{1}{2}$ inches, and their diameter depends upon the kind of work to be woven. When the wire has been cut into lengths to form the needles, one of the points of each wire is flattened, and into the flattened part is put the hole for the whip; the other end of the wire is merely rounded a little. It is important to have the ends of the needles where the whip goes through made very smooth, and well pointed; otherwise they would break the yarn. The pins are made of wire the same as the needles, but stronger and shorter, with no holes in them; their use will appear further on.

## LAPPET LAY.

The lappet lay for a power-loom is similar in many respects to a common lay, and what has to be explained here is the apparatus attached to it, for the purpose of making it a lappet lay. In the first place, the reed requires to be placed about two inches back from the race, to allow room for the frames to work in front of it; and as the whip has to come through below the reed, a thin iron groove is bolted on the lay, for the purpose of holding the under rim of the reed. To answer this position of the reed, the top shell is bolted on to the back of the swords of the lay, instead of the front.

The pin frame, which is very like a heddle shaft, is made to work as near the race as it can be got, and is kept in its position by brass slides fixed on the swords. The use of the pin frame is to guide the shuttle along the lay, in absence of the reed. On the sole of the lay, two cast iron brackets are hung, for the shifters to work in. These brackets have small friction rollers in them, for the edge of the shifters to bear upon. The shifters are made of wood about $1\frac{1}{2}$ inch broad, and $\frac{3}{8}$ thick, the length of them being regulated by the breadth of the lay, and opposite the reed space are placed two brass uprights on each shifter for guiding the needle frames. The needle frames are also $1\frac{1}{2}$ inch broad, and $\frac{3}{8}$ thick, with brass tips on their ends, made to fit the uprights on the shifters.

For illustration, suppose that the lay be made for working three frames, then it will require three shifters; and on the top of each stump or sword will be fixed a small brander, with three slits in each, for the points of the uprights to work in. The needle frames are made to fit exactly in between the uprights of the shifters, and they must slide up and down easily, without having any play endways. If this be not attended to, the figure made on the cloth with the whip will not be properly formed.

The frames being all fitted (as far as the moving parts of them are concerned), the next process is, the marking off on the edges of the needle shafts how the needles are to be arranged. After having ascertained the number of splits the flower will occupy, and the number of times it is to be repeated on the breadth of the cloth, the workman makes a mark for each needle with a pair of small dividers, which are set to answer the figure. When the same figure is to be woven in a number of looms, it saves time to mark off one shaft correctly, and keep it for marking the rest from. This is done by catching the shafts that are to be marked along with the pattern shaft, in a vice, and taking a small square and applying it to the pattern shaft, when a line can be drawn across the whole of the others, and these lines will show where the needles are to be driven into the shaft. When the quantity of needles that are required have been driven into the shafts, each shaft is put on to its respective shifter, and the pecks which work in the grooves of the wheel are set. On the end of each shifter there is a small brass knob with a pinching pin, for the purpose of holding the pecks; it is by this pinching pin that the frames are adjusted endways.

The wheel and the frames being placed in the lay, the articles employed for shifting the frames can now be applied; and the different plans that hand-loom weavers have for this purpose are very numerous, which does not require an explanation here, as the movements will be readily understood when they are described for the power-loom; suffice it to say, that what is done by machinery in the power-loom, the hand-loom weaver performs with his hands or feet; indeed, many of the things used in the first power-looms for lappets are very similar to what are employed by hand-loom weavers.

In making arrangements for the different movements, it must be taken into consideration the time that the movements should take place, and also the proportion of time they should occupy. In the best made lappet looms, the wyper shaft extends from the one end of the loom to the other, and on each end of the wyper shaft there is a cam for working the needle frames endways. These cams are so fixed on the shaft, that when the full edge of one is up the other is down. For each shifter there is a small iron lever, the weight of which is sufficient to shift the frame. Attached to the end of each lever is a leather strap or cord, which passes up and through the cast iron bracket on the sole of the lay, and the other end of the strap is fastened to a shifter with a small screw-nail. The straps are adjusted so as the levers will hang with their weight upon them when the full part of the cam is down.

When the reed comes forward to the face of the cloth, all the needles must be down below the level of the race of the lay, and this is the time the needle frames are shifted endways, the needles being all clear of the warp of the web. If the lay has seven inches of a traverse, the needles should be full down when the reed is half-an-inch from the fell of the cloth, and they should not begin to rise until the reed has receded from the fell of the cloth another inch.

Many of the lappet looms are very defective in not having a proper apparatus for lifting the needle frames; most of them being lifted by the motion of the lay; and although this mode is simple in itself, that accuracy, which is necessary for the movements of the needles, cannot be obtained; for the needles will not be at their highest point of elevation until the lay is full back. whereas they should be full up at the instant the shuttle begins to enter the shed. It is an easy matter with the movement of the lay, to have the needles sufficiently high before the shuttle enters the shed; but they will continue to ascend while the lay moves back, which will put unnecessary strain upon the whip, therefore it is better to have them lifted by a wyper or cam made for the purpose.

To make a cam for lifting the needles, first draw a circle on a piece of wood which has been planed smooth, say 7 inches in diameter, the circumference of which will be 22 inches, divide this circle into 88 equal parts, then draw a line from each part to the centre of the circle; and as stated before, the needles should be down when the reed wants half-an-inch from the fell of the cloth, and remain down until the reed has receded another inch, which will make $1\frac{1}{2}$ inch. The cam being placed on the under shaft, which makes one revolution for two picks, it will require to be similar in shape to the cam G, in Figure 2, Plate I.; consequently, one revolution of the cam will lift the needles for two shots. It will be evident that for one revolution of the top shaft, 44 parts of the 88 will have passed a given point, and as the needle frames should remain up for the time that the top shaft will take to make a half turn; this will take 22 parts, and 6 parts for the needles, to remain down, will leave 16 parts; 8 to lift the needles, and 8 to allow them to fall, making in all 44; the other half of the cam is divided in the same way, which makes up the whole 88 parts.

Suppose, now, that a circle be drawn on the piece of wood, $3\frac{1}{2}$ inches in diameter, inside the other circle; this will leave $1\frac{3}{4}$ inch for the lift of the cam, which is divided into eight equal parts on one of the radius lines, making a mark for each division. A pair of dividers are now taken, and one leg placed in the centre of the circle, and the other on the first mark in the radius line; the dividers are now turned round, and a mark made on each of the first lines in the four divisions, and so on with the others. When this is done, each mark can be joined by drawing a pencil line from the one to the other, which will give the proper curves for the cam. The foregoing description shows the principle upon which all cams or wypers are made. The same principle will do for drawing hearts for winding and dressing machines, and it will be obvious to the practical weaver, that nothing can be better adapted for lifting the lappet needles than a cam drawn upon this plan, as they can be made to work to any amount of accuracy.

The cams for lifting the levers that move the frames endways, are of a different shape from the one that lifts them, and may be understood from the following observations. Let the reader remember what has been stated before, that the frames must be shifted endways, exactly at the time when the needles are clear of the warp yarn, and that that time cannot be more than the seventh part of the time which is occupied by one revolution of the crank shaft, and from this data the form of the cams will be found.

The lappet wheel requires to be moved forward one tooth every second shot, which is done by an article called a "stamper;" this is a flat piece of iron placed in slides facing the edge of the wheel next the web. The power applied for shifting the wheel is in general a spring of the spiral kind attached to the slide, which spring is adjusted to give just as much power as turn the wheel. The wheel on the end of the wyper shaft is cast with a slit in it, into which is placed a small pulley for working the lever that lifts the stamper. When the cams that work the levers for shifting the frames endways, are in a mid position, neither up nor down; this is the time the lappet wheel should be shifted, because at this point the strain of the pecks on the grooves in the lappet wheel is taken off. The reason for not shifting the lappet wheel direct from the loom is, that if any obstruction takes place to retard its motion, it is not forced round beyond the power of the spring.

## STARTING THE WEB.

The web is put into the loom, and plain cloth made before the whip is drawn through the eyes of the needles. Below the yarn beam, on each side of the loom, the brackets are fixed for the gudgeons of the whip rolls to run in; each needle frame requires a roll for itself, and the number of needles in the frame gives the number of ends that is required to be put on the roll. After the whip rolls are put in their places, the ends are taken under and over the spring cords, and through between the legs of the heddles at the proper intervals, and then under the rim of the reed, and through the eyes of the needles. A small cord is put round each roll for the purpose of pacing the whip. When the needle frames are lifted, a quantity of whip will be drawn off the rolls; and when they descend at the time the reed comes forward to the cloth, the whip would remain slack if the spring cords did not act upon it, and the spring cords must be so adjusted that they will yield to the lift of the needles, and at the same time have spring enough to take up the slack of the whip.

The loom can now be put on, and a few inches of cloth woven; this is the best time to see that all the things are properly set. The mounting of the heddles is done in the same manner as if it were a plain web; the sheds should not be large, and the eyes of the needles when raised should not be higher than the upper half of the shed, to avoid unnecessary strain being put upon the whip, but they must be raised as high as to allow the shuttle to pass freely under the whip.

Having explained how common lappet cloth is made, and the different parts and movements for accomplishing this, a description of some of the varieties will now be given. It will readily be understood from what has been stated, how any figure of a running nature can be made; but when figures that stand detached from one another are to be woven, a different arrangement requires to be made; for instance, if a sprig is to be woven on the cloth, and each sprig to stand at a distance of half-an-inch, then the frames will require to be put out of gear, or what is called in the trade, dropped. This is managed in the following manner:—Upon the back of the lappet wheel near to its circumference, is fixed a piece of wood or iron, of sufficient length to occupy the space for the number of teeth that will be required for the half-inch of cloth which intervenes between the sprigs. This piece of wood or iron is made to project about three-quarters of an inch from the wheel, and in some convenient place a small lever is attached, in such a manner that the projection on the wheel can act upon it. This lever may be made to work either in a perpendicular or horizontal position, whatever way the form of the loom will suit best. At the point of this lever is affixed a cord, which acts upon the apparatus for dropping the needles.

As already observed, the needles and also the pin frame for guiding the shuttle, rise every shot; and suppose all the three needle frames are to be dropped at the same time, it will be obvious that the pin frame must continue to work, so provision must be made to allow the needle frames to discontinue working while the pin frame works on. This is done by having an intermediate crank or catch, which is attached to the lifting rod for each frame; and so long as the lappet wheel does not indicate that the frames are not to be lifted, they continue to rise; but when the wheel comes round to that part where the frames are to be dropped, this catch is drawn to one side and does not act, and the needle frames are not lifted so long as the wheel presses upon the small lever. But after the loom has made the number of picks necessary for the interval of half-an-inch between the figures, the catches are allowed to go into their former position, and the frame again rises and continues to work until the time arrives that they should again be dropped.

When flowers are to be woven which have different colours in them, and some of the parts being detached from the main figure which continues to work; in this case, some of the frames will be dropped, while the others will continue to work. It is by arranging the frames in this manner that many of the different varieties may be woven.

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## GAUZE STRIPES, &c.

Gauze stripes are frequently made in lappet cloth, which goes under a great variety of names. The principle upon which they are all woven is nearly the same which is to cross the warp threads, and this is done in a variety of ways, some of which we will endeavour to explain.

Plain gauze may be said to be the foundation of all the other kinds; and when it is properly understood, to comprehend the other kinds is comparatively easy. Suppose a plain web drawn upon two leaves of heddles, and the leaf next to the lay or fore leaf to be cut away, and the back leaf, with half of the warp of the web in it, fixed up in a position so as the warp threads will be high enough for the top shed; this part of the warp will be the top shed for every shot of weft. Now, suppose the yarn that was in the fore leaf to be drawn into what are called doups (which is the under part of the heddles); these doups to be on two heddle shafts, what is on one shaft is to pass over the warp threads from the right; and what is upon the other from the left so as the warp will form a shed for the shuttle to run through, first on the one side and then on the other, alternately, and this will make plain gauze. To weave gauze in this manner, it will be necessary that the back leaf be placed at a sufficient distance from the doups, so as to allow the warp threads to cross without being too much strained.

## GAUZE AND PLAIN CLOTH.

To make gauze and plain cloth, a double set of heddles is required; and if the cloth is to have a gauze stripe running across the web, besides the one in the length, such as cloth for handkerchiefs, with a border of gauze all round, and a plain cloth centre, then three sets of heddles are required—one for the plain cloth, one for the cross borders, and one for the border that runs the lengthways of the web. This sort of gauze with only the one split to cross in, has very little appearance in the cloth, and for weaving handkerchiefs, a reed of a peculiar kind has been adopted, which makes the crossing or gauze much bolder by having the same as an empty split between the crossings. It is managed in this way: Suppose the web to be woven is a $16^{00}$, and suppose the reed to be at first made an $8^{00}$, and afterwards a short split put into the under rim of the reed between each split, this short split to stand up to within one inch of the top rim, then the reed would be a $16^{00}$ at the bottom rim, and an $8^{00}$ at the top rim. When the weaver is working the plain cloth, all the yarn of the web is in the under part of the reed with two threads in each split, which makes a $16^{00}$; but when the cross border is to be woven, all the yarn in the web is lifted up to the top of the reed where it is only an $8^{00}$, and the reed is pushed a little to the one side, so as the warp yarn will all press on the sides of the splits In this position the yarn is allowed to drop down to the bottom of the reed, and the reed being pressed to the one side, the four threads of warp go into one split, leaving every alternate split empty; and when the weaver works the cross border, the warp yarn has two splits to cross instead of one, if the common reed were employed. It will be evident that this will make the border more prominent than with the one split. To prevent any of the four warp threads getting out of the splits, a small slip of wood or iron is placed along the top rim of the reed, made so broad that the under edge of it will cover the tops of the short splits. Of course this slip is removed when changing the warp yarn back to its former position.

In making reeds for this kind of work, the reed maker has just to observe that he puts in a short split, and a long one alternately; that is all the difference between making them and common reeds, but as this takes more time, the price of this kind of reed is much higher.

It will be obvious to any one who understands plain gauze weaving, that this principle of the reed could be carried out further in making gauze fabrics, or what is termed by the weavers spidering, veining, nets, crapes, &c., by having the reed made with more than one short split between the long ones, and by having more than two threads in the split. For certain kinds of work, such as sewed trimmings, special reeds can be made for the particular kind of trimming that is wanted.

Needles may be used for making gauze, and for some kinds very advantageously, if two needle shafts, such as are used for lappets, be taken, and each shaft to have as many needles in it as will contain half of the warp that is in the web, and if these shafts be placed in a frame immediately behind the lay, one shaft with the points of the needles up, and the other with the points of the needles down, and if these needle shafts are made to move up and down, and one of them to move a little endways (at the time the two halves of the warp are clear of each other), for the purpose of crossing the warp threads; if the top shaft with its needles descend $1\frac{1}{2}$ inch, and the under one ascend $1\frac{1}{2}$ inch, a shed will be formed of $2\frac{1}{2}$ inches, allowing half-an-inch for the yarn in the eyes of the needles to be clear, at the time the frame is shifted endways.

By adopting the needles and frames for working gauze in the way described, it will be easy to imagine how any kind of gauze or net work may be woven, as all the different varieties depend upon how the warp threads are crossed; and that crossing just depends upon how the needle frames are shifted endways, which can be done with a very simple apparatus, such as a lappet wheel or barrel. And for extensive patterns such as those used for shawls and scarfs, the use of the Jacquard machine may be taken advantage of for regulating the shift of the needles, when there would be no end to the variety that might be produced. But it must be understood, that when more threads are to be crossed than what are contained in one split, the needle frames must be made to work before the reed, and behind the race of the lay. It will also be obvious, that if a number of these needle frames be employed in the same manner as heddle leaves are, for tweeling, a still greater variety of patterns may be woven.

In working with a number of needle frames where the crossings of the warp are unequal, it will not do to have all the warp of the web on one beam, so that the workman will require to consider the extent of the shift for each frame, and get beams warped for these frames; which require more or less warp than what is required for the common crossings. It may be difficult to get at the exact length of the warp for each frame, when starting a new pattern; but after the first web is woven, it will be easy to find the proper quantity for each beam by keeping a note of the length first warped, and then measuring the yarn that is left on the beams, after the whole of the yarn has been woven off one of them; (that is, when one of the beams is out).

The plan or method of working the needle frames is as follows:—To shift the frames endways, has been already explained, which is done in the same manner as the needle frames for lappets. The sinking and rising of the frames can be best done by having a roller above and one below the needle shafts, and the shaft attached to these rollers in the same way as common heddles; so that when the one rises the other will descend. To accomplish this every shot, a wyper can be put on the end of the crank shaft, which makes one revolution for every shot, or a double cam or wyper (of the same kind as shown at G, in Plate I., Figure 2), can be put on the under shaft, which makes only one revolution for every two shots, and this cam will work a treadle, to be put in connection with one of the rollers, that when the treadle is depressed by the cam, the shed will be formed. But as there is only one treadle to work the frames up and down, a spring or weight must be used to close the shed or bring the frames back to the position they occupied before the shed was formed. If the spring or weight be objectionable, and in some cases it may, then a cam can be put on the shaft that will work the treadle both up and down.

When the web is very fine, great care must be taken to have the needles properly set into their frames, for if this be not attended to, the figure will not be formed according to the design.

It has already been stated that the Jacquard machine might be employed for gauze work. We will now endeavour to explain how it can be applied both for gauze and lappets. Suppose, for example, the figure requires the frames to have a range of 10 inches endways; and at the end of the lay, where the lappet wheel is usually placed, instead of the wheel, there is fixed a pair of hole boards, of the same set as the reed or web that is to be woven. These hole boards are fixed with their edges towards the lay, and the one above the other, about half-an-inch apart, and their holes right opposite. If the web to be woven be a $10^{00}$, there will be 270 holes in each board, that is allowing each hole to occupy a space equal to a split in a $10^{00}$ reed. Into each of the holes in the top board is put a piece of wire like a lappet needle, with its eye up, which is allowed to drop into the hole directly below in the under board; the under board having a piece of thin wood fixed on its under side, for the purpose of preventing the wires from falling through. The Jacquard machine is placed in any convenient part above the loom, and small cords are attached to each of the wires, and then tied to the tail cords of the Jacquard machine, in the same manner as in tying a harness, each wire having a tail cord for itself. Consequently, there will be 270 of the needles of the Jacquard machine employed.

In this arrangement, a peck is used for guiding the frames, similar to those used with the lappet wheel; but that part of it which works in the groove of the wheel is made much longer, as the length of it must be equal to the breadth of the boards that hold the wires. The figure to be woven must be drawn on design paper, in the same manner as it is drawn for lappet weaving, and the cards cut, so as the wires will be lifted to form the space for the peck to work in, in the same manner as forming the groove in the lappet wheel. The principle of the lappet wheel has been already explained. However, in working lappets with the Jacquard machine, the length of the figure will depend upon the number of cards used, and any quantity can be employed, if there be room to hold them. The machine will require to be lifted every second shot, and remain up for the two shots; the same length of time that the common lappet wheel stands unmoved by the stamper. How to accomplish this will be understood by referring to the description given of the disengaging apparatus, at page 173, also page 208.

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## WINDOW CURTAINS.

Some years ago a fabric was brought out in Nottingham for white window curtains, which to a large extent superseded the white harness muslin curtains. Some of these harness curtains were made with a plain ground, and some with a gauze ground; but in both cases they were woven with two shuttles, one for the coarse, and one for the fine weft. The coarse weft or rove formed the figure, and they were woven one shot of fine and one of rove, alternately. But the new curtains, which we shall call "Lace

Curtains," for a distinction between them and the Nett Curtains, which were also made in Nottingham.

A number of these Nottingham looms have been started in Ayrshire, and two of them in Glasgow; and it appears that the demand for this class of goods still continues to increase.

The warp is all on one beam, and the Jacquard machine regulates the warp threads, according to the figures on the design paper, to form the flowers on the cloth. The weft is much coarser than the warp, and it is put through and round the warp threads, much in the same way as it is done with the sewing frames for putting figures on the cloth, which is explained in another place. There is a sufficient number of the circular pieces as to take in the breadth of the warp, and when the Jacquard machine lifts the warp yarn, that portion of the warp which the weft is to pass round, goes into the gaps, and then they are made to make one revolution, and the weft or sewing thread, being inside the circular pieces, is carried through and round the warp threads that are lifted by the Jacquard machine.

To get an idea how the circles are made to work, it will be as well to read all that has been said under the heading, "Sewing Frames for Looms." Under that heading are explained the different ways for putting the sewing thread through the warp yarn.

## NEEDLES FOR FANCY GAUZE.

By placing a needle frame in front of the lay, a great variety of very beautiful patterns can be produced on plain cloth. The frame is a piece of wood as long as the lay is broad, between the shuttle boxes, and about three inches broad, by $\frac{5}{8}$ or $\frac{3}{4}$ of an inch thick. Into this piece of wood are driven the needles, in the same manner as lappet needles. The needles are not the same as lappet needles, but are made of brass or iron wire, very sharp at the point, and on one side of the wires is cut a small slit, like the barb of a fish hook. The barb is turned towards the point of the needle, and is about half-an-inch down from the point. The needle is about four inches over all, and it is driven into the wood about three-quarters of an inch. This leaves $2\frac{3}{4}$ inches to form the shed.

In mounting a loom of this kind, as far as regards the needle frame, the first thing that requires to be known is the set of the reed with which the cloth is to be woven, and then to fix upon the number of threads that are to be crossed. Suppose that the reed is a $14^{00}$, and that the crossing is to be formed with four threads (that is four threads turning round other four threads, in the same manner as plain gauze), the needles will require to be driven into the frame to catch every alternate four threads, and the needles in the frame will then be of the same closeness as the splits in a 350 reed. There is one heddle leaf placed either in front or at the back of the other heddles, into which one-half of the web is drawn every alternate four threads, four threads in each heddle. This leaf has long eyes in it, to allow the other heddle leaves to work when it is not in use. When the time comes to make the spidering or gauze across the warp, this heddle leaf is lifted with each alternate four threads, and the frame with the needles rises up to catch the other half of the warp; and when the points of the needles have got above the warp threads a little, the frame is shifted to one side, which causes the points of the needles to press against the yarn; and at this instant the needle frame is lifted its full height, and the four threads are taken hold of by the barbs of the needles, the frame having been shifted as much as the space that four threads will occupy. The one heddle leaf with the other half of the warp in it, is allowed to drop, and each alternate four threads goes down at the backs of the needles, and this forms the shed for the gauze shot which is put in before the needles are lowered. This operation is repeated every time that a gauze shot requires to be put in. It will be evident that this plan of working with the needle frame before the lay, has the advantage of being able to make almost any kind of cross or net work. But this kind of weaving is expensive.

## SEWING FRAMES FOR LOOMS.

There is a species of figured work done in the loom with what are called sewing frames, which may be very appropriately explained in this chapter, although it does not come under the name of lappets. To persons unacquainted with weaving, some of the figures done in the lappet loom look very like those done by the sewing frames, but they are very different, and the name given to this kind of weaving (sewing frames), implies that it comes nearer to sewed work done by the hand than any other done in the loom.

Many a contrivance has been planned, and put into operation for this species of weaving; but before describing any particular one, it will be better to explain the principle upon which this kind of sewing is done. It is a matter of choice what the ground of the cloth should be where the figures are to be sewed on; it may be either plain or tweeled, or both. But suppose it to be a plain ground, and the figure to be sewed a small spot or sprig, which will occupy a space on the cloth of a quarter of an inch, and the sewing thread to be all on the one side of the cloth; in this case one thread of the warp, or at most two, is lifted at each side, where the edge of the spot or sprig is to be formed, and the sewing thread put through below them. After this the plain shed is formed, and a shot of weft is thrown for the plain ground, then the warp