LOOM TUNING,

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Second Edition.

Printed by
Emmott & Company, Limited, 65, King St., Manchester,
and 118, Chancery Lane, London, W.C.

PREFACE.

The object of the present work is to help the loom tuner to grapple with the difficulties which face him from time to time in actual mill work.

While conscious of the futility of trying to deal with every fault that may arise in the manifold kinds of weaving, I have endeavoured to set forth the principles which underlie the timing, setting, and character of action given to the different motions of the loom in order to produce the best work under varying circumstances; and to show how many of the faults which arise may be remedied.

In dealing with the simpler and best known types of motion I have tried to make my meaning clear without giving a minute description of the mechanism, and relied upon the tuner making himself acquainted with the parts dealt with at the loom itself.

Mechanisms which are comparatively new, intricate in character, or whose setting can be better dealt with in conjunction with a detailed description, have, however, been thus described.

I have aimed at giving in a clear and concise manner the results of a number of years' experience and experiment, and trust it will help those who are studying the subject to grasp the first principles of their work, as only by so doing can they expect to master the difficulties with which they will have to deal.

JAMES BAILEY.

Keighley,
August, 1906.

PREFACE TO SECOND EDITION.

The way in which the first edition of this treatise on "Loom Tuning" has been received, encourages me to present a second edition to the public.

It is with pleasure that I extend my thanks to those persons who have been kind enough to express their appreciation of the help which they have derived from a study of its pages, and to those who have recommended it to their friends.

I trust that it will continue to help those who are studying the subject, and enable them to successfully overcome their difficulties.

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LOOM TUNING.

CHAPTER I.

SHEDDING.

The object of shedding is to make an opening for the shuttle to pass through, and to change the position of the warp threads after each pick, so that the warp and weft yarns will be interlaced together according to a definite plan or pattern. This opening is usually made either by means of healds in tappet

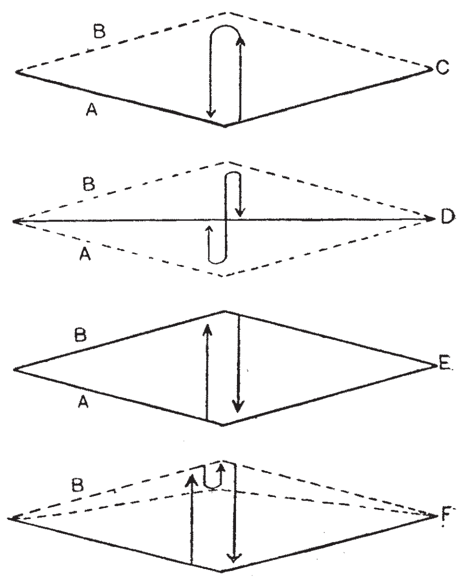


FIG. 1.

and dobby looms, or by means of harness cords in jacquard looms. Shedding motions are built on four different principles, and it is important that the manager should know the advantages or disadvantages of each in order that he may be able to select the one most suitable for his work. Single-lift dobbies and jacquards, and a few tappets, are built on the "bottom closed" shed principle, in which the bottom line of warp A is stationary, while the top line B moves from the bottom to the top and back again for each pick, as shown at C in Fig. 1. Its advantages are that the mechanism is very simple, and that the warp threads come to one level after every pick; this latter makes it especially suitable for weaving gauze cloths, as the crossing threads can readily pass round the stationary threads. Its disadvantages are the large amount of power required to drive the loom, owing to the absence of any counterpoise principle, the slow running necessitated by the distance through which the warp threads pass, and the excessive strain which is put upon the warp threads.

The "centre closed" shed principle is applied to Woodcroft and oscillating tappets, and to a few dobbies and jacquards; but there are comparatively few looms working on this principle. Even Woodcroft tappets are now made to produce an open shed. This principle of shedding consists in depressing the threads for the bottom line A, and raising those for the top line B, for each pick, and then allowing them to meet in the centre as shown at D in Fig. 1. The advantages claimed over the "bottom closed" shed are that less power is required, and less strain put upon the warp. But in actual work, especially in jacquard looms, it is found that by moving both the top and bottom lines of warp a great amount of vibration is set up, which more than counterbalances any advantages, and limits the loom to slow speeds.

In shedding motions built upon the "open-shed" principle, the warp forms both stationary top and bottom lines A and B, and changes are made by moving the threads up or down between the fixed lines as required, as shown at E in Fig. 1. This is an ideal motion, as it allows threads which are required to be either up or down for a number of picks to remain stationary in their relative positions until a change is required. The advantages which accrue from this principle of working are less strain upon the warp threads and less power required to drive the loom, as a falling thread helps to lift a rising one and a high rate of speed can be attained.

It is easy of application to tappet looms, but when applied to dobbies or jacquards a considerable increase in mechanism and in wear and tear of the working parts is often the result. The " open " shed dobby known as the " Dobcross " is a notable exception to this rule.

The semi-open-shed principle upon which double-lift dobbies and jacquards are built is shown at F in Fig. 1, and is very useful, as it gives almost the same advantages as the open shed, with a simpler mechanism. The only difference between the sheds is that the top line of shed B, instead of being stationary, comes slightly down with the falling griffe until the action of the rising griffe is fully exerted. A disadvantage of both open and semi-open shedding motions is that some auxiliary mechanism is required to make them suitable for gauze weaving, where the heald which carries the crossing thread has to lift either the pick before or after the doup. Another disadvantage is the difficulty of levelling the healds when broken threads have to be repaired.

ECCENTRICITY OF MOTION NECESSARY IN SHEDDING.

The motion given to the warp threads which are forming a shed in either tappet, dobby, or jacquard looms must be eccentric—*i.e.*, the shed must begin to move from either stationary line slowly, increase in speed to the point where the warp threads cross each other, and then gradually decrease in speed until the shed is fully open. A pause or dwell of sufficient length to allow the shuttle to pass through the warp should then be given. The length of dwell will depend upon the width and speed of the loom

the character of the material, and the amount of cover required on the cloth. For wide slow running looms with finely set fibrous material the pause should be $\frac{2}{5}$ to $\frac{1}{2}$ of a pick, while for narrow fast running looms with smooth strong yarns $\frac{1}{3}$ of a pick dwell gives an evenly covered cloth. When reediness is not considered a fault, or where the warp threads must form straight cylinders with the weft bent round them as in cords, a pause of $\frac{1}{3}$ to $\frac{1}{4}$ of a pick is sufficient. The advantage of this kind of motion is that the warp is made to move quickest when it is slackest, and slowest when it is tightest, thus reducing the breakage of warp threads to a minimum. In tappet looms the eccentricity is obtained by shaping the tappet in accordance with the pattern of the cloth, the size of the anti-friction bowl, the amount of dwell, and the length of stroke required. To test a tappet for length of dwell and eccentricity of

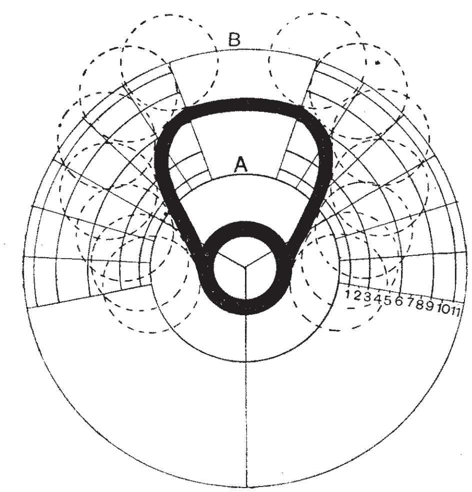


FIG. 2.

movement, it is placed over a diagram constructed for the same pattern and dwell on the principle shown at Fig. 2.

A circle A is drawn equal in radius to the distance from the centre of the tappet shaft to the centre of the anti-friction bowl, when the bowl is touching the boss of the tappet. The circle B is then described with the length of the tappet nose added to the radius of the compasses. (The centre of the anti-friction bowl which transmits the motion from the tappet to the treadle always works between these two lines).

The circle B is divided into as many equal parts as there are picks in the pattern, and lines are dropped from these divisions to the centre in order to show the number of picks clearly.

The space representing each pick is then subdivided into a number of equal parts—3 if $\frac{1}{3}$ of a pick dwell is to be given, 2 if $\frac{1}{2}$ of a pick, etc.—and radial lines are drawn between A and B from each of these divisions. One space in each pick will represent the pause or dwell given to the heald, and the others the time allowed for the rise and fall. It will be found that owing to one heald rising as another falls, the period of depression for one heald will correspond with the period of rising for another. The space alloted for the raising or lowering of the heald is divided into six equal parts by radial lines, so as to represent six equal units of motion in the revolution of the tappet. One of the radial lines is then divided into 12 equal parts, and from points 1, 3, 6, 9 and 11 arcs are described in the spaces where the healds rise and fall. If each point where a radial line is cut by a curved one is taken as the centre of the anti-friction bowl, it will be seen that the heald is moved quicker and further in one unit of speed than another. From these points—beginning at the circle B on each side of the space allowed for dwell, and taking the others in rotation until the circle A is reached—describe arcs equal in diameter to the anti-friction bowl.

The shape of the tappet may now be got by drawing lines which touch the inner surfaces of each circle, and connecting them together by an arc when

the bowl is stationary at its highest and lowest positions.

Care should be taken to see that the tappet is used in combination with the size of anti-friction bowl for which it has been made, that the bowl is in continuous easy contact with the tappet throughout its entire revolution, and that the centre of the anti-friction bowl is exactly under the centre of the tappet shaft when the heald treadle is in the centre of its stroke. Otherwise the eccentricity of action will be interfered with, and the motion will become jerky. When the pattern is one which requires the heald to remain raised for more than one pick, the pause or dwell will be continued for a length of time which will embrace both the dwell for the first and last picks over which the thread must float, and the whole of the time occupied by the intermediary picks.

In dobby and jacquard looms, the eccentricity is usually obtained by connecting the griffes or draw knifes by means of treadles and connecting rods to a crank or sweep placed on the top shaft of the loom for single-lift machines, and on the bottom shaft for double-lift machines. This crank, if the treadles are placed exactly over the centre of the shaft so that the connecting rod will be perfectly vertical when the crank is at either its top or bottom centre, will give pauses of equal lengths at both ends of the stroke, and will begin to move slowly from these points, and increase in speed towards the centre, then go slower in the same ratio until the other end of the stroke is reached. If the treadles are not in this relation to the crank, the eccentricity of the downward stroke will be different from that of the upward stroke, and imperfect shedding will result.

For very wide looms, and for cloths which require the shed for the second pick fully open before the first one is beaten up, so as to prevent curls being formed by the weft catching on the slack warp threads, as in satins, corkscrews, etc., or to allow a large quantity of weft to be beaten into the cloth (which can be better done with a crossed shed than with a shed which has simply closed), or in cases where the threads require to be evenly spread, additional eccentricity of motion is got by using a pair of elliptical gear wheels A and B (Fig. 3), and connecting the crank C and treading rod D, as shown.

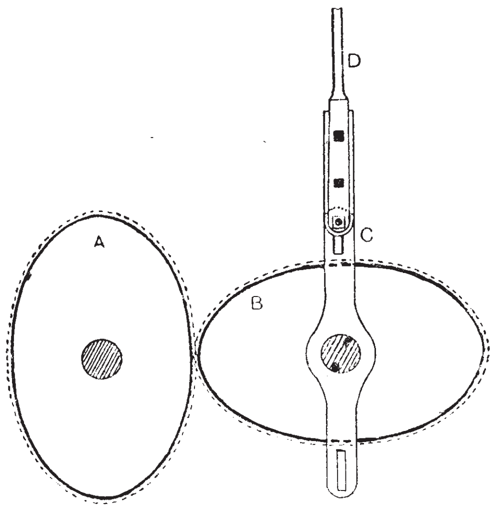


FIG. 3.

TIMING THE SHEDDING.

The timing of the shedding in relation to the picking and beating-up motions will be governed to a large extent by the length of pause given to the heald. If the pause be only of sufficient length to allow the shuttle to pass across the loom, say, one-third of a pick, it is best to turn the crank to its bottom centre, revolve the tappets until the healds just reach their highest and lowest positions, and fix them at that point. This will allow the shuttle to get clear of the warp without friction (as the shed only begins to close when the crank is half-way between the back and top centres) and the healds to

pass each other when the reed is 1in. from the cloth. If a large amount of thick weft has to be inserted, it is better to time the shedding earlier—say for the healds to cross when the reed in $2\frac{1}{2}$in. from the cloth—as this will allow the weft to be beaten in with less weight on the warp beam.

When the pause is a long one—say one-half of a pick—the rising and falling healds will require to pass each other when the crank is at its top centre, and the shed will be almost fully open for the next pick when beating up takes place. This length of dwell should only be given for the purposes already indicated, and in conjunction with good, strong warp yarns. If fine yarns were used with little twist or size, the threads would be chafed down by the friction caused in pushing the weft yarns between them, and a shorter dwell and later timing would be necessary to produce good work. Too late shedding in relation to the picking will cause breakage of the warp threads and badly drawn-up edges, while too early shedding will cause the shuttle to stitch as it passes out at the opposite end of the shed, and in some cases to leave the loom.

SIZE OF SHED.

The size of shed required to produce the best results will vary with the size of the shuttle and the quality of the warp yarns employed, but should always be as small as the circumstances will allow. Sometimes manufacturers increase the size of the shuttle for the purpose of allowing a larger cop or pirn to be used, with the idea that by so doing they will increase the production, unless there is a corresponding increase in the strength of the warp yarns, however, it will be found that the extra strain put upon the threads in producing a larger shed for the shuttle will result in breakages of the warp, which will more than counterbalance any advantages gained, as the repairing of one warp thread takes more time than changing a number of shuttles.

For good, strong, elastic yarns, a large shuttle may be employed ; but for fine, tender, or badly sized yarns, a small shuttle is the most advantageous. The shed formed for smooth, even yarns should be of such a size that the threads will barely clear the front of the shuttle when the lay is pushed to its backmost position ; but when the yarns are rough and fibrous, and difficult to separate, the shed must be made larger, because the warp yarns must be properly opened before the shuttle is inserted, or broken threads, stitches, and flying shuttles will result. When weaving rough and fibrous warps it is often advisable to insert breaker wires behind the reed. These wires are carried by a supporting rod which is fastened to the hand-tree, and are dropped between the warp threads at every 4th or 5th dent as required. The lower ends of the wires are then kept in position either by a cord or lath which is fastened to opposite ends of the lay.

If too large sheds are formed, an excessive strain will be put on the threads, which will result in frequent breakages, and in bare, lean-looking cloths ; if the sheds are too small, extra power will be required to drive the shuttle through the shed, and the friction of the shuttle will wear down the threads, and the weft will stitch at the edges.

With the object of reducing the strain upon the warp threads to the lowest possible point, a vibrating back bearer is largely employed, which slackens the threads as they are being opened by the healds. This bearer is actuated by a lever and a tappet on the crank shaft, which latter must be carefully shaped and timed in relation to the shedding. If this motion is used, there will be both equality of tension on the warp at all points of the motion, and a general easing of tension throughout, as much less weight is required on the warp beam.

Arrangements are also made for altering the size of the shed in a quick and efficient manner ; but no alteration must be made without seeing that the bottom line of warp lays properly on the shuttle race afterwards.

The alteration is made on tappet looms by changing the position of the streamer rods on the jack levers, *i.e.*, by moving them nearer to the square rod for a

larger shed, and farther away for a smaller one ; or by changing the position of the heald connections on the treadle levers in looms where the connection between the two is direct.

In dobby or jacquard looms the position of the crank stud will require to be nearer to the shaft on which it is fixed for a smaller shed, and further away for a larger one.

When an alteration is made in a dobby or jacquard loom, care must be taken to put the draw-knives in correct relation to the hooks before resuming work.

The lower line of shed should neither be made to press heavily on the shuttle race nor stand very high above it, because in the former case a great amount of wear and friction would occur, and in the latter there would be a liability for the shuttle to be thrown out ; a medium position should therefore be maintained.

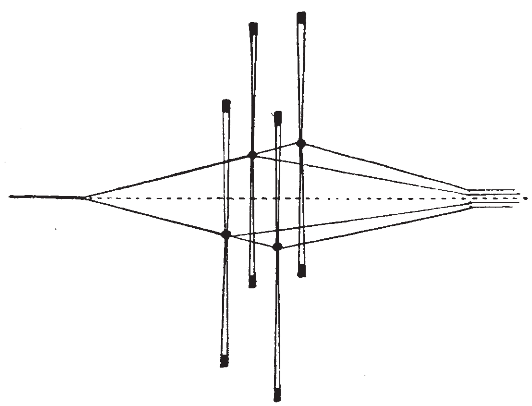
UNEVEN SHEDDING AND ITS EFFECTS.

One type of uneven shedding with which the loom tuner has to deal is that in which one end of the heald moves farther than the other, causing a large shed on one side of the loom, and a small one on the other. This fault is most frequently found in dobby looms where the healds are connected to the front crank levers by means of bow bands, and springs of uneven strengths are used to draw down the healds. The stronger spring not only causes its end of the heald to work through a shorter distance than the weak one, but also draws the heald slightly to its own side, and so causes the heald cords to rub against the warp threads, instead of working in a vertical and easy position. The best remedy is to equalise the length of the bow bands, and then to select springs of equal strengths by attaching one end to a fixed hook and putting a weight of 2 or 3℔ on the opposite end and choosing those which stretch to the same point.

An uneven shed of a similar character to the one just described is sometimes caused by uneven beaming—*i.e.*, one part of the warp being wound tighter than another,—with the result that the slacker side of the warp opens more widely than the tighter. Another type of uneven shedding is that in which some of the healds rise to the proper height, while the others either allow the threads to hang slack in the shed or draw them up very tight. The slack threads are frequently broken down by the shuttle striking them as it passes to and fro; while the tight threads either snap under the strain, or cause the beam to be jerked forward, producing a thin or cracky place every time the heald is lifted. The heald which causes the latter fault can be readily detected by placing the hand lightly on the beam flange, and noticing which shaft lifts when the beam is jerked forward.

THE POSITION OF THE WARP LINE.

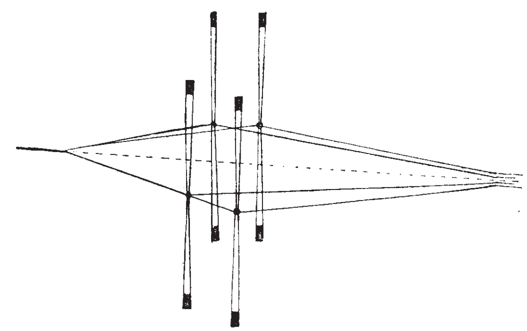
The tuner often finds a difficulty in keeping his warp threads at an even tension, and at the same time producing an even opening for the shuttle. The reason for this is that the healds which are placed the farthest from the cloth must work a greater distance than the healds which are nearest, if the



LOOM TUNING.—FIG. 4.

warp threads are to be kept in line with each other. Even if the breast and back bearers are set in the same plane, and made level with the centre of the shed so that the top and bottom lines of warp will move through equal distances, a greater strain is put upon the threads which are drawn through the back healds. This will be made clear by an examination of Fig. 4, which shows the variable take-up of the warp by the different healds. Each thread in the diagram is of the same length from the edge of the cloth.

An arrangement of the warp line which has been advocated by some tuners is shown in Fig. 5, and is one in which it is claimed that the inequality of strain on the threads is totally destroyed, the general strain being reduced to the lowest point. The threads which form the bottom line of the shed are made to lie evenly on the shuttle race by sinking the healds gradually from front to back, while the healds which carry the top line of warp are all raised to one level, the back one being raised high enough for the threads to clear the shuttle. A string is then passed over



LOOM TUNING.—FIG. 5.

the breast beam and back rail, and the latter lowered until the string forms a line midway between the top and bottom sheds. If a careful examination be made of this system, it will be found that though the different shafts may require more equal lengths of yarn, there is a decided difference in the tightness of the threads when the healds are at their highest and lowest points; thus the threads in the first heald would be tighter when the heald was at the top than at the bottom, and those in the back heald tighter when at the bottom than at the top.

For soft warps, for warps which contain fine and thick yarns, and for warps where some of the threads take up slacker than others, it is best to have the breast and back rails level with the centre of the healds (as in Fig. 4), for by this means the threads on each heald are at the same tension whether the heald is raised or depressed, and the tendency to form runners on the thick or slack threads is neutralised. Then, as each heald at the starting of the warp will retain for itself the requisite length of warp to work from one extremity to another, the strain on the threads of the back shafts will not be so great as at first appears.

When the threads do not require to be spread in the cloth, this is the best position for the warp line, as it gives equal sheds with the evenest tension. When, however, the threads require to be spread, as in most classes of plain cloths, the sheds are purposely made of an uneven tension by "troughing" the shed, so that when the reed beats the weft up to the cloth, the slack threads which form the top line of the shed may be forced into the middle of the space between the tight ones; and as this occurs alternately with the two halves of warp, a perfect distribution is produced. "Troughing" consists in raising the breast and back rails to a higher position than that of the heald mails when the healds are level.

THE USE OF LEASE RODS.

The chief use of the lease rods is to keep the warp threads in a given relation to each other, so that if a thread breaks its proper place can easily be found in the cloth, and so that it can be kept from getting crossed with the other threads at the back. They are also useful in reducing the tendency of soft spun woollen and worsted threads to form "down" and

"runners" on the warp by the chafing of the threads in a long black shed, and in keeping the threads from feltering by the acute angle formed by the shortened distance between the healds and the point where the warp opens. Their position requires to be carefully regulated to the style of cloth which is being woven. For finely set or rough warps they should be as near to the back heald as the cloth is to the front heald; while for cloths which require to have cover they should be placed a long way back, because bringing them near the healds tightens the top shed.

A disadvantage which they possess is that they cause an uneven tension upon the warp threads when one of the sheds opens on to the front rod, and the others close over it. This disadvantage may be counterbalanced in plain weaving by using four healds, two for each shed, and drafting the threads into the first, third, second, and fourth healds successively; so that if the lease is made two-and-two, and the healds which carry the threads that are over the front rod are raised a little higher than those which carry the threads that are under it, an even tension will be produced. In addition, the threads will pass each other easier when the warp is finely set, owing to being at slightly different heights. With odd shaft twills where the thread and thread lease have to be retained for future purposes, or in cases where the unequal strain caused by the lease rods is detrimental to the weaving, clasp laths should be used to equalise the tension.

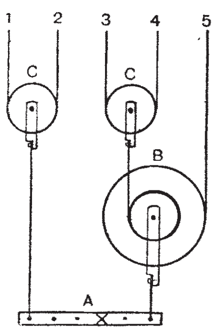
REVERSING MOTIONS FOR NEGATIVE SHEDDING.

When the shedding motion is negative in its action —*i.e.*, when it only moves the threads in one direction, —it is necessary to introduce some additional parts which will reverse the action and bring the threads back to their normal position. In jacquards this is usually done by means of lingoes attached to the bottom of the harness cords. These lingoes must vary in weight according to the class of cloth to be woven; thus, if the warp for any reason has to be held very tight, the lingoes will require to be heavier than for light or medium tensioned warps, or the threads will not drop down to the bottom line, as the tension will be greater than the weights can overcome. The disadvantages which arise from the use of weights as reversing motions are that they consume a great amount of power, as the same weight is to lift at all points of the motion; and that they have a tendency to swing and twist round each other when high speeds are reached or uneven patterns woven. Many tuners reduce this swinging action by enclosing the lingoes in a box and passing dividing wires through the box at short intervals; this divides the space into sections and counteracts the swinging motion.

Springs are chiefly used in combination with dobbies, and give a steadier action at high speeds. When applied in their simplest form an excessive amount of power is consumed, as they must be made tight enough to hold the healds steady in their normal position, so that when the springs are tightened by the upward movement of the shed the resistance is increased. The ideal spring-reversing motion should exert most power when the heald is in its lowest position, and decrease in power as the heald moves to its highest point. There have been many attempts made to attain this ideal, in some cases a combination of springs and eccentrics being adopted, and in others springs and levers with specially arranged fulcrums. Of these, Kenyon's motion is perhaps the best known. For heavy work, where the springs require to be very strong, a great advantage is derived from the use of one of these motions, for not only is there a considerable saving in the amount of power consumed, but also in wear and tear, especially upon the healds and shedding mechanism. The amount of power saved by their use as compared with ordinary springs soon repays the initial cost of the mechanism.

In some cases springs are also used along with tappets, but if the pattern is a regular one—*i.e.*, one in which the same number of healds are lifted

for each pick,—it is better to use a compound reversing motion, such as stocks and bowls, as by this means the rising and falling healds counterbalance each other, and only sufficient power is required to make the straps run round the bowls. This type of reversing motion may be applied either above or below the healds as required, and is constructed on the principle of balancing different weights on a lever by changing the relative lengths of lever on each side of the fulcrum, according to the weight. Thus, Fig. 6 shows an under-motion of

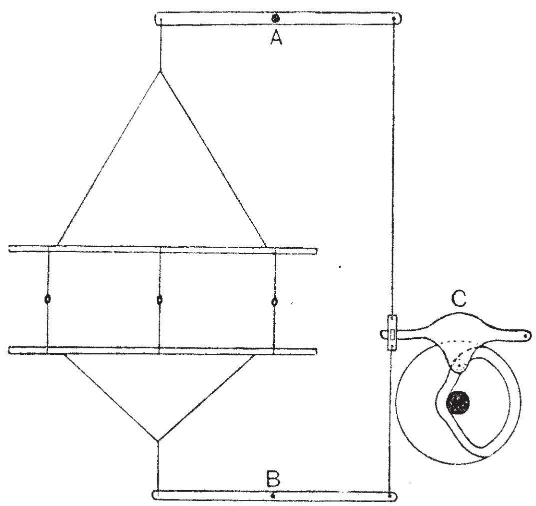


LOOM TUNING.—FIG. 6.

this class suitable for five healds. Lever A is divided into five equal parts, three of which form the arm to which healds 1 and 2 are connected, while healds 3, 4, and 5 are connected to the shorter arm of two parts. Heald 5 is then made to balance 3 and 4 by attaching it to the large step of the compound bowl B; healds 3 and 4 are then connected to the smaller step, which has only half the circumference of the larger, the different sizes of bowls acting in the same way as different lengths of levers. Anti-friction bowls C allow healds 1 and 2, and 3 and 4, to be connected to their respective levers and bowls, but heald 5 is connected directly to the bowl. Levers and bowls may be constructed to suit any kind of regular pattern by working on these principles.

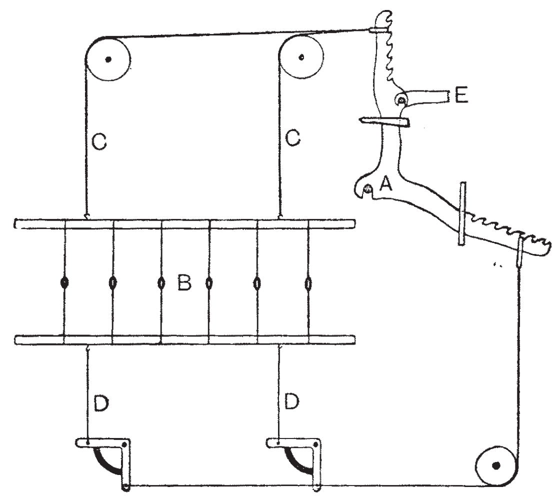
POSITIVE SHEDDING.

A positive shedding mechanism is one which both raises and depresses the heald without the aid of a reversing motion, and is of great service when heavy cloths are to be woven, as these require the warp to be held very tight. When the motion is derived from two flanged tappets, or from Woodcroft tappets, the treadle is moved up or down by the pressure of the inner or outer flanges upon the anti-friction bowl, which is fastened to the side of the treadle by means of a stud; while with a Nuttall's chain the direction of the motion is decided by the position of the bowls and blanks in the pattern chain, a bowl on one chain always being opposite a blank on the other. The positive action of the treadle is then imparted to the



Loom Tuning.—Fig. 7.

heald by attaching the top of the heald to the inner end of jack lever A, Fig. 7, and the bottom to the inner end of the lever B. The outer ends of these two levers are then connected to their respective treadle C. When in their working position the treadle and tappet are parallel with the loom frame. The object of the sketch is merely to show the connection. When Woodcroft tappets are used, there is sometimes a tendency for the treadles which work healds that contain only a few threads to leave their position in the tappet, owing to the tension of the warp upon the heald not being sufficient to hold down the treadle. When this is the case the treadle should be slightly tensioned by attaching a spring near to its fulcrum.



Loom Tuning.—Fig. 8.

Knowles and Keighley dobbies are made to produce positive sheds by shaping the harness jacks A as shown in Fig. 8. One arm is connected to the top of the heald B by means of straps C, and the other arm to the bottom by straps D. The harness jack is then connected with the baulk lever in the Keighley dobby, or with the vibrator gear in the Knowles machine, by means of the connecting arm E. The vibrator gear in the Knowles dobby is made to work the harness jack positively by means of the revolving cylinder gears, with which it engages alternately. When a heald requires lifting, the vibrator gear engages the top cylinder, and is turned half-way round in an outward direction, and in an inward direction by the bottom cylinder when the heald requires to be depressed. The positive motion gained in this way is then transmitted to the harness jack by the connecting arm.

In order to make the Keighley dobby produce a positive action, the griffes for each lift are duplicated ; one of the griffes draws the catches up as in the ordinary dobby, and the other is set close to the baulk lever and pushes them down. For the purpose of making the latter griffes always work in the same close relation to the baulk levers, for reducing friction, and for preventing catches jumping off the griffes, they are made to work in grooves at the same angle as that in which the ends of the baulk levers move when they are drawn forward. The catches which do not drop on to the lifting griffe, and are attached to the healds which must remain stationary, are kept from rising by the sneck on the top side of the catches coming into contact with a fixed bar. This is placed in such a position that it will allow the catches to change positions when they are set free by the lifting griffe, but will effectually prevent them from moving upwards when the heald is required to form the bottom shed. The heald straps in these machines must be connected so as to get the same length of leverage on each side of the harness jack fulcrum, or the heald will be tighter at one extremity of the motion than at the other.

THE CAUSES OF STITCHING.

If a peg be broken or missing from the lags of a dobby, a small weft stitch will be visible on the face

of the cloth ; it will be clearly defined, will occur at every repeat of the pattern, and can easily be remedied by finding the heald which carries the thread that the pick floats over, and inserting a peg at that point.

When the cylinder is not set true with the peg feelers, or when the lags have a small amount of play between the sides of the cylinder, warp stitches of an irregular character will be caused, owing to some of the pegs engaging two feelers instead of one. If the pegs are too short or of uneven length, or if the needles, catches, and drawing knives are unequally worn, weft stitches will be formed, owing to the catches not being dropped low enough to be caught by the knife. Sometimes they will get a slight hold and be raised for a short distance, and then slip off and cause both weft stitches and the breakage of the warp threads. When the cylinder sticks or is not turned over properly, long floats of weft will occur, and no proper pattern will be formed. In some cases when the inside of the dobby has become worn, the baulk levers are drawn forward at an angle and cause the catches to press against the sides of of the grids in which they work, or against neighbouring needles, in such a manner that both needles and catches fail to respond properly to the action of the pegs in the lags. The best remedy (except the renewal of parts) is to twist or bend the baulk levers so that they will allow the catches to be drawn straight through the grid.

A method of reducing the breakage of pegs to a minimum is to raise the grid in which the heels of the feelers rest, so that the catches only clear the lifting knife by $\frac{1}{4}$in. ; the cylinder is then lifted into easy working contact, and only pegs of a sufficient length to drop the catches firmly over the knife used. Long pegs break much more frequently than short ones, as they are relatively weaker and lift the feelers unnecessarily high. When the pegs are not properly driven into the lags they are sometimes broken by the knife working against the top of the feelers. In jacquards, weft stitches will occur when the needle does not enter the hole in the pattern cards. Sometimes these stitches occur on every fourth pick and show that the pegs on one face of the cylinder allow the holes in the cards to be only partly opposite the holes in the cylinder. At another time the stitches only occur on certain picks in the pattern, proving that the peg holes in these cards are worn too large, or that they are not the same pitch as the rest of the cards. There are other times when the stitches may be found irregularly all over the cloth, or forming stripes up one side of the repeat. In the former case the cylinder is either too high, too low, or too much on one side; while in the latter, one end of the cylinder is right and the other is too low or too high.

The greatest difficulty occurs when the cards are not cut to the same pitch as the cylinder, and the only way to avoid stitches is to set the cylinder so that the needles go exactly into the centre of the holes. The cylinder pegs are then placed in such a position that the holes in the cards will hold the same relation to the holes in the cylinder at both ends. The easiest method of obtaining the position of the cylinder in relation to the needles is to touch the needles with oil or colour, and then weave a few picks, when the marks made by the needles will be clearly visible on the cards, and will show in which direction the cylinder requires to be moved for the needles to enter into the centre of the holes. When the threads run continuously underneath the cloth it will be found either that the heel spring is worn out, the needle sticks, the hook is bent, or the neck-cord is broken.

Weft stitches are also formed when the cards are partly thrown off the pegs by the cylinder beginning to turn over too soon, as this causes the edge of the cards to catch on the ends of the needles. In such cases the catch should be lengthened so as to allow the cylinder to move further back before beginning to turn over, and the cylinder made to work farther outward to suit the lengthened catch. It is not advisable, however, to work the cylinder too far, or the flapping of the cards will cause the same fault.

Warp stitches are formed when the cylinder does not press the hooks out of the way of the griffes,

and may occur either up one side of the pattern or all across it. The remedy is to make the cylinder press the needles evenly, firmly, and a sufficient distance. Care should, however, be taken not to press too hard, as this causes a large amount of wear and tear upon the needles, especially those which are nearest the top of the hooks.

Stitches are also caused by the improper timing of the cylinder and griffes in relation to each other. If the cylinder moves away from the needles before the griffe has risen clear of the hooks, some of the hooks will spring back on to the griffe; and if it does not press against the needles in time to act upon the hooks as soon as they are liberated by the griffe, a proper selection cannot be made before the griffe rises again.

In weaving wide goods stitches are often formed at the edges, especially when the harness cords are short, because the top shed forms the arc of a large circle, as the harness cords which are placed under the hooks have all the advantage of a straight lift, while those at the edges lose a percentage of the motion owing to the angle of the harness cord between the hook and the comberboard being less acute when the hook is raised than when it is depressed. This should be avoided as far as possible by having the harness cords made of a good length, and raising the jacquard machine to correspond; or when the cards fall over the end of the loom by passing smooth steel rods through the long rows of neck cords, and fixed at the point where the harness spreads. This will keep the harness cords from spreading and make the angle a fixed one. This latter method, however, increases the friction and reduces the life of the harness.

COMPOUND MOUNTINGS.

When a stripe of chain effect formed by making some of the threads work 4/4, or any other similar pattern, is required upon a plain ground, the simplest way is to weave the plain portion with the tappets under the loom, and the chain effect with the tappets at the end of the loom. In this way the tappets can be timed to suit each other, and the different parts of the pattern will always hold the same relationship to each other. When wide stripes or borders which require a large number of healds have to be woven on a plain or twill ground, it is necessary to combine tappet and dobby shedding in order to produce good results. Some tuners, however, prefer to yoke the ground healds to the dobby and save the trouble of mounting and timing both shedding motions. The objections to this method are that more power is required, that a great amount of wear and tear is thrown on to the dobby (as it is necessary in most cases to double the springs upon the ground healds in order to keep them from swinging on the warp), and that the ground cloth cannot be made to look as even and smart as with tappets.

When extra warp figures have to be woven upon a plain twill or satin ground, a combination of heald and harness mounting is required, unless the jacquard harness is sufficiently fine to allow both the ground and figuring threads to be drawn into it, or unless the hooks and harness are specially arranged for weaving this class of goods. When the figuring warp is of tender, soft spun, or fibrous material, and the ground warp clean and strong, the ground healds should be placed behind the figuring healds or harness. In this way less strain and friction are put upon the weak warp, and the shed will open close to the shuttle, reducing breakages and stitching of slack threads. If the striping or figuring yarn is thick, and the ground yarn fine and closely set, the figuring healds should be placed behind the ground healds, as the thick yarn will stand the strain of a large shed better than the ground yarns. When there is a great difference of take-up in the ground and figuring warps, it is advisable to put the warps on different beams, so that they can be tensioned separately. If the difference is not very great, but is yet sufficient to cause the warp in the figured portions to hang slack in the shed, it is sometimes possible to weave with all the warp on one beam, by timing the shedding so that the threads will cross each other when the reed is about 2in. from the cloth. In this manner, when

the weft is beaten up through a crossed shed, there is a tendency to draw forward the slack warp threads.

VARYING THE PATTERN IN TAPPET LOOMS.

Though the tappet loom is more limited as to the number of shafts which can be effectually worked and the length of pattern which can be obtained than the dobby, there is a method of producing new patterns in a simple and easy manner which is somewhat overlooked. It consists of altering the position of the streamer rods which connect the tappet treadles and jack levers together in such a way that a treadle can be made to actuate any heald it is desired to move. As an example, assuming that a set of tappets are fixed on the loom for the purpose of weaving a 4-weft 1-warp twill, and that before the warp is finished it is required to change to a 4-weft 1-warp satin; the only alteration which would be necessary would be to connect the 2nd heald to the 3rd treadle, the 3rd to the 5th, the 4th to the 2nd, and the 5th to the 4th. In this way any derivative of a twill may be woven by using the tappets which will give the common twill from which the derivative is formed, and connecting the treadles and healds according to the basis of the re-arrangement. Thus, patterns B

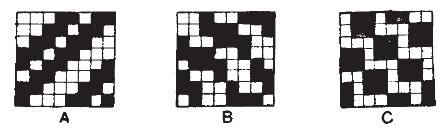


FIG. 9.

and C, Fig. 9, could be woven with the same tappets and drafting as pattern A. For pattern B the connections would be heald 1 to treadle 2, 2 to 1, 3 to 4, 4 to 3, 5 to 6, 6 to 5, 7 to 8, and 8 to 7; while for pattern C the connections would be heald 1 to treadle 1, 2 to 4, 3 to 7, 4 to 2, 5 to 5, 6 to 8, 7 to 3, and 8 to 6. When the new pattern is of a totally different lift, a fresh tappet will be required, except in the case of "Woodcroft" tappets, where the pattern may be varied by altering the position of the risers and sinkers on the tappet plate. These are interchangeable with each other, and any pattern may be produced which will divide into the number of picks to one round of the plate.

TAPPET DRIVING CALCULATIONS.

When the pattern of the cloth has only two picks to the round, the tappets may be fixed upon the low shaft of the loom; but when patterns with more than two picks are required, the best way is to lengthen the low shaft so that a "pap" wheel can be placed upon it. This "pap" wheel usually consists of a wheel of 120 teeth with a long neck or sleeve upon which the tappets can be fixed. It may be revolved around the low shaft in either direction as easily as if it was placed upon a stud. It is driven by means of a pinion wheel which is placed on the crank shaft of the loom. As the pinion varies in size with the number of picks in the pattern, an intermediate wheel is used to transmit the motion to the pap wheel.

When the number of picks required by any given pattern is one which will divide into the teeth contained in the pap wheel the calculation is simply —teeth in pap wheel ÷ by picks in pattern = teeth in the pinion wheel.

If, however, a number of picks is required in a pattern which will not divide into the teeth of the pap wheel, or if the pinion wheel obtained by this method of calculation is too small for practical working it will be necessary to resort to the use of a compound intermediate wheel. As an example assume that it is most convenient to use a pinion wheel with 20 teeth on the crank shaft, and that the pap wheel had 120 teeth. What must be the relative size of the compound intermediate wheels if the pattern had seven picks to the round?

The simplest way is to take the product of the picks in the pattern and the teeth in the pinion wheel, and the teeth in the pap wheel, and reduce them to

their lowest terms, and use any wheels in the same ratio, thus:—

$$\frac{\text{Picks required} \times \text{pinion}}{\text{Teeth in pap wheel}} = \frac{\text{proportion of teeth in 1st driven wheel}}{\text{proportion of teeth in 2nd driver}}$$

$$\therefore \frac{7 \times 20}{120} = \frac{140}{120} = \frac{7}{6} \text{ or } \frac{7 \times 4}{6 \times 4} = \frac{\text{28 teeth in 1st driven wheel}}{\text{24 teeth in 2nd driver}}$$

To prove that this is correct, multiply the driven wheels together and divide the product by the product of the driver wheels multiplied together, thus:—

$$\frac{120 \times 28}{20 \times 24} = 7 \text{ picks for 1 revolution of the tappets.}$$

When changing from one pattern to another it is often sufficient to change only one of these wheels; and it may be either a driver or a driven, but the following formulas will suffice.

$$\frac{\text{Driving wheels} \times \text{picks in pattern}}{\text{Driven wheel}} = \text{Required driven wheel.}$$

or

$$\frac{\text{Driven wheels} \times \text{picks in pattern}}{\text{Driving wheel}} = \text{Required driving wheel.}$$

WEAR AND TEAR IN SHEDDING MOTIONS.

When shedding is compared with the other motions of the loom, the amount of wear appears of little consequence, yet there are points which require careful adjustment in order to get the best and most economical working. In tappet shedding there is very little wear except upon the healds and connecting bands, and even this may be made of small moment if the healds lift straight, and are kept from rubbing against each other or from being rubbed by the connecting bands. This latter is a fault which requires guarding against when compound reversing motions are used. The healds should be set back so that they will just clear the lay when it moves to its backmost position, or the healds on the first shaft will be beaten down. When weaving warps which require false reeds to keep the shed clear of loose fibres, small pieces of leather should be nailed on to the front shaft to protect the healds.

The points of connection between the treadles and the healds and the proportional sizes of the parts of the reversing motion should be so arranged that the heald will be the same tightness throughout its motion, or the healds will work unsteadily and cause breakages of healds, connecting bands, and warp threads.

In dobbies of the Keighley type the chief points of wear-and-tear are at the connections between the catches and the baulk lever, between the baulk lever and the heald jack, and between the hook end of the catches and the draw knives. The greatest defects which arise from wear-and-tear at these points are that the catches jump off the draw knives, and that stitches and wrong lifts are caused by the twisting of the baulk. A number of these defects have, however, been overcome in the newer types of this dobby by the introduction of knuckle, oil retaining, and other joints, and by the introduction of specially constructed feelers which govern the lower set of catches without the aid of indicating needles.

In single-lift, and in double-lift double-cylinder jacquards the life of the needles and hooks is equal to if not longer than that of the harness cords, and the wear-and-tear is evenly distributed throughout. But in many builds of double-lift single-cylinder jacquards the wear-and-tear on the back rows of needles and harness cords is much greater than on the front rows. The reason for this is that when the cylinder presses the needles for a selection of hooks on the bottom griffe, the hooks which are connected to the top griffe, and which are governed by the same needles, have to be bent before the needles can press the hooks which have to remain stationary out of the way of the rising griffe. This puts a great amount of strain upon the needles and causes them to wear out quickly. In many cases the hooks are pushed off the top griffe when it has passed the top centre, and allows them to drop down by the weight of the lingoes, without any steadying motion from the griffe. This dropping of the hooks causes breakages in the harness cords, owing to the sudden check which they

receive at the bottom and to the unsteadiness caused by the rebound. The manager will do well to see that his machines are constructed in such a way as to avoid this fault, as some tuners try to prevent the harness cords from dropping by the doubtful methods of enlarging the shed, or lowering the warp line so as to increase the pressure of the warp on the harness cords, with the object of preventing the hooks from being pushed off the griffe.

One method of meeting the trouble is to lengthen the hooks so that they will stand $4\frac{1}{2}$in. above the needles, and only allow the needles to project $\frac{3}{16}$ to $\frac{1}{4}$in. through the needle-board. The lengthening of the hooks will allow them to be selected with a shorter movement of the needles. The needle will not require to bend the hook which has hold of the top griffe to as great an extent, and the point of contact between the two will be nearer the centre of the hook, therefore more pliable and less subject to excessive friction.

Another method is to make the legs of the hook V-shaped instead of parallel with each other. In this way the hook which is at the bottom keeps in proper touch with the needle and griffe, the lifted hook is able to swing back instead of bending when pressed by the needle, the wear-and-tear on the needles is reduced to a minimum, and the dropping hooks avoided. The two hooks which are governed by the same needle should be connected together by a link, so that only one neck cord will be required. When the two cords are attached to the same bunch of harness cords, breakages are frequent, owing to the cords being unravelled by the alternate slack and tight action of the different lifts, and the fault caused in the cloth by weaving with one of the neck cords broken is often undetected for some time.

CHAPTER II.

PICKING.

The operation known as picking consists in throwing the shuttle which carries the weft yarn from one side of the lay to the other, and although the mechanism which is used for performing this operation is of simple construction, there are several reasons why the tuner must exercise the greatest care in the setting and timing of the motion. There are also points which must have careful consideration before he can clearly understand the character of the work which has to be done. In picking, a large amount of force requires to be generated in a short space of time, and expended at a given moment—expended in such a way as to cause as little harshness and reaction as possible.

The amount of force required for the work is difficult to calculate owing to the shuttle constantly changing its weight with the amount of weft which has been drawn off; to the force of the blow varying with the speed of the loom; to the irregular amount of friction between the warp and the shuttle; to the variable drag of the weft; and to the width of different looms.

The rapid and uncontrolled movement of a body whose centre of gravity is continually changing, and which the weft is dragging first in one direction and then the other across a lay which is not only swinging backward and forward, but also varying in height, renders the work of getting the shuttle from side to side without accident very difficult. It is not easy, therefore, to lay down an absolute rule as to the amount of force required for this work owing to the many influences by which it is affected; but the mechanism is capable of a large amount of adaptation in the hands of a tuner who has looked at the subject from a variety of standpoints, and may be made to work quite smoothly and easily.

DIFFERENT TYPES OF PICKING MOTIONS.

The two types of picking mechanism which are most largely used are known as the over-pick and the under-pick motions. Both types can be modified to suit the requirements of box patterns in which odd picks of different colours have to be inserted.

The cone picking motion, which is the commonest kind of over-pick, has proved itself to be specially suitable for fast-running looms of a light and medium

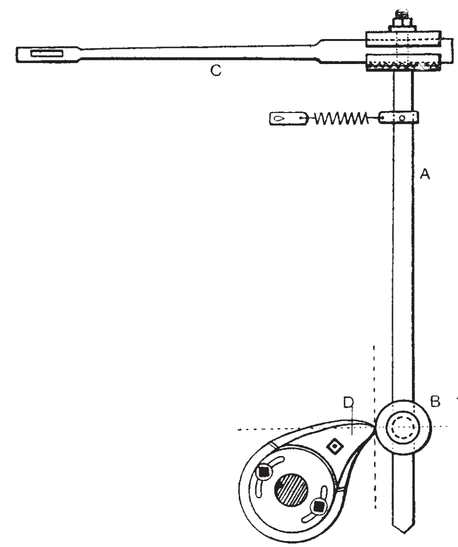


FIG. 10.

build, and for working in conjunction with circle boxes; it consumes less power, is smoother in action, and less liable to throw out the shuttles than under-pick motions.

It is an application of a simple lever, and consists of an upright shaft A (Fig. 10) which carries a stud with a cone-shaped anti-friction bowl B and a wooden arm C known as the picking stick, to which the picker is attached by means of the picking leather. The stud and picking stick are the two arms of the lever, and the upright shaft is the fulcrum. The relative lengths of the stud and the picking stick and the length of the shuttle-box will determine the length of the tappet nose D which acts on the cone in such a way as to impart the requisite amount of force to drive the shuttle across the loom. It will be seen later that this force must be applied in a manner which will render the action smooth and easy, and keep the wear and tear on the various parts at the lowest possible point.

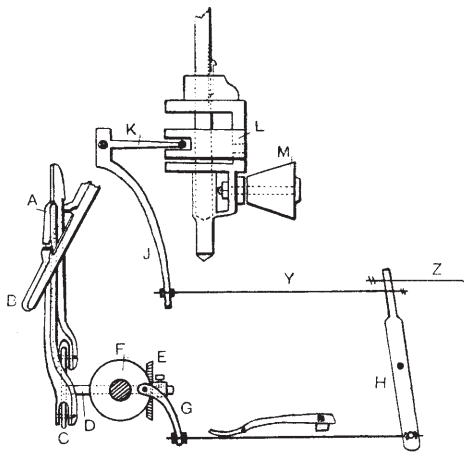


FIG. 11.

A modification of the cone-picking motion which makes it possible to pick any number of times from either end of the loom in succession is shown in Fig. 11. It is an arrangement by which the cone and stud may be driven back by the tappet without

moving the picking stick. It consists of two catches A which have their hooks turned in different directions and are controlled by an elbow lever, one end of which is placed over the pattern cylinder, while the other is brought down to govern the catches by means of two nudges cast on its side, so that when there is a hole in the pattern card the hook which faces towards the back of the loom is pressed over the vibrating lever B, but when there is a blank the hook which faces towards the front of the loom is acted upon. These hooks are attached, one to each end of a short lever C, which is in turn connected with a bevel wheel E by means of a short shaft D, so that when one catch is raised the wheel is turned in one direction, and when the other is raised, in the opposite direction.

The wheel F which gears with wheel E has a lever G connected near to its periphery, which is drawn backward or pushed forward by the revolution of the wheel. The motion of the lever G is transmitted to another lever H which has holes bored for the reception of rods Y and Z, so that when it is moved in either direction it pulls at one or the other. The effect is that when the rod Y is pulled towards the centre of the loom the lever J is drawn inward; the arm K lifts the clutch L out of gear, and the picking cone M can be pushed back by the picking tappet without moving the picking stick. At the time the rod Y is acting in this manner the rod Z allows the clutch at the opposite side of the loom to connect the cone and picking arm, and picking to take place. The picking tappet is constructed with two noses, one for each revolution of the crankshaft, so that it will strike the cone every pick and allow the clutch to transmit the power to the picking stick in any order.

The lever pick, which is one of the best-known under-pick motions, consists of an arm A (Fig. 12) which is keyed to the low shaft of the loom, carrying an adjustable stud B and anti-friction bowl C, which as they revolve come into contact with a curved metal plate D that is bolted to a horizontal wooden lever E. This lever is placed outside the loom frame and fulcrumed at the back, while the forward ends rest upon a short iron arm F that forms part of the shoe into which the picking arm G is fixed.

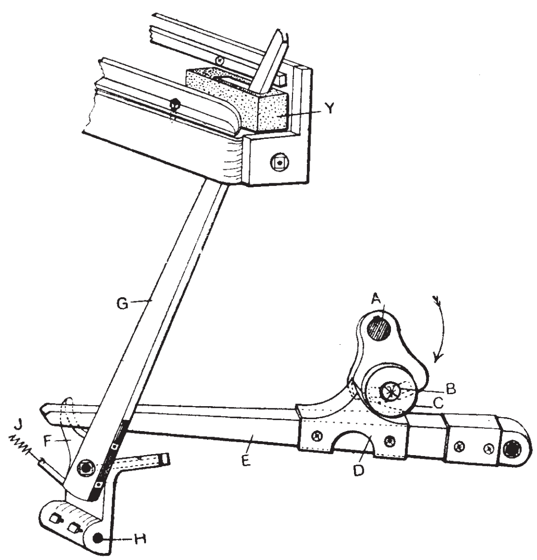


FIG. 12.

The picking arm G has its fulcrum stud bolted to a bracket on the rocking shaft H, so that it can swing backward and forward with the lay. Its highest end passes through the bottom of the shuttle-box, and has a picker Y dropped on to it. A wooden or iron rib fastened to the back of the shuttle-box keeps the picker from working up and flying off the end of the picking arm and from getting out of its true position in relation to the shuttle. When the bowl C strikes the plate D the lever E is depressed. The picking arm G and the picker Y are driven towards the centre of the loom, and the shuttle passed from side to side.

The spring J pulls the picking arm back to its normal position after the blow has been delivered.

In some looms the nose of the picking plate D is held firmly against the shoulder of a groove by means of a spring when the loom is working in its normal direction, but if it is turned backward the spring will be extended, and the nose will slide outward along the surface of the plate instead of depressing the lever and throwing out the shuttles. Various modifications of the lever pick have been made to meet the requirements of odd-pick patterns. One method is to make A (Fig. 12) with double arms and bowls—one for each revolution of the crankshaft,—and pivot the plate D in such a way that it can be turned either to receive the stroke of the anti-friction bowl or to allow it to pass without acting upon the lever. The pattern chain which governs the position of the plates is laid according to the order of picking desired. Another method, which is applied to wide, slow-running looms where a great amount of force is required to drive the heavy shuttles from side to side, is to run the low shaft at the same speed as the crankshaft (because the blow delivered by the same length of arm is four times as powerful as when it only runs at half the speed), and to slide the arm and bowls laterally along the shaft for the purpose of hitting or missing the plate.

A type of this class of mechanism which is applied to the Knowles loom is shown in Fig. 13. A is the low shaft of the loom, and keyed upon it is a disc B with grooves at each end through which the arms of the striking lever C can slide. The striking lever carries the anti-friction bowl D and fits loosely upon the shaft; compounded with it is a short neck E which has a ring groove cut into its surface. The forked ends of the lever F, which is fulcrumed at G and governed from the dobby by means of the connecting rod H, fit into the grooves of the neck E. When the connecting rod pushes the striking lever to the right, the anti-friction bowl will strike the plate Y, which is fastened to the square shaft J by means of set screws. The ends of this shaft are rounded and fit into suitable bearings fastened to the loom frame. An arm K is placed on the same shaft and connected to the picking stick L by means of leathers and steel straps M, so that when plate Y receives the blow of the bowl, the arm K draws the picking stick towards the centre of the loom and drives the shuttle across.

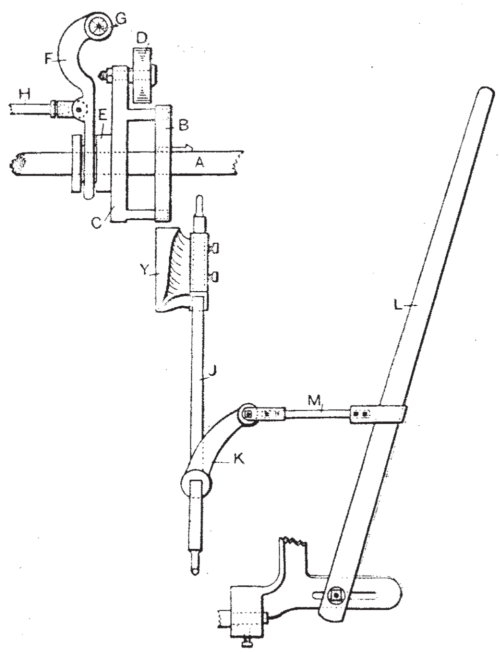


FIG. 13.

The fixed disc B through which the arms of the striking lever C slide renders the picking firm, and keeps it from getting out of time with the shedding.

The mechanism at the other end of the loom is turned in the opposite direction and governed by the same connecting rod H, so that when the arm at one end of the loom is striking its respective plate, the arm at the other end is working off the side. There is, therefore, no possibility of picking from both ends at the same time, as the mechanism which puts one end into gear puts the other out. The striking arms being under the control of the dobby, the picking and shedding are always kept in proper relationship to each other, however irregular the wefting pattern may be.

THE CHARACTER OF THE PICK.

The amount of wear and tear on the picking mechanism, of re-action on the other parts of the loom, and of power consumed, is dependent upon the character of the pick or blow given to the shuttle ; and the character of the blow is in turn dependent upon the shape of the tappet nose in the cone pick, or the plate in the lever pick. The tappet nose and picking plate should be so shaped that the power will be gradually developed, and push the shuttle gently out of the box until it is free from the pressure of the swell before the full force of the blow is delivered.

In the cone picking motion the tappet must also gradually tighten the picking strap before commencing to push the shuttle. When the power is developed too suddenly, or the blow delivered before the shuttle is free from the pressure of the swell, the action is of a harsh and jerky character, which causes a great amount of wear and tear upon the pickers and straps, as well as upon the various parts of the picking mechanism.

A long tappet nose with a correspondingly long shuttle box always gives better results than a short one with a sharp curve, because the force depends more upon the length of the stroke than the curve of the tappet, and more time can be allowed for developing the force. With this kind of tappet the shuttle will move steadier, there will be less wear and tear, the chances of the shuttle being thrown out of the loom will be decreased, and the loom will run with an easy swinging movement.

In the cone-picking motion the relative positions of the low shaft and the upright shaft influence the character of the pick in a very decided manner, and should be determined by the length of the tappet nose, and by whether the upright shaft is placed in the centre of the stroke or otherwise. The upright shaft should be placed in such a position that the face of the tappet will work upon the face of the cone throughout its entire revolution. When this is impossible owing to the tappet being badly constructed, special care should be taken to see that they work face to face when the blow is being delivered—*i.e.*, at the nose of the tappet, as that is the point where the most wear and tear occurs, and where steadiness and firmness of action are most desirable. The height of the cone stud in relation to the tappet is also important. When the stud is placed too low a considerable amount of the strength of the blow is expended in trying to force the stud downward as well as outward, and a harsh, jerky movement is the result. If it is placed too high, the stroke of the picking stick will be shortened, the force of the pick lessened, and the anti-friction bowl liable to run off the rim of the tappet. The best position is to have the centre of the cone stud set to the height of the outer rim of the tappet disc; and the full force of the blow delivered when the extreme nose of the tappet is in contact with the anti-friction bowl at a point directly opposite the centre of the cone stud. With this setting the direction of the force is as near as possible at right angles to the low shaft; consequently the loom will run smoothly and with less power, as the tappet will push the cone directly along the plane in which it moves, instead of wasting its power upon the stud and socket.

TIMING THE PICK.

Under ordinary conditions the shuttle should begin to move out of the box when the crank is at its bottom centre, and have received its final blow by

the time the crank is half-way between the bottom and back centres; because between this point, and a point half-way between the back and top centres the lay is travelling very slowly and the reed is drawn back to give full advantage of the open shed. When the loom is running very fast, and the cops or pirns are softly built and liable to slip off the nose of the peg, it is often advisable to time the picking a little earlier, because by so doing more time is allowed for the traverse of the shuttle, and the pick can be made a little weaker. With wide box looms it is sometimes desirable to pick a little later from the box end, especially if there is any vibration caused by changing the box; but this must not be carried too far, or the fault described in the preceding paragraph will be produced, and the loom will not run smoothly. Badly timed picking usually results in breakages of the warp, stitches, looped or fringed edges, flying shuttles, knocking-off of the loom, shuttles catching in the shed, broken cops, and excessive wear and tear of the loom.

THE EFFECT OF THE SHUTTLEBOXES ON THE PICK.

The shape of the shuttle box, and the amount of pressure put upon the shuttle by means of the swell, affect the amount of power required for picking in a very material manner. The back of the box should be parallel with the reed except for the projection of the swell, and the front of the box should be set a little wider at the opening than at the end.

The reasons why this shape gives the best working are that the pressure is put upon the shuttle gradually as it enters the box, slackening its speed, preventing the shuttle from rebounding, and the weft from slipping off the spool; and that the pressure is gradually taken off the shuttle when it is being pushed out of the box, leaving it free when the full force of the blow is delivered. The pressure of the swell upon the shuttle should only be sufficient to keep the protector steady and the shuttle from rebounding. When the swell spring is too tight a large amount of unnecessary force has to be expended in driving the shuttle both in and out of the box, and the loom is subjected to a large amount of wear and tear.

Many tuners have successfully reduced the wear and tear on the picking mechanism by taking the pressure off the shuttle during the time it is being pushed out of the box. There are several ways in which this may be done, and almost every tuner is capable of fixing up some simple arrangement to suit his own class of loom.

THE USE OF THE CHECK-STRAP.

The primary purpose of the check-strap is to assist in preventing the shuttle from rebounding, and at the same time allow it to have free play in the box; without it the shuttle would become jammed at the end of the box, and the picking would be jerky. When the shuttle is driven into the box at one end it should draw the picker and check-strap at the other end towards the centre of the box, so that when the shuttle is driven in the opposite direction it will be met by the picker, which will slide gradually backward under the pressure of the shuttle, against the check-strap to the end of the box.

The length of the check-strap should be carefully adjusted because when it is too short the shuttle does not get far enough back in the box; and when it is too long it is practically useless, as the shuttle will rebound. In either case the picker is unable to exert sufficient force to throw the shuttle to the opposite end of the loom. A short check-strap will also cause the cops to break and the weft to slip off the bobbin by stopping the shuttle too suddenly.

WEAR AND TEAR IN THE PICKING MOTION.

The cost incurred in the renewal of pickers, straps, and other parts of the picking mechanism represents the major part of the expense necessary to keep the loom in good working order. This arises no doubt from the fact that the motion is intermittent in action, and expends a large amount of force in a small

fraction of time. The fact that some tuners incur more expense in the upkeep of their looms than others in the same mill, and with the same class of work, indicates that there are certain methods of adjustment, timing, etc., which give better results than others, and which it is to the tuner's as well as the master's advantage to study. To get the most service out of a picking strap, it should be allowed to hang in a dry room until it loses all traces of sponginess. The top of the picker should be made smooth and round, and the picking leather fastened to it by passing one end of the leather through a hole punched about one inch from the other end, so as to form a loop, and then threading the straight

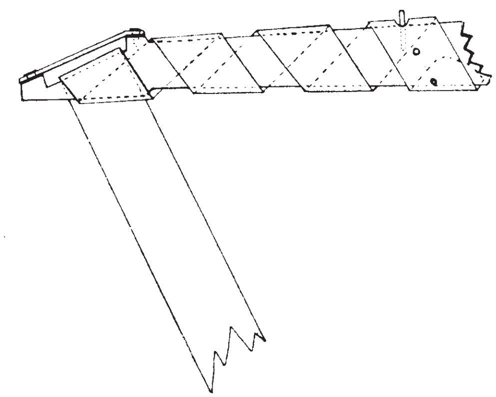


FIG. 14.

end between the top of the picker and the spindle, and through the loop. The strap should then be passed over the picking stick, wound tightly around it, and fastened by means of a string, or hooked on to a staple driven into the stick.

The end of the picking stick should be shaped similar to that shown in Fig. 14, so that the whole surface of the strap will bear the strain of picking equally, and not wear out from side to side, as is the case when it is passed through a slot cut parallel with the stick or round a ring groove. Sufficient length of strap should be left between the picker and picking stick to allow the picker to work easily along the spindle when the lay is pushed back. When it is made too tight there is not only a great strain put upon it, but the power of the pick is also weakened by the friction of the picker upon the spindle. It is a mistake to imagine that the tighter the leather the stronger the pick, because when the leather is tightened above a certain point the power is lost, as just indicated, and not gained.

The picking stick should be fastened in such a position that there will be from 3 to 4½in. between the picker and the spindle stud when the cone is in contact with the extreme end of the tappet nose, in order to allow the stick to swing freely after the blow has been delivered; otherwise the buffers, pickers, straps, and picking sticks will wear out very rapidly. The cone should revolve freely around the stud, and should be kept well oiled, or it will wear irregularly, with the result that the pick will vary in strength—*i.e.*, it will be weak when the tappet strikes the flat side of the cone, and strong when it strikes the round side.

The buffers should be fastened to a leather which will prevent them being driven against the spindle-stud. When the buffers and stud are in contact the former are soon worn out, while there are more breakages of pickers and straps.

If the picking nose and cone are not in full contact with each other when the pick is being delivered the former will require constant repairs.

FLYING SHUTTLES.

The prevention of flying shuttles has been a burning question between manufacturers and the Home Office during the last few years, owing to the latter insisting that all looms shall be fitted with efficient shuttle guards, irrespective of the class of goods which are being woven or the capability of the loom tuner. This is no doubt a wise attitude for

the Home Office to assume in their attempt to guard the workpeople against accidents, towards which they often contribute by their own negligence, as flying shuttles are often attended with serious results.

The shuttle guard must not, however, be looked upon as a cure for flying shuttles; its objects are merely to keep the shuttles from rising high enough to become dangerous, and from travelling too far away from the loom. The cure will be found in a proper attention to those parts of the loom which are liable to cause the shuttle to be thrown out.

If the following points are attended to, the work of the shuttle guard will be limited to the prevention of accidents which arise from unavoidable causes, such as felters formed by broken threads or healds.

The reed and the back of the shuttlebox should be in line with each other, and present a smooth surface for the guidance of the shuttle. When the reed is bent—*i.e.*, standing farther forward in one place than another—the shuttle will be thrown out. The tuner should always test the reed when starting a new warp by running his rule across from side to side, as a very slight imperfection will often cause the shuttle to travel irregularly, if it is not thrown out altogether. The bottom line of warp should lie as closely to the lay as possible without causing undue friction, because when it is raised too high the shuttle is liable to be thrown out when mounting over the edge of the warp into the shed. The shuttle should be so constructed that the back and bottom are at the same angle to each other as the reed and the lay of the loom. The box spindle should be placed a little higher, and a little further forward at the end of the box nearest the reed than at the other end, in order to pick the shuttle in the same direction as that in which the lay is travelling—viz., backward and downward. Any downward pressure on the end of the shuttle which is in contact with the picker just as it is leaving the box and mounting the edge of the warp into the shed is bound to cause the shuttle to fly out.

Proofs of this may be found in underpick motions, which are undoubtedly more liable to this fault than overpick motions ; and in overpick motions, where the spindles are set straight, especially when the pickers are getting worn, and liable to tilt up at the back with the force of the blow. When fibrous warps are difficult to separate, they should be well sized in order to make the threads as smooth and compact as possible, and the healds should be placed as near the cloth as the lay will allow. If this is not sufficient to effect a separation, a false reed or breaker wires must be used. The shedding should be timed to produce a clear open shed for the passage of the shuttle, and the weaver should keep a keen look-out for broken threads. In check looms the box should have become quite stationary and free from vibration before the picking operation takes place, and every chamber of the box should be straight with the reed and the lay.

EFFECTS OF HARSH AND WEAK PICKING.

Harsh picking may be due to the nose of the tappet being too short and requiring to be shaped in the form of a hook in order to develop the necessary force ; to the tappet being placed close to the loom frame and striking the cone too near the upright shaft for easy working ; to the picking being timed so late that it requires a very strong pick to get the shuttle through the shed before it closes ; to the shuttle boxes being made so tight that an excessive amount of power is required to drive the shuttle in and out ; or to the cone stud being set too low and allowing the tappet to strike it down, instead of pushing it outwards.

The defects which usually arise from these causes are an excessive amount of wear and tear on every part of the picking mechanism, an undue consumption of power, a frequent breakage of shuttles owing to their clacking in the boxes and becoming jammed, a great reaction and vibration in the loom, a large quantity of waste weft due to the cops breaking and slipping off the tongue, and a tendency to throw out the shuttle with the least impediment in the shed or crookedness of the reed. These defects are of such a

serious character that when they are found to exist in any loom the tuner should set to work to carefully examine the causes one by one until he obtains a smooth and easy pick.

Weak picking may arise either from causes outside the picking mechanism, such as the irregular running of the engine or motor, the belt slipping on the pulleys, the friction pulleys not pressing tightly against each other, the driving wheels having become loose on the shafts, the irregular power required by the shedding motion in weaving patterns of an uneven character, or from faults in the picking motion itself, such as the picking nose being worn short, the picking cone getting worn flat in some places, the slipping loose of the tappet or the cone stud, the drag of the picker on the spindle when the strap is too tight and when the spindle is short of oil, and the stretching or slipping of the picking strap.

When any of the first class of causes exist, the shuttle will be caught in the shed and the loom knocked off at the intervals when the loom is running slowly or irregularly owing to the momentary deficiency of power ; while with the latter class the knocking off, etc., will occur incessantly.

REGULATING THE STRENGTH AND TIME OF THE PICK.

The strength and time of the pick often require altering to meet the changed conditions which arise from an alteration in the weight of the shuttle, in the drag of the weft, in the time of the shedding, and in the amount of friction on the shuttle caused by a change in the size of the shed, or in the quality of the warp.

In the under-pick motion the alteration of strength is effected by moving the fulcrum stud of the lever E, Fig. 12 (page 39), a little higher when an accession of strength is required, and a little lower when a diminution of power is desired ; and the timing by moving the stud B of the friction bowl C forward in the direction in which the arm A is moving when it is desired to pick earlier, and backward if later.

In the cone-pick motion a stronger pick may be obtained by moving the boss of the tappet a little nearer the loom frame, as this makes the picking stick move further; while a weaker pick would require the boss to be moved a little nearer the centre of the loom. In cases where the deficiency

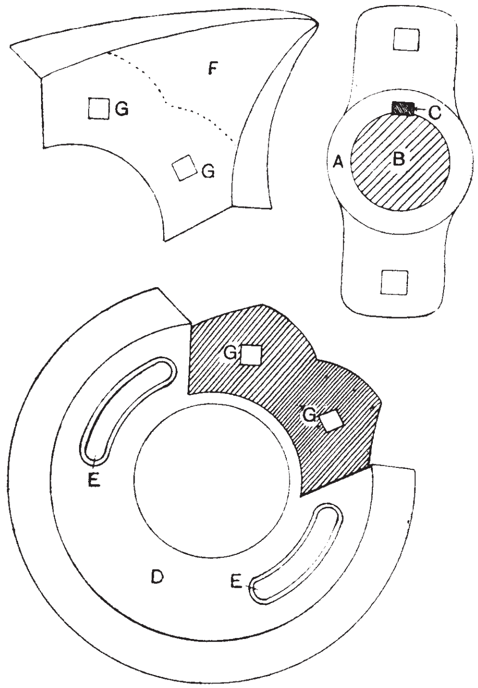


FIG. 15.

in the strength of the pick arises from the tappet nose being badly worn, the nose should be replaced by a new one or re-dressed by an experienced workman, as this gives better results than moving the

tappet. The re-dressing, however, needs to be very carefully done, or the last state will be worse than the first. The best firms do not allow any re-dressing of the tappet nose, as they consider that it is cheapest in the long run to provide a new one. To make the tappet pick earlier it is moved forward in the direction in which it is travelling, while for a later pick it is moved backward.

In order to allow the tappet nose to be renewed and the timing of the pick to be altered without lifting the driving wheels out of gear and altering the timing of the shafts, the picking tappet is constructed in three parts as shown in Fig. 15, where A represents the boss which is fixed to the low shaft B by means of a key C; D the shell or disc along which the cone runs when not in action, and in which long bolt holes E are made so that it can be moved backward or forward without interfering with the boss when the bolts are slackened; and F the tappet nose which is fastened to the shell by passing bolts through the holes G.

THE EFFECT OF THE SHUTTLE ON THE PICK.

The size of the shuttle will require to be altered either to meet a change in the size of the cop or pirn or in the drag of the weft caused by an alteration in the counts or the roughness of the material. The amount of alteration required in the first instance will depend upon the amount of space required inside the shuttle for the purpose of preventing the weft from being broken by rubbing against the inner sides of the shuttle, and from protruding either above or below the shuttle and breaking down the warp threads; and in the second instance upon the weight required to overcome the tendency of the drag to draw the shuttle out of its proper course.

When there is excessive drag on the weft the working of the shuttle is seriously affected owing to the fact that it is drawn in different directions according to the end of the slay towards which it is travelling, as shown in Fig. 16, from which it will be seen that if the drag is too great for the weight of the shuttle, the latter will be thrown out.

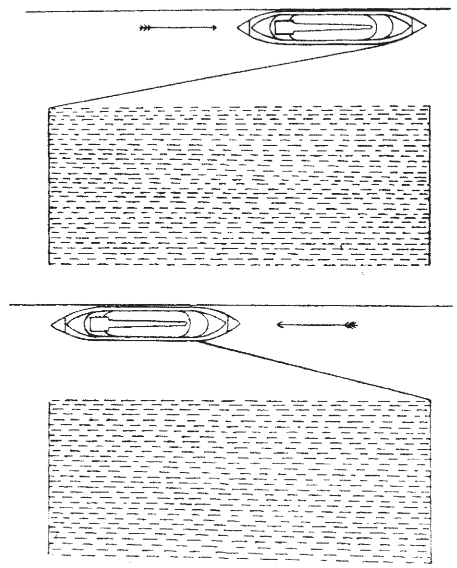


FIG. 16.

When two shuttles are used for the purpose of facilitating changes and allowing the weaver to refill the shuttle with the loom running, they should be carefully gauged, both as regards weight and size, and shaped to the bevel of the lay. When the shuttles vary in size, it will be found either that the larger one will become jammed in the box or the smaller one will not raise the stop rod lever clear of the frog. When they are of different weights, it will be found that the strength of pick which is necessary to drive the heavier shuttle across the loom will not be sufficient to drive the light one, consequently the

loom will be continually knocking-off when the light shuttle is in use ; while if the blow be made strong enough for the lighter shuttle, the loom will pick harshly when the heavier one is in work.

Uniformity in the size and weight of the shuttles is also of the highest importance in check looms when the weft yarns are of different counts. When one of the weft yarns is of a much thicker or rougher count than the other, it is sometimes found advisable to place it in a heavier shuttle of the same size in order to counteract the increased drag. If this plan is not feasible, as much drag as possible should be put on the finer yarn without causing it to break by placing brushes in the eye of the shuttle.

In order to keep the drag as even as possible and so prevent breakages of the weft and irregularly drawn-up edges, the pirns should be as small as possible, so that the weft from the hind part will be able to unwind easily. Sufficient distance should also be left between the shuttle eye and the end of the tongue or pirn to allow the weft to spread itself out or balloon, as this will materially help the easy unwinding of the yarn.

The position of the point or tip of the shuttle is an important one, and has been the subject of much discussion among textile experts. Some of these have advocated placing the tips a little nearer the front and top of the shuttle than the bottom and back, so that the force will be exerted above and in front of the centre of the shuttle and press the shuttle backward against the reed, and at the same time downward against the lay, thus preventing the tendency to fly up or forward.

Others have claimed that the tips should be placed as low as they can possibly be worked with, as by so doing the shuttle will pass under any obstruction in the shed, instead of being thrown out by passing over it, as is often the case when the tips are placed above the centre.

The author's experience is that the best all-round results are obtained by having the tips placed exactly in the centre of the shuttle, and fixing the spindle a little higher and further forward at the buffer end than at the back, as this will cause the shuttle to follow the reed backward and the lay downward, and at the same time allow the tip to always face the centre of the shed, where it is most likely to be clear of tangles and slack threads.

THE CONDITION OF THE SHUTTLES.

The shuttles themselves should be kept in good repair, and the tuner can prevent a considerable number of breakages and loss of time by carefully overhauling them at least every time a fresh warp is started. The chief points to watch are the spring, the pin which holds the tongue in position, and the weft groove. If the spring is getting weak it should either be tightened or replaced by a new one, or the tongue may fly up and cause a considerable breakage of warp threads. When the pin gets worn, the tongue will drop down at the nose and allow the cop or pirn to project below the shuttle and rub down the warp threads; the weft will also be broken owing to the difficulty of dragging it round the nose of the pirn and to the tongue oscillating from side to side with every movement of the shuttle. When the shuttle gets worn flat on the front side a fresh groove should be made, or the weft will be constantly cut by being pressed between the side of the box and the moving shuttle; or, in the case of bleached or delicately-coloured yarns, the weft will be marked in the box and make stained places in the cloth. When the eye of the shuttle gets "nicked" it should be turned to prevent the weft running in the nick and being rubbed down.

CHAPTER III.

BEATING-UP.

The function of the going-part is very often looked upon as being simply that of driving the last pick of weft up to the cloth, but it has also to serve the purpose of guiding and carrying the shuttle as it passes across the loom. In order to perform these two functions to the best advantage, it is desirable that it should have an eccentric action, which will allow the movement at the back extremity of the crank's revolution to be as slow and protracted as possible in order to give the travelling shuttle all the advantages of a fully open shed; while at the front extremity the movement should lose as little of its momentum and give as short a pause as possible, so as to drive up the weft sharply and firmly. This is a part of the loom which requires but little attention from the tuner beyond that of keeping the crank or connecting arms in good repair, providing that the parts are properly set at the commencement. There are, however, several points in relation to the adjustment of the parts to which it is necessary for him to give his attention in order to run his looms to the best advantage.

HOW THE ECCENTRICITY MAY BE VARIED.

The amount of eccentricity given to the lay will vary in the same ratio as the size of the crank and the length of the connecting arm. Thus, a crank with a connecting arm of infinite length would give equal speeds at both ends of the traverse, but as the arm gets shorter and the crank larger there is more time given to the lay at the back stroke and less at the front. The increased eccentricity obtained with the larger crank is due to the acute angles which are formed by the connecting arm as the crank revolves.

A narrow, fast running loom which requires only a short time for the passage of the shuttle, and very little power to drive up the weft, should therefore be made with a small crank and a long connecting arm, as this will cause the loom to run smoothly, and put the least friction upon the warp yarns. A wide, slow running loom which is weaving heavy goods of a fibrous character that require the shed to be open as wide, as long, and as clear as possible, and in which the momentum of the shuttle is likely to be decreased by the distance through which it must travel, and by the friction of the warp threads, should have a large crank which will allow time for the shuttle to reach the opposite box.

In looms which have short connecting arms, the ear of the sword to which the connection is made should always be lengthened for the purpose of allowing a sufficient amount of working space for the healds between the lay and the crankshaft.

THE POSITION OF THE CRANK AND CONNECTING PINS.

The relative positions of the crank and connecting pins are of importance if the eccentricity is to be properly distributed, and the proper length of stroke given to the lay. If the lay was moving backward and forward in a perfectly horizontal plane, the best distribution of eccentricity would be obtained by placing the centres of the crank and the connecting pin in the same horizontal plane. But as the lay is placed almost at the extreme end of a lever whose fulcrum is 27 to 30in. from the connecting pin, it is evident that both the lay and connecting pin must work in the arc of a circle. The centre of the crankshaft will therefore require to be placed in a line with the points which will be touched by the centre of the pin when it is at its highest and lowest positions, if the proper distribution of eccentricity is to be maintained.

Assuming that the shuttle is in the middle of its journey, and that the shed is fully open when the crank is at the back extremity of its revolution,

any alteration from the proper position should be in favour of placing the pin a little lower, as this gives an advantage to the shuttle in the latter half of its journey, by having the lay travelling slowest when the speed and momentum of the shuttle are decreasing. Any variation of the true relationship between the two centres will also be accompanied by a slightly increased sweep of the lay.

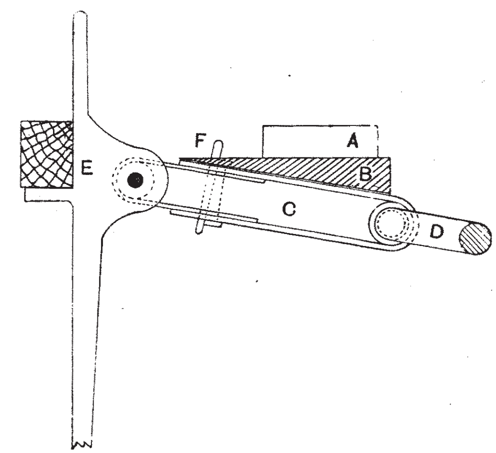


FIG. 17.

When the sword and rocking shaft are not shaped so as to fit each other at a fixed point which will give the true motion, but are simply made with smooth faces and long slot holes in the swords for the reception of the bolts, the easiest method which the tuner can adopt is to have a block like that shown at B in Fig. 17 made to the angle in which the connecting arms C of his looms must rest when the crank D is either at its front or back centres, so that by placing this, along with a spirit level A, upon the arm which he is adjusting, he can raise or lower the lay E till the proper position is obtained.

RELATION OF THE CONNECTING PIN TO THE BREAKAGE OF SWORDS.

It is a well-known fact that when force is applied to a lever between its fulcrum and the point where the movement is resisted, there is a tendency to break the lever. This tendency is accentuated when the resistance has to be overcome suddenly, as in the beating-up of heavily picked cloths, where the take-up or let-off motions have to depend upon the cloth being driven forward by the force of the blow given to it by the reed.

Heavy looms should therefore be so arranged that the force will be delivered as near the point of resistance to the motion as possible. This can be done by having the ears of the swords through which the connecting pins are passed almost in a line with the shuttle race.

In fast running looms, however, the swords are broken more frequently by the looms knocking-off than by the beating-up of the weft. This is especially the case when the stop rod bearings are fastened to the sword at a good distance below the connecting pin. For this class of loom it is best to have the stop-rod bearings formed on a special projection of the sword, and the ear for the connecting pin placed directly behind the bearings.

The position of the crank in relation to the connecting pin also exercises considerable influence in this connection. It has been found that when the lay has been raised too high there are more sword breakages than when it is placed too low. The reason for this will be evident upon examining Fig. 18, where A represents the sword, B the protector blade of the stop rod, and C the direction in which the force is delivered when the connecting pin and crank centres are in the position for obtaining the best distribution of eccentricity, but with the forward movement of the sword stopped 2½in. from its extreme forward position by the blade striking against the frog D. E is the direction of force when the connecting pin is raised above the normal position, and F when it is sunk below it.

If the connecting pin and crank are in the position shown at F, it will be seen that the protector blade, the stop-rod fulcrum, the connecting pin, and connecting arm are all in line with each other when the loom knocks off, so that the force is delivered directly in the line of resistance, and breakages

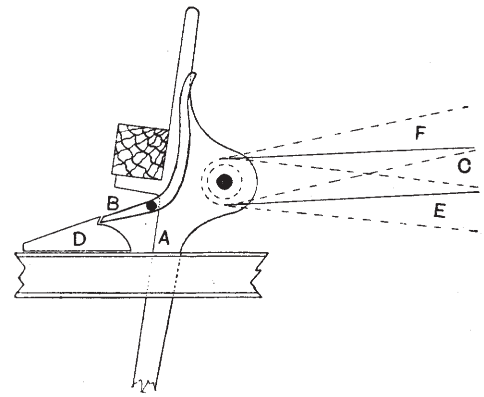


FIG. 18.

seldom take place. When the parts are in the relative position shown at E the force is delivered at a widely different angle to that in which the protector blade is fixed, and continual breakages will occur. The angle at which the force is delivered when the pin and crank are in the positions shown at C, though not exactly in line with the protector blade, is one which would cause few breakages.

THE POSITION OF THE ROCKING SHAFT.

The rocking shaft, which acts as the fulcrum for the lay, should as a rule be fixed in a position which will allow the sword and the reed to be vertical when the weft is beaten up to the cloth. The advantage of this setting is that a "quarter-circle" movement is given to the lay, which reduces vibration, and makes the passage of the shuttle as smooth as possible. The shuttle race is also set at right angles to the reed, and so never dips forward, but gives a suitable angle upon which the bottom line of the shed may rest when the lay is in its backmost position. This provides a shuttle race on which the tendency to fly out is counteracted by the inclined position of the reed and lay when the shuttle is travelling from side to side.

The above rule for fixing the position of the rocking shaft is suitable for looms fitted with tappets, or with double-lift dobbies or jacquards; but when single-lift machines are used it is advisable to make the swords travel 1 or 2in. past the vertical line for the purpose of reducing the dip of the lay at the back extremity of the motion to coincide with the lower angle found by the fixed bottom line of warp. This must not, however, be carried too far, as it is important that the race shall never dip forward during the passage of the shuttle. When the position of the rocking shaft best suited for the work to be done has been decided upon, it should be permanently fixed, as any alteration from this position necessitates a change in the lift and length of the protector lever, and in the inclination of the shuttle race to the bottom line of shed.

FAULTS CAUSED BY THE BEATING-UP MOTION.

When the connecting arms are allowed to work slack, the movement of the lay will be of a jerky character, causing vibration in the loom, excessive wear and tear on the bushes and crank, and thick and thin places in the cloth. The latter fault is due to the irregular beating-up of the weft and letting-off of the warp (the letting-off usually takes place when the reed is in contact with the cloth, and is largely governed by the tension put on the warp at this point) and occurs most frequently when the speed of the loom is affected by an uneven pattern, or when the weaver holds the lay to stop or start the loom, as

the free play of the lay is interfered with when the motion is checked or helped forward.

This fault may be easily remedied by driving the cotter F shown in Fig. 17 further into the slot, as this tightens the straps which hold the parts of the connecting arm together. When the arm becomes very slack it is often advisable to place a strip of leather between the cotter and gib, and even in some cases to have the slot holes in the straps made shorter. The tuner would find it an advantage to see that the connecting arms are put in good repair when starting a new warp, because the slacker they are allowed to become the greater will be the wear and tear and cost of repairs.

The reed should be fixed in the lay in such a manner that it will be parallel with the back of the boxes when picking takes place, and held firmly in position when beating-up takes place. In heavy looms the hand tree or reed cap should be of sufficient strength to keep the reed from being bent by the blow required to drive up the weft. The reed should be deep enough to allow a proper shed to be opened, sufficiently fine in the wiring to prevent reed marks being formed in the cloth and the weft from gathering around the warp threads and forming curls, and open enough to allow the warp to pass through without excessive friction.

THE DOUBLE-BEAT SLAY.

When some classes of heavy sackings, carpets, velveteens, etc., are being woven, it is necessary to resort to the use of a double-beat slay in order to drive up the weft. In this type of beating up motion, the lay is connected to a stud at the back of the loom by means of a connecting arm formed in two parts, the joint of which is placed directly over the centre of the crank shaft. A short arm connects this joint to the crank, so that when the crank descends it will bend the double connector arm by drawing down the joint.

When the double connecting arm is straight, the reed is in contact with the cloth, but when it is bent either upwards or downwards the lay is moved backwards. The length of the short arm is such, that the double connector is straight when the crank is at a point half-way between the back and top centres, and also at a point half-way between the top and front centres. The reed will therefore be in contact with the cloth at these two points at every revolution of the crank. When the crank is at the top centre the connector will be bent upward and the reed will be drawn back ready for the second blow. When the crank is at the bottom centre the lay will be drawn fully back for the shuttle to pass through, and the picking will be timed to correspond.

It is clear that a beating up motion of this character will enable more weft to be beaten into the cloth than the ordinary type, but the loom must be well fixed to the floor, or it will be loosened by the vibration set up.

CHAPTER IV.

WARP PROTECTORS.

Although warp protectors are looked upon as auxiliary motions, they are of great importance to the weaver, and require the careful and regular attention of the tuner to keep them in good working order. Their object is to prevent a breakage of the warp threads when the shuttle from any reason is stopped in the shed as the lay moves forward to beat up the weft. In negative pick looms this may arise either from insufficiency of force in the pick, irregular running of the loom, broken picking straps or defective pickers, the slipping loose of some part of the picking mechanism, broken threads or healds becoming entangled in the warp threads and deflecting the shuttle out of its course or blocking up the shed, or from the shuttle rebounding in the box and not getting the full force of the blow given by the following pick, etc. There are two distinct types of warp-protector motions in use—the loose or fly reed which is pressed out by the shuttle when it is caught in the shed, and the fast reed which has a stop-rod arrangement that instantly blocks the forward movement of the lay when the shuttle is not in the box.

THE LOOSE REED MOTION

This type of mechanism is chiefly used for weaving cloths of a light and medium weight which require very little force to drive up the weft, and for revolving shuttle-box looms. It is very suitable for this class of work, as it allows the loom to run smoothly and quickly, and consumes a comparatively small amount of power. The parts of this mechanism are shown in Fig. 19, and can be made to control the reed in such a manner that from the moment the shuttle should be at rest in the box—say when the crank is nearly at its top centre—till it is within 1in. of

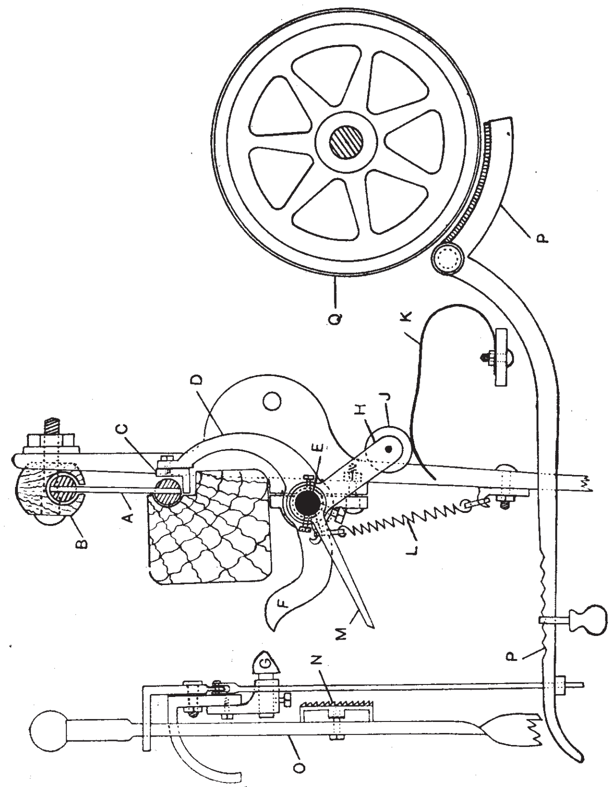


FIG. 19.

the front centre there will be no pressure put upon the reed A except that exerted by the spiral spring L. This should only be sufficient to prevent the reed from being pushed back by the frictional resistance of the warp and weft threads, as it is between these

two points that the danger of breakage to the warp threads is greatest. When the lay has moved forward to the point indicated, and the shuttle has not been caught by the reed, it may be safely assumed that the danger is passed, and that the reed may be locked fast for the purpose of beating up the weft by allowing the curved finger F to pass under the pointed frog G which is bolted to the breast beam.

In order to allow the spiral spring to be as easy as possible, and at the same time prevent any tendency to vibration in the reed during the time the shuttle is travelling from side to side, a lever H, which carries an anti-friction bowl J, is made to press against a curved steel spring K when the crank is between its bottom and top centres.

If the shuttle does not get through the shed it will be pressed forward by the reed until it touches the cloth, or until the tension of the warp around the shuttle causes it to stop and press the reed (which is supported at the top by means of a groove cut in the handtree B) outward at the bottom until it is free from the pressure of the iron lath C and lever D. The lay can then move forward with the shuttle in the shed without breaking the warp threads.

The finger F and the frog G are shaped in such a manner that immediately the reed is pushed outward by the shuttle the finger is raised over the frog, and the further liberation of the reed is effected with only a slight pressure of the shuttle. The sliding of the finger up the face of the frog also causes the lever M to rise and strike the face of the corrugated plate N which is fastened to the starting handle O and push it off its notch in the framework of the loom. This throws the belt on to the loose pulley and drops the brake P into contact with the fly-wheel Q and stops the loom. In this class of loom the shuttle boxes are fitted with a flat spring sweller to keep the shuttle from rebounding.

ADJUSTMENT OF THE PARTS.

The different parts of this motion require careful adjustment if breakages are to be effectually prevented and the loom made to work properly. When the handtree which supports the reed is fixed in position, a test should be made to ascertain the amount of power which is required to press the reed out of contact with the lath, because if it is fixed too low difficulty will be experienced in pushing it out, and breakages will be frequent and serious. If it is set too high the reed will work up and not be flush with the back of the box, and the shuttles will fly out. The spiral spring should not be strengthened for the purpose of beating up a heavier cloth. Any alteration required to effect the driving up of the weft should be made at the frog, which can be moved nearer the finger when the reed requires to be locked sooner and firmer, and farther away when less power is needed. The height of the frog should be governed by the position and thickness of the reed baulk, and should be raised or lowered to suit any change in the reed. If this adjustment was not made, the beating up would be defective, especially with weaves of an irregular character, as the reed would not be held firm enough to drive each successive pick to the same position, owing to the finger and frog not being in close contact with each other.

Both the frogs should be in the same relative position to their respective fingers, and the arms which support the lath should keep it in contact with the reed from end to end. The lever M should be fixed low enough to pass under the corrugated plate when the shuttle is in its normal working position.

Several methods of locking the reed have been introduced, but so far the method shown in Fig. 19 is the most extensively used and gives the best satisfaction. Mechanisms which are dependent upon a spring drawing the locking motion out of gear as the lay moves backward should be avoided, as they are liable to cause smashes in the warp, either when the spring breaks or when the spring fails to act through a blockage of waste or dirt, as in either case the reed would remain locked when the shuttle was caught in the shed.

THE FAST REED MOTION.

When heavy cloths have to be woven which require a firm blow to beat up the weft, and where the reed has to be tightly held in position during its forward movement in order to overcome the resistance offered by the weft when it is being pushed through the finely-set warp, the reed should be firmly fastened between the lay and the handtree. When the reed is fastened in this manner it is necessary to bring the forward movement of the lay to a sudden stop whenever the shuttle is caught in the shed, if breakages of the warp are to be avoided. The great drawback to this motion is that unless both the protector and picking mechanisms are in good repair there is a tendency for the loom to be constantly knocking off and causing breakages in the loom itself.

When the mechanism is in working order, the belly of the swell A, Fig. 20, should project into the shuttle box about $\frac{1}{4}$ to $\frac{3}{8}$in.; the finger B—which may be either bolted to the stop-rod fulcrum C which passes from end to end of the lay or set-screwed to a backward projection at its extreme end—should be placed in close contact with the free end of the swell which projects through the back of the box. The protector blade D should be fixed at a height which will ensure the wedge-shaped edge striking directly into the groove of the frog E when the finger B is not pressed back by the swell, and the spring F made of sufficient tightness to draw down the protector blade without putting excessive pressure on the shuttle when it is in the box. This adjustment effectually stops the lay from moving forward when the shuttle is out of the box, and at the same time allows the loom to run freely when the shuttle presses the swell outward against the finger, because this outward pressure raises the blade clear of the frog. In order to render the concussion caused by the sudden stoppage of the lay as easy as possible and prevent breakages of the driving wheels and swords, the frog is made to slide forward against a lump of indiarubber G or strong spiral spring placed between it and the framework, or in some cases a projection

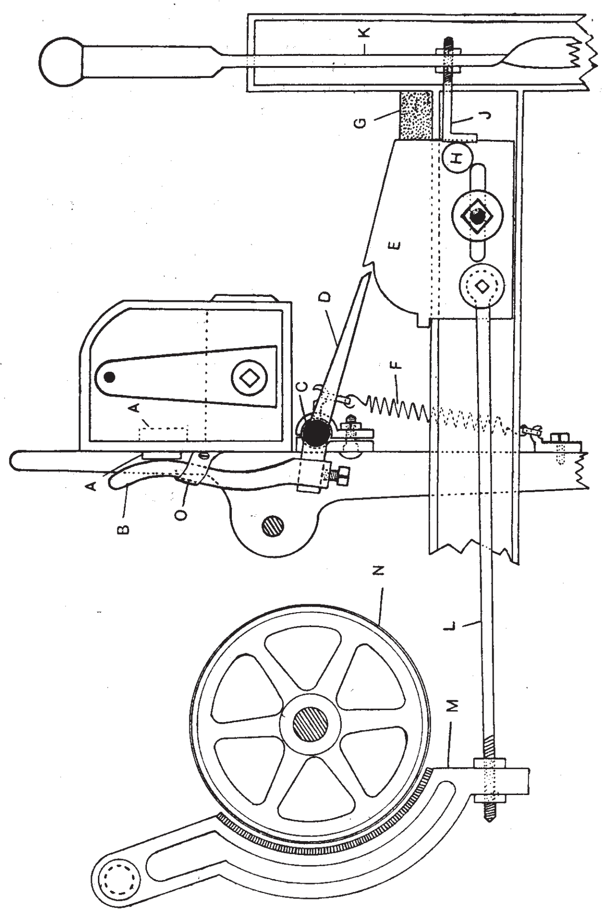


FIG. 20.

passes through the frame and presses against a flat spring bolted to the front of the loom frame. As the frog slides forward, an arm H, which is cast on to its side, and which is in close contact with the adjustable bolt J, pushes the belt handle K on to the loose pulley, while a connecting rod L draws the brake M against the balance wheel N. By these means the driving force is taken away, and the momentum of the loom is checked immediately the blade and frog come into contact with each other. When the adjustable bolt in the starting handle, the length of the brake connector rod, and the buffer rubber or spring receive the attention at the hands of the tuner which their importance demands, comparatively few breakages result from knocking off.

THE CAUSES OF FAULTY WORKING.

The strength of the spring F should receive careful attention, because when it is too slack the blade will be liable to jump over the frog and allow breakages of the warp. It should, however, only be made tight enough to prevent this. Some tuners tighten it for the purpose of steadying the vibration of the blade when the shuttle enters the box and of preventing the shuttle from rebounding; but this can be best accomplished by passing a leather O round the back of the finger B, and making it tight when the shuttle is fully in the box. This prevents the vibration, and makes it possible to work with the spring at a safe but easy tension.

If the spring is made too tight an excessive amount of wear and tear is put upon the picking mechanism and the swell pins, owing to the great amount of force required to drive the shuttle in and out of the box. When the swell pins get worn by the large amount of work put upon them, the swells begin to move outward at the fulcrum end, instead of at the end which is in contact with the finger B, with the result that the protector blade is not lifted clear of the frog. This may either result in the loom continually knocking off or in the blade and frog wearing each other's surfaces by the slight chiselling

CHAPTER V.

SHUTTLE CHANGING MOTIONS.

When two or more colours, counts, or materials have to be introduced into the same cloth, in the form of weft yarn, provision must be made for changing the shuttles which carry the different kinds of yarn automatically.

In order to work successfully, the mechanism must bring the proper shuttle into line with the lay, according to the requirements of the pattern; and make the change at a time which will not interfere with the working of the other parts of the loom.

REVOLVING BOXES.

Revolving boxes are usually applied to fast-running loose-reed looms for weaving cloths of a light or medium weight into which two or more colours or qualities of weft have to be introduced. Attempts have been made to apply the fast-reed principle, but manufacturers and tuners have not looked upon them with favour.

The commonest type of loom has six boxes at one end of the lay, and is suitable for weaving patterns in which the colours are arranged in 2's or multiples of 2. Looms which are intended for weaving odd-pick patterns have boxes placed at both ends of the lay, and are fitted with a pick-at-will mechanism on the principle shown at Fig. 11 (page 37). Compared with rising-boxes, very little power is required to move in either direction, as the movement is circular, and the boxes and shuttles help to balance each other. The mechanism is simple in construction, and is well known to tuners and weavers, therefore it will only be dealt with for the purpose of illustrating the manner of adjusting the parts in order to obtain the best working of the loom.

RELATION OF SHUTTLE-BOX AND LAY.

In order to prevent the shuttle from repeatedly flying out and being a source of danger to the weaver, the back of the shuttle-box should be kept parallel with the reed, and the bottom of the box on a level with the shuttle race. The manner in which the boxes are supported sometimes renders a perfect adjustment difficult. For example, if the bearing through which the supporting spindle of the box is passed at the outer end of the lay has got slightly out of place, it is impossible to adjust the boxes by

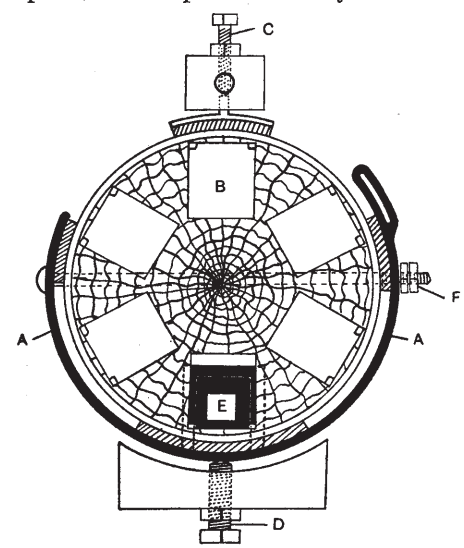


FIG. 21.

means of the collar A, shown in Fig. 21, and the bearing has to be carefully re-fixed in its proper position. An indication that this bearing has slipped will be found when the back of the boxes point either inward or outward as compared with the line of the reed when a straight edge is run along them.

In most cases, however, the necessity for adjustment is caused by the wearing down of the supporting spindle and the collar A. In these circumstances the simplest way to get the boxes level with the shuttle race again, is to slacken the bolt by which the collar is fastened to the lay and raise or lower the boxes to the desired position by means of the adjusting screws C and D.

To get them parallel with the reed, the collar is moved slightly backward or forward by means of the slot E through which the supporting bolt is passed. The boxes should also be kept free from vibration as the lay moves backward and forward by keeping the collar in firm but easy contact with the boxes by means of the bolt F.

TIMING THE BOX MOTION.

The timing of the boxing and picking motions has a decided influence on the easy working of the loom. When the box changes too soon, or the picking takes place too late from the belt side of the loom, the shuttle is liable to be trapped between the box and the facing plate before it has got into its proper position. On the other hand if the picking takes place too soon at the box end, or if the box changes too late, the shuttle will be thrown out owing to the vibration caused by the picker catching the edge of the box.

Generally the best time for changing is to begin to move the boxes about 1½ to 2in. before the reed beats up the weft, and complete the changing almost immediately after passing that point. The length of the draw hooks should be carefully regulated to ensure that the time of changing is the same in both directions, and that the hook which is not acting is clear of the disc peg when the box is turning. The check straps should keep the shuttle from being driven too far back into the box, or a considerable amount of wear-and-tear will take place on the anti-friction bowls and shuttle tips owing to the shuttle having to be pushed into the box for the purpose of taking up a convenient position for receiving the

pick when it is next brought into work, and of enabling it to pass the picker easily. The picker should also allow the box to turn freely, and not block the path of the shuttle which is being turned into position. A retaining spring placed behind the picker will prevent it from sliding forward and causing an obstruction. The spring hammer should only be strong enough to keep the boxes steady when no change is taking place, and a stop motion should be used to keep the boxes from turning too far, and to steady them when changes are being made. In some looms this is done by depressing the draw level which is not turning the box so that it will meet the rising disc peg just as the box gets level, and prevent it both from moving forward in the same direction and from vibrating.

In other cases two small nudges are placed on swivelling pins at opposite sides of the boxes and connected together by means of a spring which draws them inward. Under normal conditions a rounded casting fastened to the draw hook keeps them from operating; but whenever either of the draw hooks are depressed it allows the nudge to be drawn into the path of the descending disc peg, and checks further motion.

HOW TO PREVENT WRONG PATTERNS.

In order to prevent the loom from either making wrong changes or missing changing altogether, it is important that the bell-crank levers should work easily; that the feelers should drop into the centre of the holes in the pattern card; that the pattern cylinder should always bring the card over perfectly level and well on the pegs; that the heels of the bell-crank levers should drive the short upright catch clearly and firmly over the vibrating lever; and that the small spiral spring which steadies the upright catch should be tight enough to prevent it being caught except when it is pushed outward for the purpose of changing the box by the heel of the lever.

When the pattern cards are of great length they are liable to get off the cylinder pegs unless the rings or strings which connect them together are in good condition, and the cards are then made to swing in short lengths on wires in a rack, or are taken round anti-friction rollers for the purpose of reducing drag to the lowest possible point. The position in which the catch that turns over the card cylinder is connected to the bell-crank lever, and the distance through which they are made to move should be such as will ensure the card cylinder being always turned into its proper position. If the cylinder is only partly turned over by the catch, and has to rely upon the spring hammer bringing it level, any extra drag on the cards will tend to the production of wrong patterns.

If the upright hooks are only pushed a short distance over the vibrating lever, the surfaces soon become worn round, and the hooks slip off again as soon as the heel of the bell-crank lever moves out of contact with them, and the box remains unchanged. When the heels of the bell-crank levers are set too close to the upright hooks there is a danger of wrong changes occurring, unless the springs are made strong enough to prevent vibration. When the loom is stopped owing to a breakage or failure of the weft yarn, it is usual for it to run for 3 or 4 picks after the weft gives out, and even after the belt has been thrown on to the loose pulley; and unless the connection between the pistol lever—to which the weft fork holder is attached—and the bell-crank levers and turning catch is properly adjusted, a considerable amount of time is lost by the weaver in turning back the card cylinder and putting the boxes into a position which will prevent the pattern from being broken when the loom is restarted. This connection should be so fixed that immediately the pistol lever is drawn back the feelers on the bell-crank levers are prevented from dropping into the holes in the pattern cards, and the catch thrown out of gear with the ratchet wheel of the card cylinder.

PREVENTION OF FRINGED SELVAGES.

In some cases the different colours of weft yarns at the box side of the loom are drawn into the cloth for a considerable distance and give it the appearance

of broken patterns. This generally arises from the weft yarns curling together owing to excessive twist; to the absence of drag in the shuttles; to the weft sticking either to some roughened surface, grease, or dirt, or catching between the faceplate and the race board; or to the rubbing action of the shuttle, which rolls the different yarns into cord form by repeatedly passing over them.

To prevent the yarn from curling or hanging slack owing to the length drawn off between the piece edge and the eye of the shuttle, the drag on the weft should be made as great as the strength of the yarn will allow without interfering with good weaving, and the shed should be timed to be fully open when the shuttle enters it.

To avoid the weft catching and rolling, the boxes should be kept smooth and clean; a cord of soft warp yarn should be tied between the box end and the end of the shuttle race to keep the weft from sticking to the faceplate, and a cloth with a slightly nappy surface should be glued on to the shuttle race, between the piece edge and the box, so that the shuttles can pass over the strands of weft yarn from the various shuttles without causing them to roll together.

CARD SAVING APPLIANCES.

If the dobby and boxing patterns require to be kept together in order to produce the correct effect in the cloth, as in weaving spots, fancy checks, etc., it is best to control the boxes from the dobby lags and do away with the box cards altogether. By so doing the tuner not only prevents the shedding and boxing patterns from getting into wrong relationship with each other, but also saves one set of pattern cards. An easy and effective method of connecting the two motions together is to have a pair of levers A, Fig. 22, placed at right angles to the bell-crank levers and parallel with the heald jacks of the dobby. The heavy ends of these levers are connected by cords B to the heald jacks, and the light ends to the box motion by cords C.

No motion whatever is given to the levers except for making changes, when one of the heald jacks rises and drops the bell-crank lever, which causes the box to be turned in the desired direction. No pattern cards are placed upon the box pattern cylinder, but

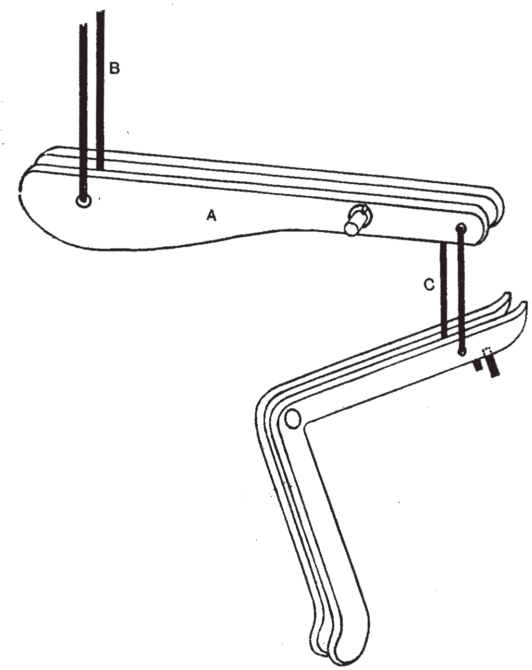


FIG. 22.

a peg is inserted in the dobby lag to raise either one or the other of the heald jacks which are connected to the levers A. This is equivalent to placing a hole in the boxing cards.

Under ordinary conditions the pattern cylinder for the boxing motion is turned over for every two picks,

and there are half as many cards as there are picks in the pattern. When long patterns are being woven in which the picks are arranged in 4s, 6s, 8s, or multiples of these numbers, a saving of $\frac{1}{2}$, $\frac{2}{3}$, or $\frac{3}{4}$ of the cards may be effected by only allowing the bell-crank levers to drop at every 4th, 6th, or 8th pick, as the case may be.

It is only when the levers have been dropped down and are rising again that the pattern cylinder is turned, and changes in the boxes only take place when the levers drop down, and one of the feelers enters a hole in the pattern card. In this way a card with a hole would represent 4, 6, or 8 picks, and a blank followed by a hole 8, 12, or 16 picks, etc. The rising or falling of the bell-crank levers could easily be regulated to the required number of picks either from the dobby or tappets.

For weaving cross-border checks the best method is to have the ground pattern on one cylinder, the border pattern on another, and to have a third cylinder for the purpose of throwing the other two in and out of gear and governing the number of patterns which have to be woven from each.

When the patterns are symmetrical in character a reversing motion may be used, by which the complete pattern may be formed by chaining together the cards for the first half of the pattern and then working them alternately backward and forward. This is effected by means of a double catch—one in front and one behind the cylinder—and a supplementary lever, which when acted upon by the index card will throw first one catch and then the other into gear. In making the following pattern, 12 blue, 4 yellow, 20 blue, 4 red, 8 blue, 4 red, 20 blue, 4 yellow, the cards would be made as if the pattern was 6 blue, 4 yellow, 20 blue, 4 red, 4 blue, with a nudge in the last card to act on the supplementary lever and change the position of the catches.

PLANNING OUT THE PATTERN CHAIN.

Considerable difficulty is experienced by many tuners in making out their pattern chains. This generally arises from lack of method, without which it is certainly difficult to keep in mind the position of the various colours in the boxes and the direction in which every change must be made, especially if the pattern is of any great length. A plan showing the position of every colour in the boxes and the direction in which every change must be made serves not only to render the work of pattern-making less difficult, but also to lessen the time required to perform it, and in many cases makes it possible to delegate the work to an apprentice.

When the pattern is one which has more colours on one side of the ground shade than the other, the larger number of colours should be kept to the front of the box; while if it is one which requires the box to turn oftener in one direction than the other, the greatest number of turns should be made forward—because, by so doing, the tendency to drag the weft into the edges is reduced to the lowest point by preventing the weft from being laid across the path of the shuttle.

When patterns are arranged with three different colours following each other in succession—as, for example, 2 red, 2 pink, 2 white,—the box should turn continuously forward and have two shuttles of each colour of yarn arranged: red, pink, white, red, pink, white. The following plan shows the treatment which unevenly balanced patterns should receive in order to prevent the yarns which are used in the smallest quantities from being rolled together by the crossing of the shuttles during the weaving of the ground portion:—

Box.	Picks.	Colour.	Movement.
1	24	White	Forward.
6	4	Blue	Backward.
1	24	White	Backward.
2	2	Red	Backward.
3	2	Black	Backward.
4	2	Fancy Twist	Forward.
3	2	Black	Forward.
2	2	Red	Forward.

In some cases it is necessary to introduce two shuttles of one or more of the colours, owing to these particular colours being separated by others which intervene between the shuttle which is being used and the one which it is required to turn up next. This often occurs in tartan patterns, and the following plan shows a typical example in which a black shuttle is required both in the third and sixth boxes, and a green one in both the second and fourth:—

Box.	Picks.	Colour.	Movement.
1	24	Blue	Forward.
6	4	Black	Backward.
1	4	Blue	Forward.
6	4	Black	Backward.
1	4	Blue	Forward.
6	4	Black	Backward.
1	24	Blue	Backward.
2	24	Green	Backward.
3	4	Black	Backward.
4	4	Green	Backward.
5	4	Yellow	Forward.
4	4	Green	Forward.
3	4	Black	Forward.
2	24	Green	Forward.

Many instances might be given in which an apparently unworkable five-colour pattern may be made to run easily by splitting one of the colours and working half the picks with one shuttle and the other half with an additional shuttle of the same colour of weft as in the following example:—

Box.	Picks.	Colour.	Movement.
1	20	White	Backward.
2	4	Pink	Backward.
3	4	Black	Forward.
2	4	Pink	Forward.
1	20	White	Forward.
6	2	Navy	Forward.
5	4	Sky	Backward.
6	2	Navy	Forward.
5	4	Sky	Forward.
4	4	Black	Forward.
3	4	Black	Forward.
2	4	Pink	Forward.

SKIPPING BOXES.

When the pattern is one which, either owing to the number of colours introduced or to the peculiar arrangement of the colours, does not permit of the shuttles being worked in proper succession on any of the principles described, it becomes necessary to employ a loom in which more than one box can be turned in either direction—*i.e.*, a loom which will skip over the intervening colours to the one required by the pattern.

For example, if there are six chambers in the box, it is possible to move 1, 2, or 3 chambers in either direction, and so reach any shuttle at will. Thus, if the loom is working with the shuttle in No. 2 box, and it is desired to change to No. 4, it will be necessary to skip No. 3 or turn the distance of 2 boxes.

In order to change to No. 5, it would be necessary to skip Nos. 3 and 4, or turn the distances of 3 boxes; while if it was to turn up No. 6 box, two boxes would be moved in the opposite direction and No. 1 would be skipped. From this it will be quite clear that no trouble is experienced in reaching any box which may be required.

Fig. 23 illustrates the mechanism employed in the newest type of circular skip box made by Messrs. G. Hattersley and Sons, of Keighley, who were the original inventors of this type of loom. It consists of a duplex rack A, which may be made to gear with either side of a spur wheel B placed on the end of the revolving box spindle, by raising or lowering the lever C, to which is connected the eccentric D that fits between the inner flanges of the duplex rack. When the lever C is raised the right-hand side of the rack is put into gear with the spur wheel to move the box forward, but when the lever C is lowered the opposite side of the rack is brought into gear to turn the box backward.

The revolving motion of the boxes is derived from the downward movement of the duplex rack which is connected with the horizontal lever E; while the amount of movement given to the rack is dependent upon the vertical catches F and G which are connected

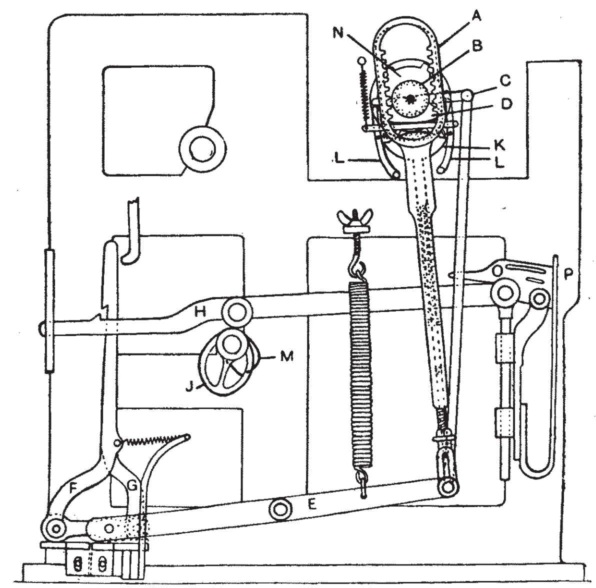


FIG. 23.

to the free end of the lever E. If the indicator (the vertical arm of the elbow lever) causes F to be thrown over the vibrating lever H (which is raised and lowered by the tappet J), one box will be turned; but if G be selected, two boxes will be turned; while if both F and G be raised together, three boxes will be turned. This method does away with the multiplicity of tappets and vibrating levers which are used in the older types of loom.

SAFETY OF ACTION.

In order to render the motion safe and easy in its action, the vertical catches which place the duplex rack into gear with the spur wheel, that draw down the hammer or T-head spring K and expand the locking catches L, are acted upon by a separate vibrator lever which receives its motion from the tappet M. This is timed to commence its action slightly earlier than the tappet J, so that the duplex rack and spur wheel may be firmly in gear and the locking catches expanded before any rotary motion is given to the boxes. The hammer spring and locking catches should also be liberated at the moment the box has reached the desired position.

This arrangement results in the box always being turned the required number of compartments, and ensures freedom from vibration when the motion reaches its extremity of action, for the locking catches slide under the projections of the star wheel N as the duplex rack and spur wheel become disengaged. The perfection of the motion, and the ease with which it works, are largely due to the fact that whenever a change is to be made the T-head spring is drawn down, releasing the box not only from the pressure of the spring, but also by its action in expanding the locking catches L, leaving the box free to receive any movement which may be given to the spur wheel by the duplex rack.

In order to prevent breakages in the loom when a shuttle is caught between the box and the face-plate, or when the duplex rack is acting on the spur wheel without the locking catches having been drawn out of contact with the star wheel, the vibrator lever H is provided with a movable fulcrum at O. Under ordinary conditions the flat spring P, which holds the dog's head down on the fulcrum stud, is strong enough to keep it firm when the boxes are being turned, but weak enough to allow of its being raised when the catch end is prevented from moving in its natural course.

THE PATTERN CHAIN FOR SKIP BOXES.

The following plan shows the method of arranging the shuttles in the boxes, and indicates the kind

of change necessitated by the Macbeth pattern for a skip box loom :—

Box.	Picks.	Colour.	Movement.
1	68	Blue	1 Backward.
2	6	Yellow	1 Backward.
3	8	Black	1 Backward.
4	2	White	1 Forward.
3	2	Black	1 Backward.
4	2	White	1 Forward.
3	2	Black	2 Backward.
5	20	Green	1 Backward.
6	10	Red	3 Forward.
3	2	Black	3 Backward.
6	4	Red	2 Forward.
4	2	White	2 Backward.
6	4	Red	3 Forward.
3	2	Black	3 Backward.
6	10	Red	1 Forward.
5	20	Green	2 Forward.
3	2	Black	1 Backward.
4	2	White	1 Forward.
3	2	Black	1 Backward.
4	2	White	1 Forward.
3	8	Black	1 Forward.
2	6	Yellow	1 Forward.

NOTE.—As tuners do not all work on the same principle, it is necessary to state that in these examples the movement is understood to be given by the last card of the colour, and therefore represents the direction of movement necessary to change from the colour against which it is placed on to the colour following it.

RISING BOXES.

Rising boxes are most suitable for wide, slow-running looms which are weaving heavy cloth that requires a firm reed for the purpose of beating up the weft, as the fast reed warp protector motion can be applied without difficulty. The systems upon which rising boxes are constructed are so numerous that it is impossible for the same writer to deal with them all from a loom tuner's point of view, as this requires not only a knowledge of the principles upon which they are constructed, but also a personal acquaintance with the actual working of the loom, the defects which arise from time to time, and the best methods of overcoming them. The author will, therefore, only deal with the types which have had his personal attention.

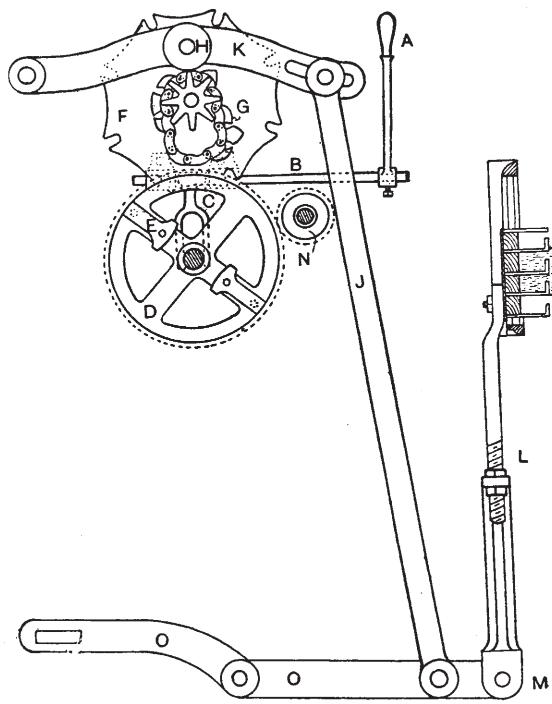


FIG. 24.

NEGATIVE MOTIONS.

DIGGLE'S CHAIN.

The oldest and simplest type of rising box is known as " Diggle's chain," and is negative in its action—*i.e.*, the boxes are raised by means of the pattern chain and lever connections shown in Fig. 24, but drop by means of their own weight.

The parts in this loom which require the most attention from the tuner are the construction of the pattern chain, the timing of the box in relation to the picking, and the balancing of the box to secure steady working.

For looms which have only two boxes, the operation of making the pattern chain is comparatively simple, as only four kinds of links are used—*viz.*, a flat link for working from the top box ; a pointed link for raising the second box for two picks ; a riser dwell and a sinker dwell to raise it for four picks ; a riser dwell, a full dwell, and a sinker dwell for raising it for six picks ; with an additional dwell for every additional two picks required from this box. (A sinker dwell is the same as a riser dwell, but is fixed in the chain with the shoulder in the opposite direction.) In looms which have four boxes working, as many as twenty different kinds of links are necessary, some of which must be used in two different positions—*i.e.*, either as risers or sinkers. The disadvantages of this type of pattern chain are that it is ill adapted for producing long patterns or short patterns requiring a long drop ; it is heavy, costly, difficult to build, and sometimes almost unmanageable. When long patterns have to be woven it is not uncommon to throw the chain out of gear either for the purpose of weaving the ground portions without turning the cards, or for moving them backward a certain distance in order to repeat a portion of the pattern. This is accomplished by changing the position of the lever A, which is fulcrumed on the shaft B, and supported in brackets on the loom frame. The opposite end of this lever consists of two prongs C, which fit into a groove that is cut in the neck of the slide wheel D. When the loom is running under normal conditions a spring keeps the peg E on the slide wheel D and the star wheel F in gear with each other ; but when the lever A is moved to a fresh notch, the slide wheel is pressed outward and the peg E is withdrawn from the star wheel. This allows the pattern cylinder either to remain stationary or to be turned into any desired position.

Variation in the relative positions of the different boxes to the level of the lay should be reduced to the lowest point, by placing the centre of the connecting pin M parallel with the centre of the sword when the box is exactly equidistant from its highest and lowest positions, and the sword at the centre of its stroke.

The best time to commence changing the box is when the reed is from $1\frac{1}{2}$ to 2 inches from the edge of the cloth, and the change should be completed almost as soon as the weft has been beaten up so that the box may be free from vibration when picking takes place. This is especially the case when more than one box has to be dropped. Any alteration in the time for changing the boxes can be made by moving the point of gearing in the slide wheel D and the pinion wheel N, one or more teeth in the desired direction. Another fault of this type of loom is that though the box is raised by the direct action of the chain, it falls by means of its own weight and rebounds when the extremity of the fall is reached, causing much wear and tear, and precluding high speeds. Theoretically any box may be brought flush with the lay at any time, but in practice it is found that to drop more than two boxes is unsafe, owing to the amount of vibration set up. In order to reduce this vibration to the lowest point, and at the same time lessen the wear and tear on the mechanism, the lever K has a backward extension from which can be suspended weights which will help to counterbalance the boxes. The weights must not, however, be too heavy, or there will be a danger of the box not moving decidedly from point to point, and of the shuttle being thrown out.

Knowles' Motion.

Although the Knowles' rising box motion made by Messrs. Hutchinson and Hollingworth is negative in its action, it is free from the disadvantages which usually make negative motions difficult to operate. This arises from the motion given to the boxes being eccentric in character, *i.e.*, they begin to move slowly, increasing and decreasing in speed as the centre of the traverse is approached and passed respectively ; then move very slowly as the extremity of motion is reached. Owing also to the boxes being connected to the draw levers by means of chains, these latter effectually prevent them from rebounding when they are allowed to drop.

There are two draw levers, A and B, Fig. 25, which are arranged in the proportion of 1 to 2, and which

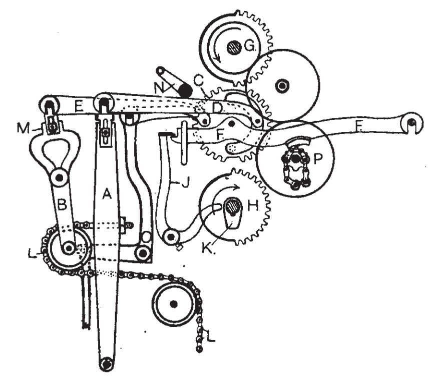


Fig. 25.

may be worked either singly or together, or may even be made to act in opposite directions. These are each attached to toothed crank wheels C by means of the connectors D and E. The crank wheels which give the eccentric motion to the boxes are pivoted on the vibrator levers F, and are raised or lowered into contact with the cylinder gears G or H, which revolve in different directions, by means of the chain on the pattern cylinder P. When the shuttle is working from the first box, the pattern chain is blank; when from the second box, bowls are made to act on the vibrator lever which governs the draw lever A, and on the draw level B for the third box; while both levers are made to draw together when the shuttle is required from the fourth box. A connecting chain L is attached to the lever A, and is then passed round the bowl on the lever B, over a number of anti-friction bowls, and connected to the spindle which supports the shuttle boxes.

When a bowl in the pattern chain lifts the crank wheel into contact with the cylinder gear G, the boxes are raised; but when a blank allows it to drop into contact with H, the boxes are lowered. The cylinder gears G and H have adjustable segments which will allow the boxing and shedding to act at different times. It is advisable, however, not to time the portion which governs the boxing and picking too much behind that which governs the shedding, or the change will not be completed when it is necessary to withdraw the locking knife J. This knife is for the purpose of keeping those crank wheels C, which are lifted, in contact with the cylinder gear G, and those which are dropped in contact with H. If the knife is withdrawn before the motion is completed, the crank wheels spring out of gear with the segment wheels, and the box does not reach its proper level; while the crank wheels are not capable of utilising a new selection of positions from the pattern cylinder.

The timing of the locking knife in relation to the cylinder gears which actuate the shedding is governed by the tappet K, which is keyed to the shaft of the cylinder H; so that it is only the portion of the cylinder which governs the boxing that needs attention.

If, by reason of the chain becoming entangled or sticking to the flanges of the pattern cylinder—which will sometimes occur if the links are not perfectly adjusted,—the proper timing of the pattern cylinder

in relation to the locking knife and cylinder gears is destroyed, the greatest care should be taken when re-setting them to see that the pattern cylinder moves forward to select the vibrator levers F when the locking knife is withdrawn, and that the selection is complete before it moves back into position. The boxes sometimes get out of flush with the lay, either through the wear and tear on the chains and anti-friction pulleys, or by the relative leverage of the levers A and B being disturbed. The first of these faults may easily be remedied by tightening the chains by means of the screws on the bolt which connects it to the spindle that supports the boxes, because in this case each of the boxes will be out of flush to the same extent. When the leverage has been disturbed, however, it will be necessary to ascertain which of the draw levers causes the fault. If the lever A is the cause of the fault, and it is found that the second box is too low in relation to the shuttle race, the chain L will require to be connected higher up the lever; while if the box is raised too high, the connection will require to be lowered. A slot is provided in the lever for the purpose of adjustment.

When the fault is due to the lever B, the third and fourth boxes will be affected, and the traverse given to the boxes will require to be increased by shortening the top arm of the lever at joint M when the boxes are too low, and decreased by lengthening it when they are too high.

A heavy swivelling bar rests upon the connectors D in order to keep them free from vibration after the motion has been completed in either direction. Under ordinary circumstances this bar is sufficient for the purpose, but when the loom is made to run above the normal rate of speed, or when the order of picking is being rapidly changed, it is advisable to attach a spring to the connector which governs the draw lever O that puts the picking motion in and out of gear. The addition of this spring effectually prevents mispicks and their resultant breakages of warp, as the connector is kept perfectly steady.

In heavy looms of this description every care should be taken to prevent the shuttle from rebounding in the boxes, so that constant knocking-off and consequent breakages may be obviated. This may be done by the proper tensioning of the swell spring, by bringing the picker forward slightly to meet the advancing shuttle, and by passing a strap over the swell finger on the principle illustrated in Fig. 20 (page 69).

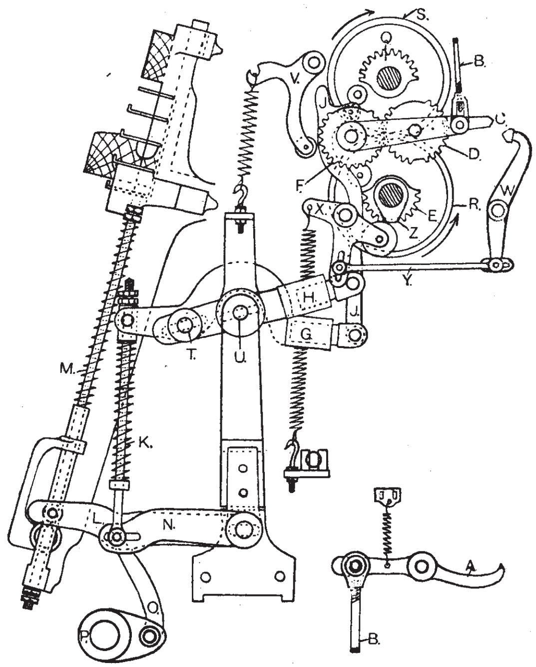


FIG. 26.

POSITIVE MOTIONS.

A rising box motion which combines the best features of the Knowles mechanism with a positive action is made by Messrs. G. Hattersley and Sons,

and is shown in section in Fig. 26. The positive action of this mechanism is the result of making a direct lever connection between the draw levers and the shuttle boxes. Instead of the cylinder gears, toothed crank wheels, and vibrator levers being part of the dobby, they are mounted at the end of the loom and controlled from the dobby. The tooth gearing is considerably strengthened in order to allow greater speeds to be attained, and to reduce the wear and tear (which is often very great in this principle of working) upon the first teeth of the cylinder gears and crank wheels. A supplementary cylinder is placed on the end of the ordinary lag cylinder spindle, outside the framework of the dobby. Over this cylinder are placed five levers A, two to govern the boxes at each end of the loom respectively, and one for the picking.

When a peg is placed in the lag the curved portion of one of the levers A is raised and the opposite end depressed, causing by means of a connecting rod B the depression of a vibrator lever C, and therefore of the gear wheel D. The result is that D comes into contact with the lower cylinder gear E, which is fixed on the crankshaft of the loom and is turned one-half of a revolution. A crank wheel F gears with the wheel D, and is connected to one of the levers G or H by means of a sickle-shaped connector J in such a way as to impart a downward motion of an eccentric or differential character to them. If either one or both of the levers G or H are depressed at the back extremity, they will rise at the front, and as this end is connected by the rod K and the lever L to the spindle M which supports the boxes, the latter will be raised.

In order to convey the motion to the boxes at the opposite end of the lay, the rod K is connected to a short lever N (as shown in the drawing), which is in turn connected by means of another arm O to a swivelling shaft P which runs underneath the loom to the opposite side, where the swivelling shaft is connected to a lifting lever similar to L by mechanism exactly like that shown at O.

When the boxes have to be lowered the pegs are omitted from the pattern lags, and the vibrating lever C places the gear wheel D in contact with the higher cylinder gear Q—which is supported on a stud fastened to the loom frame and driven by means of the connector wheels R and S—with the result that the whole of the mechanism acts in the opposite direction to that described for raising the boxes.

When the boxes require to remain stationary in any given position, the pegging which caused them to take up that position must be continued for the number of picks required. The toothless portion of the gear wheel D always faces the cylinder gear which has acted upon it last, and will be unaffected so long as the same kind of pegging is continued; but as soon as the pegging is changed it comes in contact with the opposite cylinder gear and the position of the box is altered. If it is desired to move one box in either direction, the lever G—which is fulcrumed at T on the lever H—will be raised or lowered. To move two boxes, the lever H, which is fulcrumed at U, is actuated; while to move three boxes both the levers are moved at the same time.

Care should be taken in pegging the lags to see that no slack pegs are inserted, because these drop out and cause two or more shuttles to come on to the shuttle race at the same time. This fault may be prevented by using split wire pegs. High speeds are rendered safe for this class of loom by placing a lever V, with its spring and anti-friction bowl attachments, behind each of the connecting arms J. This effectually prevents vibration and causes the crank wheel to travel from one dead centre to the other whenever movement takes place.

The locking lever W, which is connected to the T-shaped lever X by means of a rod Y, is controlled by the tappet Z, and is timed to lock the vibrators C in position during the time that the cylinder gears are acting. The picking motion in this loom is arranged on the "upright-shaft-clutch" principle, and is controlled from the pattern cylinder of the dobby, so that any order of shuttling may be obtained.

Changing the Boxes by Eccentrics.

The method of raising and depressing the shuttle boxes by means of compound eccentrics was introduced by Whitesmith, and is one which has been

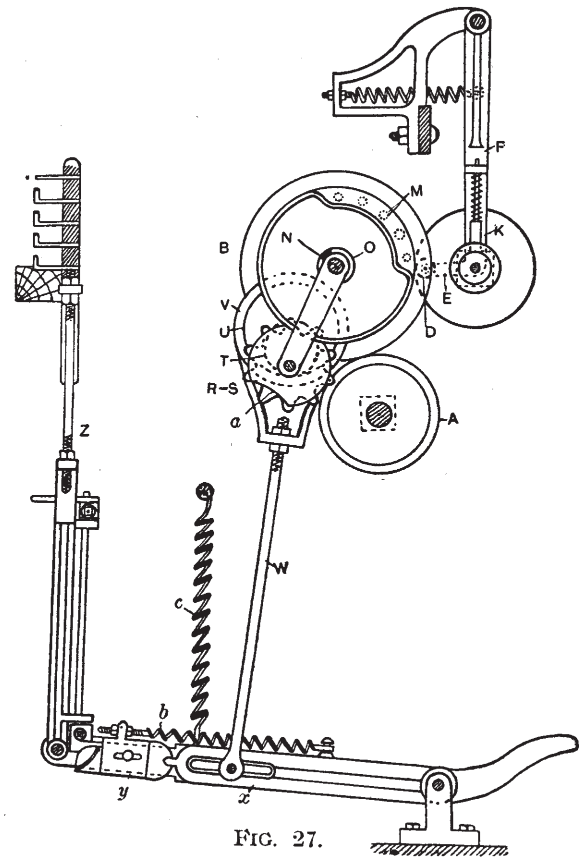


Fig. 27.

adopted by several loom makers in one form or another.

The fact that the boxes are moved positively in either direction, that there is no vibration at either extremity of the movement, and that the change from the first to the fourth boxes, or *vice versa*, is made as easily and quickly as from the first to the second, shows that the principle is both theoretically and practically correct.

The difference between the various looms working on this principle consists chiefly in the manner of selecting and actuating the eccentrics, and the position in which they are fixed in relation to the lifting levers. A well-known type of rising boxes governed by eccentrics is that made by Messrs. Hacking & Co., of Bury, an end elevation of which is shown at Fig. 27, while the method of selecting the eccentrics is illustrated at Fig. 28. The various parts of the mechanism are driven from the crankshaft by means of a pinion wheel A of 18 teeth, which gears with a stud wheel B of 36 teeth.

On the inner side of the wheel B a bead is cast in such a way as to form a cam C, which by its frictional contact with the bowl D (attached to the arm E which projects from the bottom of the swing cylinder carrier F) causes the cylinder G to move in and out of contact with the needles H. When the cam C has pressed the cylinder a sufficient distance away from the ends of the needles H, three strong teeth which project from the wheel B engage with the cylinder wheel J, causing the cylinder to turn over a quarter of a revolution and present a fresh card to the needles. A spring hammer K is placed over the squared end of the pattern cylinder to aid in turning it, and to keep it free from vibration. The stud wheel B has also a long projection or sleeve, upon which are loosely mounted the grooved cams L, and their respective peg wheels M, with which they are compounded. The two discs or peg wheels M face each other, and are kept constantly revolving owing to the side projections N which are cast on their outer edges fitting loosely into the hoops O which are carried by the sleeve of the wheel B.

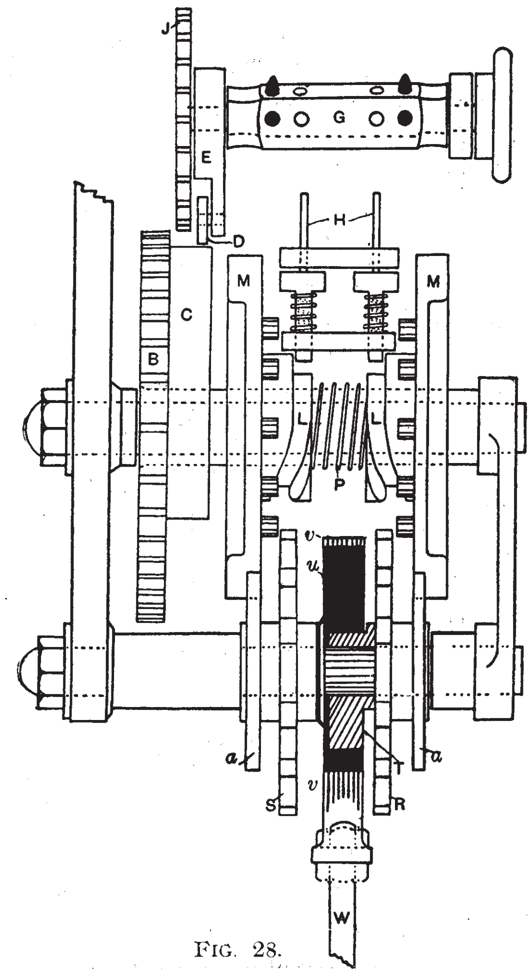


FIG. 28.

When the steel cards which are passed over the cylinder G contain holes opposite each of the needles H, the latter remain inoperative, the spiral spring P which is passed round the sleeve between the two cams keeps them apart, and no motion is transmitted to the eccentrics. If the card is blank, however, the needles are forced into the grooves of the cams L, the peg wheels M are drawn towards each other, and the five pegs engage with the star wheels R and S, causing them to turn one half of a revolution—*i.e.*, from one dead centre to the other. When the card is blank on one side and punctured on the other, the peg wheel which is governed by the needle that is opposite the blank portion of the card will be put into operation, while the other will remain unaffected. The star wheel R is directly compounded with the small eccentric T; while the star wheel S governs the large eccentric U by means of a projection cast on the outer side of U, which fits into a corresponding groove in the nave of the star wheel. The small eccentric T is enclosed by the large eccentric U, which is in turn encircled by the strap V, and all move freely round the supporting spindle as desired. The strap V is in turn connected by the rod W to the broken backed lever X Y and the rod Z which supports the boxes, so that whatever motion is given to the eccentrics is at once transmitted to the boxes.

If the star wheel R is acted upon by the peg wheel, the small eccentric will raise or lower the boxes the distance of one chamber, the direction of the movement depending on the position of the eccentric before movement is given; if the star wheel S is acted upon, the box is traversed through the space of two chambers, while if both are moved together the boxes will be raised or lowered the distance of one or three chambers according to the relative positions of the eccentrics—*i.e.*, both may move in the same direction, or they may cancel each other.

A disadvantage arises in card building, and in finding the correct position after unweaving, from the fact that similar holes in the card may mean either a raising or lowering of the boxes, and the positions of the eccentrics have to be carefully

considered before any change is made. This disadvantage, however, has been overcome in the newer type of loom made by the same firm. By the introduction of four supplementary levers and two additional needle boxes, which contain four needles each and are capable of a rocking action, similar holes in the pattern cards always bring the boxes into the same position.

Locking plates *a*, which prevent action on the part of the eccentrics except at the times when the peg wheel is drawn into contact with the star wheels R or S, are compounded with each of the star wheels, and have pieces cut out at opposite sides to exactly coincide with the full curved surfaces of the peg wheels M, whichever position they may hold; and before a change can be made a thin part of the surface of M must be presented to that of *a*. In order to prevent breakages when the shuttle is trapped by the rising or falling boxes, the spring *b* which draws the groove of Y on to the wedge of X gives way, and the connection between the two is severed; the eccentrics are then free to move without operating the boxes. For the purpose of counterbalancing the weight of the boxes and shuttles, and lessening the power required to raise the boxes, a spring *c* is attached to the lifting lever X.

One of the great advantages of this loom arises from the fact that both the card cylinder and the peg wheels which turn the eccentrics into position are driven by direct connection with the spur wheel B, and it is impossible for these parts to get out of time with each other. The only timing required is that of the boxes in relation to the picking motion; and any necessary alteration in the timing of the former can easily be made by varying the point of connection between the wheels A and B.

Other advantages which accrue from the use of eccentrics are that the movement begins and ends slowly—the greatest speed being attained in the centre of the stroke—and that the eccentrics being encircled by the same hoop and connected to the lifting lever by the same rod, the boxes may be readily adjusted to the level of the lay. This may be done either by adjusting the screw on the supporting rod Z, or by changing the point of connection between the rod W and the lever X.

In many rising box looms a difficulty arises from the bottom of the boxes getting out of level with the shuttle race, *i.e.*, dipping down at one end and tilting up at the other. This may be due to the amount of play allowed in the grooves through which the boxes move, or to the manner in which the boxes are supported. Every effort should therefore be made to ensure the even wearing of the grooves and framework of the boxes.

CHAPTER VI.

WEFT STOP MOTIONS.

In power-loom weaving it is necessary to stop the loom automatically when the weft runs out or breaks down, and a perfectly adjusted stop motion saves the weaver a considerable amount of time and anxiety. The mechanism employed—especially for fine counts of weft yarns—must naturally be of simple construction, delicate in action, and capable of being easily adjusted to suit the class of material which is being woven; and although usually classed as an auxiliary motion, it is one which requires careful attention if thin places, broken picks, and cut weft are to be kept out of the woven cloth. Weft stop motions are constructed on two different principles, according to the requirements of the cloth which has to be woven. Side weft forks are used when the weft is all one colour or quality, or even for a number of colours and qualities, if the changing boxes are only placed at one end of the lay; while centre weft forks are used in box looms which have changing boxes at both ends of the lay, or when it is necessary to prevent the broken picks which are sometimes caused by the weft breaking and catching in again before a side weft fork could detect the breakage.

SIDE WEFT FORKS.

These are so called because they are placed between the edge of the cloth and the shuttle box, at the driving side of the loom. A grid A, Fig. 29, is fixed to the sword of the lay in such a manner as to be either flush with the reed or set slightly behind it, so that every time the shuttle is picked to the belt end of the loom, the weft B is laid across the front of the grid. The prongs of the fork C are placed exactly opposite the holes in the grid, so that when the lay moves forward to beat up the weft the prongs of the fork will pass through the grid unless the weft is laid between them. When the weft is present the grid pushes it against the prongs with sufficient force to raise the hooked end of the weft fork handle, and the loom will continue to run. If the weft is absent, however, the prongs pass through the grid, and the catch end of the fork remains stationary upon the lower face of the hammer lever D, which at this point of the lay's motion is made to move outward by means of a crank E which is fastened to the low shaft of the loom.

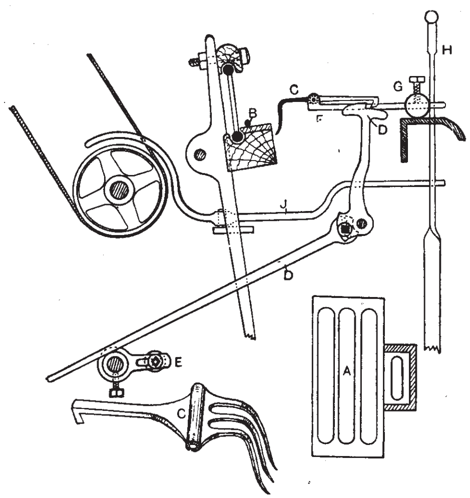


FIG. 29.

The weft fork C is supported by means of a holder F which is in turn set-screwed to the pistol lever G of the loom. Therefore, any backward movement of the hammer lever D when the catch end of C is resting upon it will cause the pistol lever to move outward, so as to cause the friction brake to drop into contact with the brake pulley, throw the take-up motion out of action, push the starting handle H

off its notch, and throw the belt on to the loose pulley. The bent arm of the belt fork lever J is passed through the starting handle for this purpose.

The perfect action of this mechanism depends very largely upon nicety of adjustment, and the tuner cannot be too careful in his attention to the accuracy of his settings. If the crank E is not made to act upon the lever D exactly at the moment that the reed is beating up the weft, the loom will be continually stopped, because at this point the catch end of the fork is raised to its highest point by the pressure of the weft on the prongs. If the prongs of the fork touch the side of the grid, the loom will continue to run after the weft has given out or broken, because the contact between the two will have the same effect as if the weft was present. The same fault will often occur when the ends of the prongs rub against the bottom of the groove in the lay. When the weft is of a stiff, harsh, or inflexible character, the bars of the grid often get badly "nicked," with the result that the weft is frequently cut. One method of remedying this defect is to have the bars refaced, but a better method is to cut out the bars, and bore holes for the reception of drop pins, which take the place of the bars. These have the advantages of being interchangeable, of leaving more space for the prongs, and of a rounded surface, which is easier on the weft yarn.

These drop pins should, however, fit tight in the hole bored for their reception, or they are liable to vibrate and cause the prongs to be pushed back when the weft is absent. Another method is to replace the wires by strings of fine catgut. This is an advantage when weaving fine weft yarns in fast running looms, and has been made the subject of a patent by Messrs. Robert Pickles, Ltd., for their "ideal" loom.

When the fork is set too far away from the grid, the weft will not exert enough pressure to raise the hooked end clear of the hammer lever, while if it is set too near it will break the weft, or cause it to curl. Light weft forks should be used for fine yarns, so that the hooked end can be raised without putting too great a pressure on the weft. When the weft runs off easily it must be tensioned in the shuttle, or there will not be sufficient resistance to make the fork act, and the loom will be continually stopping. If the prongs are bent forward with the object of putting more pressure on the weft, there is a tendency for the weft to slide up the fork rather than to press it backward; while the lengthening of the distance between the ends of the prongs and the fulcrum causes the former to rub against the bottom of the groove in the lay, and work unsteadily.

If the fork is then raised to prevent the rubbing, the weft will catch on the prongs, holding it out of action, and giving a fringed edge to the cloth. It is, therefore, best to keep the prongs at their normal angle, and move the fork forward or backward as desired, by means of the holder F.

The position of the hammer lever in relation to the catch of the weft fork must also have attention in order that the pistol lever may be drawn outward a sufficient distance to liberate the starting handle. The weights on the drop brake should be regulated to stop the loom at the right side, and the catches of the take-up motion arranged to cease action and slip back two or three teeth when the loom stops, in order to prevent the weaver having to turn the loom over before starting, and holding the catches out of gear to prevent thin places.

CENTRE WEFT FORKS.

These are attached to the centre of the lay underneath the shuttle race. The mechanisms employed by different loom makers vary considerably in structure, but all aim at the same object—to raise the prongs of the fork when the shuttle is being passed across, and then allow them to fall on to the weft when it has been laid across the shed; or, if the weft is absent, to allow the fork to drop down into a groove cut in the lay for its reception, lock a sliding piece, and cause the starting handle to throw the belt on to the loose pulley. When the weft is present it will support the fork till the catch in the sliding piece has passed, and the loom will continue to run.

One of the simplest and most effective of its class is that made by Messrs. Hutchinson, Hollingworth and Co. A plate A, Fig. 30, is fastened to the front of the lay, through the ears of which screws B are passed to support and adjust the rocking piece C, to which the prongs D are fastened. Underneath the rocking piece is placed a sliding piece E, with a twisted shoe-shaped face. This sliding piece is fulcrumed at F and connected to a swivelling stud G, which is dropped into a socket in the breast beam—by means of a connecting rod J. The socket is placed in such a position that whenever the lay moves backward,

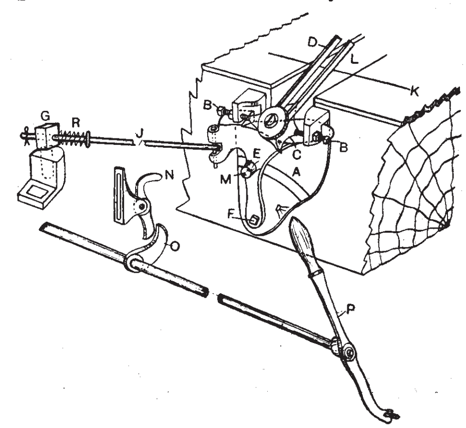


FIG. 30.

the sliding piece E will be drawn to the left and the prongs of the fork will be raised. When the lay is moved forward E is pushed to the right, the prongs are allowed to drop down on to the weft K, which supports them and suffers the sliding piece to be pushed to the extremity of its motion. If the weft is absent, however, the prongs drop down into the groove L, the end of the rocking piece C to which the prongs are attached falls into the catch or heel on the face of the sliding piece E, and prevents it from reaching the extremity of its motion. The result of this locking action on the part of C and E is to cause the nudge M which is cast on the face of E to come into contact with the finger N, which, when forced backwards, causes its lower arm to push against the arm O and displace the belt handle P. A spiral spring on the connecting rod J allows the forward motion of the lay to continue without breakage or strain when the locking action of C and E takes place.

The swivelling stud G, through which the connector J is passed, should be adjusted in a position which will allow the prongs to rise without striking the edge of the cloth on the one hand, and, on the other hand, raise them high enough to be clear of the shuttle as it passes across; while the spring R should be strong enough to force the sliding piece to the extremity of its traverse when no locking action takes place. The finger N should be adjusted to receive the blow from the nudge M right in the centre when E is locked, and transmit a sufficient amount of force to the arm O to effectually dislodge the belt handle. It must also allow a clearance when weft is present. The prongs must be short enough to be withdrawn from contact with the weft before it is beaten up, but long enough to prevent the sliding and rocking pieces from interlocking when weft is present. If the weft is fine it must be tensioned sufficiently to support the prongs, or frequent stoppages will occur. The prongs must be made to lift perfectly straight so as not to become bent, or to rub against the warp.

CHAPTER VII.

LET-OFF AND TAKE-UP MOTIONS.

LET-OFF MOTIONS.

It is essential that the warp yarn shall be delivered from the beam regularly, and at even tension, in order that the cloth may be free from thick, thin, or shady places, and that it may be of the same quality throughout. The majority of looms which are engaged in weaving light or medium weight fabrics are fitted with negative let-off motions. The principle of these consists in tensioning the warp by means of some frictional arrangement which will allow the warp to be drawn slightly forward either when it is tightened by the opening of the shed or by the beating up of the weft to the cloth.

The commonest method is to attach ropes to the loom frame, coil them a number of times round the ruffles of the beam, and then fasten them to weighted levers. The weight on the levers and the number of coils of the rope around the beam are, therefore, dependent upon the amount of tension required upon the warp. The greatest defect of this type of let-off motion is the tendency to produce barry places across the cloth. These are usually due to the beam holding for a few picks and then slipping suddenly forward. In some cases this sudden slippage is due to one of the healds being lifted higher than the others, and drawing its threads tight; while in other cases it is due to the threads from the back heald being under the front lease rod, and the lease rods being too near the healds, so that the warp is jerked forward when the strain caused by the acute angle between the heald and lease rod overcomes the tension of the ropes.

When the defect is due to the irregularity of grip between the ropes and the ruffles, the best way to effect a remedy is to free the ruffle from rust, dirt, or any other sticky matter, turn the rope over so as to bring an unused side into touch with the ruffle, and scatter a little powdered black lead or French chalk upon them to render the contact as smooth and even as possible. When the warp and weft yarns are of various shades, or if they have to be dyed to different colours in the piece-dyeing process, or even if the cloths are of delicate construction, the tendency to form thick and thin places is very noticeable. Chains are then frequently used in place of the ropes, owing to the grip of the latter being affected by the varying humidity of the weaving shed, and by the tendency of the weights to settle down and tighten the ropes when the loom is standing. Chains also avoid the expense of frequent renewals, which with ropes may vary from one to five shillings per annum, according to the strength of the cloths which are being woven. The amount of drag obtained depends very largely upon the smoothness or otherwise of the ruffles, and on the diameter and condition of the ropes, a new rope exerting more resistance than an old, smooth, and oily one.

The position of the back bearer in relation to the warp beam has a considerable influence on the amount of weight which it is necessary to put on the levers. When the beam is made to stand outside the loom, the angle formed by the warp line between the beam and the bearer is lowered (unless the bearer can be moved outwards a corresponding distance), and the straining action of the shedding and beating-up motions is transmitted more directly to the warp beam, instead of being exercised upon the bearer. In weaving heavy goods it is not uncommon to draw the warp off in the opposite direction to that which is employed under normal conditions, in order that it may get a better grip of the bearer and reduce the weight on the levers. The number of coils of rope around the ruffle has a great influence on the amount of weight required on the levers, as the following table will show.

This gives the result of actual tests with a 1 lb counterweight attached to the end of the rope which is usually connected to the loom frame.

Laps of Rope on Ruffle.	Weight in lbs. required to slowly raise the 1lb. Counter.	Laps of Rope on Ruffle.	Weight in lbs. required to slowly raise the 1lb. Counter.
$\frac{1}{2}$	1.6	2	8.0
$\frac{3}{4}$	2.1	$2\frac{1}{4}$	10.0
1	3.0	$2\frac{1}{2}$	14.0
$1\frac{1}{4}$	4.0	$2\frac{3}{4}$	20.0
$1\frac{1}{2}$	5.1	3	23.0
$1\frac{3}{4}$	6.6	$3\frac{1}{4}$	30.0

The point at which additional coils would be useless is found when the weights are dragged up by the beam.

A serious defect sometimes occurs in weaving by placing too many coils of rope around the beam, because the weights are drawn up by it, and the loom frame to which the inner end of the rope is attached does not take up the rope in the same way as a counterweight, but allows it to remain slack until a sufficient length is drawn up to lower the tension of the coils and allow the weighted lever to drop down again.

Another difficulty of considerable importance arises from the impossibility of keeping the warp at even tension from start to finish. This arises from the fact that as the diameter of the beam decreases, the relative leverage between the warp and ruffle decreases, and as a natural result the tension on the warp increases.

It is well known that the best fabric is produced when the warp is stretched at the highest tension which the strength of the warp will permit, except perhaps in such goods as soft woollens. This being the case, the tuner will start the warp with sufficient tension to produce the best results, and the weight must be reduced by the weaver from time to time as the size of the beam decreases, or there will be considerable breakage of warp threads. If the weaver is careful to lighten the weight on the levers a little at frequent intervals, the warp will continue to weave well, and the piece will be of the same quality throughout; but if the weight is retained until the warp is strained, and then lightened too much, there will not only be bad weaving, but the cloth will be uneven in quality—*i.e.*, one part will be fuller, finer, and of better weight and appearance than the other. In order to overcome this difficulty a number of attempts have been made to slide the weights automatically towards the fulcrum of the lever as the size of the beam decreases, or in other ways adjust the load to the strain required.

The advantages of the rope and lever let-off motion arise from the simplicity of construction, the relatively small amount of attention it requires from the tuner, and the fact that warp can be paid off and taken back as a shed opens and closes by the oscillation of the beam and weighted levers, or, if desirable, by a vibrating back lever. It is widely adopted, and is sufficiently powerful for light and medium weight fabrics, but for heavy goods the amount of weights required on the levers is so great that there is a considerable expense incurred in renewing the ropes, and the weaver has great difficulty in relieving the beam when the warp requires to be drawn backward.

Many attempts have been made by means of clutches and specially fulcrumed levers to cause a small weight on the levers to exert a great restraining influence on the let-off, and at the same time allow the beam to be readily drawn backward when required. An arrangement of this character, known as the Briggs let-off motion, is shown in Fig. 31. The ruffles of the beam are turned perfectly true and rest upon chairs A, and pressing plates B are placed above the ruffles. Into the inner ends of these, hooked connectors C are dropped, which have strong spiral springs D wound round their lower ends, and are tensioned by the pressure between the bearings E and the lock nuts at the bottom of the connectors. A second pair of connectors F are passed through the outer ends of the pressing plates, and attached to the hooked levers G, which are fulcrumed at H. To the bottom of one of these hooked levers a specially shaped weighted lever J is attached, while to the other a handle K is connected. J and K are then linked together by means of a rod L. When K is raised into the position shown in the drawing it causes the weighted lever to

draw the bottom ends of the levers G inwards and throw the strain on to the pressing plate. The position of the fulcrums of the levers G and J enables a small weight to exert a large amount of drag on the beam. When the beam requires to be drawn backward, the handle K is disconnected from the hook M and lowered, with the result that the weighted lever falls to the floor, and the lower ends of levers G move outwards and liberate the beam from the pressure of the plates B. The ruffles must be kept perfectly true, and the chairs and pressing plates must be slightly grooved with a facing file to give them the proper gripping power. The motion only requires a small amount of weight, costs little in renewals, is easily adjusted, and is more convenient and less cumbersome for the weaver than heavily weighted levers.

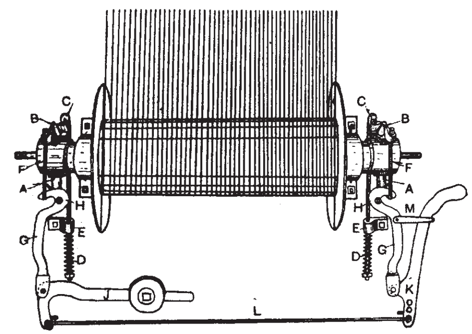


FIG. 31.

Motions have also been made to deliver the warp positively, and regulate the delivery to the requirements of the take-up. The length of warp required for a given length of cloth, however, varies according to the weave, the thickness and closeness of the warp and weft, the flexibility of the material, and the timing of the shedding, so that they are difficult to regulate and have not come into general use. It is also found that if the relative lengths of warp and cloth have been ascertained, the varying diameters of the yarns will cause uneven places, and that the constant change in the humidity of the weaving room will cause a varying amount of shrinkage in the length of yarn between the warp beam and cloth, and consequently a constant change in the tension of the threads. Thick and shady places are also difficult to avoid after unweaving, or when the weft has run out and the cloth has to be let back, owing to the difficulty of drawing back the corresponding length of warp.

A positive let-off motion is constructed by Messrs. Hutchinson, Hollingworth and Co. which will act automatically according to the strain which is being put on the warp, and is to be preferred to the measuring roller type.

In these motions the back rail is fitted in bearings and carefully weighted so as to respond to the tension of the warp. A worm wheel is fixed to the end of the beam, and gears with a worm placed on the end of a rotating shaft which carries a ratchet wheel. Over the ratchet wheel are placed a pair of pawls which are operated alternately by the movement of the lay. A tin shield which partly encircles the ratchet wheel is capable of sliding between the wheel and the pawls and stopping the letting-off action when the tension is too slack. This shield is directly controlled by the sensitive back rail, which responds to the varying tightness of the warp. If the warp is too slack, the bearer moves outward and allows the shield to slide between the wheel and the pawls until the excess of length is taken up and the warp brought to its normal tension. In a motion of this kind made by Messrs. G. Hattersley and Sons, two ratchet wheels are placed on the shaft with the teeth in opposite directions, and the pawls so arranged that one will let off the warp and the other turn it back if required. In this loom the shield puts the turning-back pawl out of gear when letting-off is required, and regulates the let-off to the tension of the warp on the rail; while if the warp is too slack the shield will throw the let-off pawl out of gear and put the turning-back pawl into gear until the excess of warp is drawn back. The advantages obtained from the use of this kind of let-off

motion are that the sensitive bearer being weighted to the required tension, takes up any variation in the tightness of the warp and prevents thick and thin places; and the inconveniences of frictional let-off are avoided.

TAKE-UP MOTIONS.

The object of the take-up motion is to carry the cloth forward a certain distance every time a pick has been inserted, and to coil it round a roller in a manner which will prevent it from being soiled or getting into the way of the weaver. These motions may be either positive or negative in their action according to the class of fabric which is being woven. Positive take-up motions are usually employed when the weft is evenly spun, and where a definite number of picks must be inserted into every inch of cloth; while negative motions are resorted to when the weft yarn is uneven in counts, and a definite weight of cloth has to be produced throughout, irrespective of the number of picks inserted.

In the negative type of take-up motion the cloth is usually held stationary until it is pushed forward by the reed, and a corresponding length of warp drawn off the beam. A weighted bar (Fig. 32) which is attached to the pawl B is raised after every pick by the forward action of the lay C. When the lay moves backward the stalk drops down and causes the pawl to act on the ratchet wheel D, which draws forward the slackened fabric by the action of the worm E upon the worm wheel F which is fixed to the end of the cloth roller G. The weights which govern both the pawl and the warp beam must be varied from time to time in order to ensure a regular weight of fabric. The reason for this is that as the cloth is coiled round the roller the diameter becomes greater, and causes the power which is exerted by the weights upon the pawl to be proportionately diminished, with the result that the number of picks per inch is gradually increased. At the same time, every revolution of the warp beam reduces its diameter, makes it less able to overcome the resistance of the friction let-off motion, and renders the cloth more difficult to draw forward. As a consequence the tension of the warp must be reduced as the weights on the take-up motion are increased, or the warp will be broken by the increased strain. The changes must also be slight, and made at frequent intervals, or the quality of the cloth

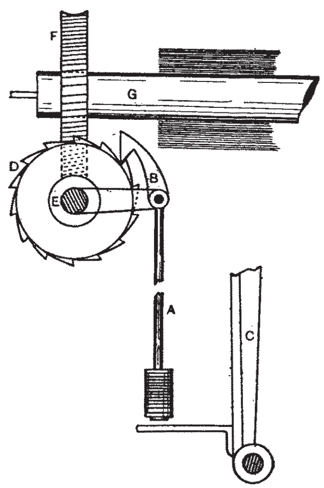


FIG. 32.

will be irregular. When the let-off motion is of the semi-positive or sensitive bearer type, constant attention need only be given to the weighting of the take-up motion, as the let-off will always respond to the tension put upon the warp by the speed of the take-up motion.

A positive take-up motion, whether of the continuous or intermittent type, aims at carrying the cloth forward at the same pace from start to finish, irrespective of either the counts of yarn, the beating up of the cloth, or the tension of the warp yarn; and at regulating the pace to suit the number of

picks required in the cloth. An excellent feature of the continuous motion is that when the loom is run backward for the purpose of finding the pick, or for unweaving wrong places, etc., the cloth is unwound from the roller and placed in the right position for restarting the loom when the proper pick has been found, or the spoiled picks withdrawn. The direct and continuous action of the driving power upon the train of wheels prevents slipping, and leaves the motion few opportunities for producing thick and thin places in the fabric. It is very valuable for heavy woollen and worsted goods where the yarns are of an elastic character, but is not so advantageous for weaving fine, tender warps, owing to the strain upon the threads being increased simultaneously by the shedding and take-up motions. It is not so readily adapted to the requirements of extra weft spotting and cramming as the intermittent type.

This latter type of take-up motion consists of a train of wheels which receive their motion from the swinging action of the lay through the medium of a pawl or pushing catch. The pawl represents both the strength and weakness of this type of motion. The advantage consists in the ease with which it can be connected to the shedding mechanism, and the accuracy with which it can be put in and out of gear with the ratchet wheel when intermittent spot figures, cross-overs, or fancy checked patterns have to be woven.

An easy method of connecting the take-up and shedding motions for this class of work is shown at Fig. 33. The pushing catch A, which acts upon the ratchet wheel B, is provided with an additional short arm C which can be attached to the short arm of the horizontal lever D by means of a connecting wire. The lever D is fulcrumed upon a suitable stud fixed to the loom frame, and has its longer arm connected by a cord E to a convenient heald lever of the dobby, or hook of the jacquard; so that when an extra pick has to be inserted the pushing catch can be lifted out of gear with the ratchet wheel, and the cloth left stationary. This cramming action is rendered more easy of accomplishment by the positions in which the swing lever F is fulcrumed, and the catch A connected to it.

The arrangement allows the shed to be formed and the connecting cord operated when the catch A is being moved backward free from the pressure of the ratchet wheel. The catch is therefore raised out of gear when the extra pick is put in, and is prevented from taking into the ratchet wheel when the pick is beaten up. If the positions of the fulcrum and catch

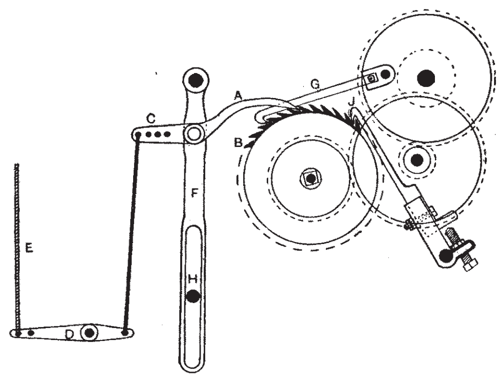


FIG. 33.

connection were reversed, the catch would have to be drawn out of gear with the ratchet wheel when in the action of taking forward the cloth, and the cramming would be caused by the ratchet wheel springing backward to the holding catch G. Even when ordinary cloths are being woven, the swing lever should be fulcrumed as shown in Fig. 33 because by this means the cloth is taken forward as the shed closes—*i.e.*, when the warp threads have the least strain upon them. Exception must, however, be taken to this rule in looms where the take-up motion contains seven wheels in place of five, because in that case the teeth of the ratchet wheel would be turned in the opposite direction, and the wheel would require to be drawn forward with a hooked pawl

instead of being pushed over in the ordinary way. This reversed direction of the movement of the ratchet wheel will require the catch to be attached to the top of the swing lever, and the fulcrum to be placed about 3in. below the catch, if the forward motion of the cloth has to coincide with the closing of the shed.

Thick, thin, and shady places are the faults which usually arise from this class of take-up motion, and are mostly due to irregularity in the action of the ratchet wheel, caused by the improper adjustment of the pushing catch. The finger H, which transmits the motion from the lay to the swing lever, should be set so as to allow the catch to drop over a tooth of the ratchet wheel when the cranks are at their back centres, and to take one tooth forward at each stroke of the lay; while the holding catch must be fixed to clear a tooth by about $\frac{1}{8}$in. when the cranks are at the front centres. In order to avoid thick places it is necessary that sufficient clearance should be given to allow the catches to drop firmly on to the ratchet wheel, that the tension should be sufficient to cause the ratchet wheel to spring back into touch with the holding catch as the pushing catch moves outward, and that the finger H should be kept in good condition, because when it gets worn down there is too much play, and the catch does not always travel the required distance. On the other hand, too much traverse, combined with any slackness of the finger H or any irregularity in the ratchet wheel, would cause the catch occasionally to take two teeth and produce thin places.

When cloths are lightly picked and change wheels with the proper number of teeth are not at hand, the pushing catch is sometimes made to take two teeth at each forward movement of the lay by raising the position of the finger H nearer to the top of the slot in the swing lever, and reducing the teeth in the change wheel by one-half. The slip catch J should be so adjusted that when the pushing and holding catches are lifted out of gear with the ratchet wheel on the loom being stopped by the action of the weft fork upon the pistol lever, the cloth can run back the distance of 2 or 3 picks which the loom has run without weft.

The cloth beam should be weighted sufficiently to keep it in contact with the take-up beam; while for heavy goods the pressure should also help the smoothing rod to prevent the take-up beam from slipping forward without taking the cloth along with it. The position of the smoother has a very material influence on the slipping action, as it can be adjusted in a manner which will keep the cloth in contact with the take-up beam for from $\frac{3}{8}$ to $\frac{3}{4}$ of its circumference.

The method of altering the number of picks per inch varies in different looms. When the change wheel is a driver, an increase in the number of teeth in the wheel reduces the number of picks per inch in the cloth, and *vice-versa*; while if a driven wheel has to be changed the teeth and picks will vary in relative proportions, and in most cases the teeth in the wheel will be made to correspond with the picks per inch, per $\frac{1}{2}$ inch, or other unit of measurement.

When the change wheel is a driver, it is usual for the tuner to be supplied either with the number of teeth required in the wheel, or with the number of picks required and the gauge point from which he can readily ascertain the number of teeth required in the wheel, by dividing one into the other. If the gauge point is not known it may be easily found by the following formula:—

$$\frac{\begin{array}{c}\text{Teeth in}\\\text{Ratchet Wheel}\end{array}\times\begin{array}{c}\text{Teeth in}\\\text{Stud Pinion}\end{array}\times\begin{array}{c}\text{Teeth in}\\\text{Beam Wheel}\end{array}}{\begin{array}{c}\text{Teeth in}\\\text{Stud Wheel}\end{array}\times\begin{array}{c}\text{Circumference of take}\\\text{up Beam in }\frac{1}{4}\text{ inches}\end{array}}=\begin{array}{c}\text{Wheel required to}\\\text{give 1 pick per }\frac{1}{4}''\end{array}$$

In weaving most cloths it will be found that there are more picks per inch on the table than in the loom, and many manufacturers will, therefore, add a 10th, a 12th, a 20th, etc., to the gauge point in order to give the required number of picks on the table; while others will give a slightly less number of picks to the tuner than is required in the piece on the table.

The difference will be decided by the amount of shrinkage which experience has shown takes place in the different types of cloth.

CHAPTER VIII.

SELVAGES.

The importance of good regular selvages cannot be too strongly insisted upon by the manufacturer. There are few things which will injure the prospects of future business more than the delivery of a number of pieces with irregular, curly, fringed and rolling edges; while a good even edge will give the piece a nice appearance and produce a good impression. The production of a proper edge will also have a good influence on the weaving qualities of the warp, and will help to impress upon the weaver the necessity of careful and perfect work throughout.

In most cases it is advisable either to make the edge of a different count, colour, or weave to the body of the cloth. When a cloth is made with a fine single-twist warp yarn, or with a weave or weft yarn which will cause the cloth to be considerably narrower than the warp is set in the reed, it is necessary to use a good two-fold yarn for the edges, as it will more easily withstand the friction of the reed and the tension of beating-up. The two-fold yarn should not, however, be too thick, or too finely set, or the edges will be clumsy. In many instances the edges are made strong enough to overcome the friction of the reed and the tension of beating-up by putting double threads in a few of the outer mails. This can, however, only be adopted when the yarns are of fairly strong and thick counts. When double or two-fold threads are introduced into the edges of cloths which are woven with fine weft yarns, a fringed or unequal edge is often formed, owing to the yarn which is being drawn from the nose of the cop, pirn or spool not having sufficient tension to draw the thick edging yarn as near to the body of the cloth as when the weft is being drawn from the base. This difficulty will be most easily overcome by placing brushes in the eye of the shuttle, and timing the shed to be fully open when picking takes place. Unevenness of denting and missing threads always produce a poor and unseemly selvage.

The colour of the selvage may be different from the body of the cloth either for the purpose of ornamentation, or for the purpose of distinguishing between the two; while they may be either woven in the same pattern as the body of the cloth or in a different weave. When the edges are woven in a different pattern from that of the body of the cloth, the object is either to enable a clear distinction to be made between them, as when plain edges are woven on satin cloths, or to prevent the weft from being drawn back by the returning shuttle as in repp, matt, and other weaves which put two or more picks into the same shed, or in figured fabrics which would allow the weft to be carried back to the point where the threads are making the ground weave.

PLAIN AND TWILL SELVAGES.

In jacquard looms, plain, repp, or twill selvages may be easily produced on any type of ground cloth by passing special harness cords through small adjustable comber-boards, which can be fastened to the ordinary comber-board, and actuating them by means of special hooks fixed outside the figuring hooks in the jacquard machine. It is usual to cut holes in the pattern cards to lift the edging harness at every pick, and then peg the holes in the card cylinder to weave plain, repp, or twill, as desired. To make the selvage perfectly plain, the supplementary harness need only be placed in front of the comber-board, and the front edge hooks of the jacquard operated alternately. The repp edge may be woven in a similar manner with the addition of catch threads at each side actuated by harness cords attached to the back edge hooks of the machine. A twilled edge will, however, require the supplementary harness to be placed both in front and behind the comber-board, and the threads drawn into them according to the order of lifting adopted for the edging hooks.

In dobby looms the simplest and most economical method is to employ special selvage healds, and actuate them by means of hooks set aside for the purpose. When the pattern of the cloth requires all the hooks, the plain selvage may be formed by attaching cords to the ends of the draw-knives outside the dobby frame work, passing them over friction bowls, and connecting them to the special healds through which the selvage threads are drawn. In order to produce matt edges upon 2-and-2 twilled cloth, the easiest method is to draft the threads in pairs through two of the healds which work opposite to each other. The same healds should not be used for both selvages, or a catch end will be required to prevent the weft being drawn up to the ground of the cloth by the returning shuttle, and one of the edges left unwoven. This catch thread will not be necessary if the threads of one selvage are drawn through healds 1 and 3, and through healds 2 and 4 for the opposite selvage, as the sheds can be crossed at both edges before the shuttle is returned to the opposite end of the loom.

When plain or approximately plain edges are required on twill or satin cloths, numerous devices are employed to produce an apparently plain selvage without resorting to the use of special healds. This is notably the case when the cloths are woven in tappet looms, because the use of special healds would necessitate the use of two sets of tappets running at different speeds, fixed on different parts of the loom, and actuated by two separate sets of gearing. If the edge healds can be worked without special tappets, by connecting them to some other part of the loom which will allow the necessary motion to be obtained in a ready manner, it is advisable that the manufacturer should take advantage of these means rather than produce an imperfect edge. When this cannot be done a common method is to use what is often termed a "boat," by means of which a selvage either plain or sufficiently near to plain to serve the purpose can easily be obtained. The conditions necessary to produce a plain edge by this method are that the healds shall not remain up

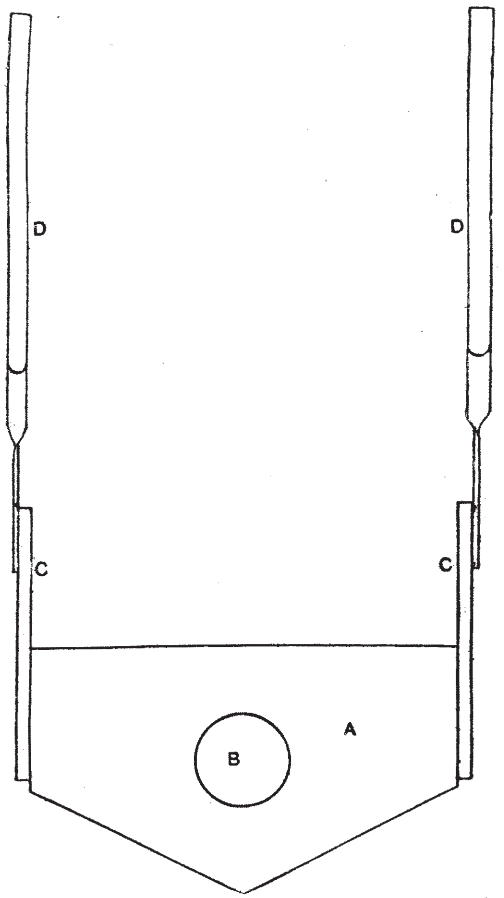


FIG. 34.

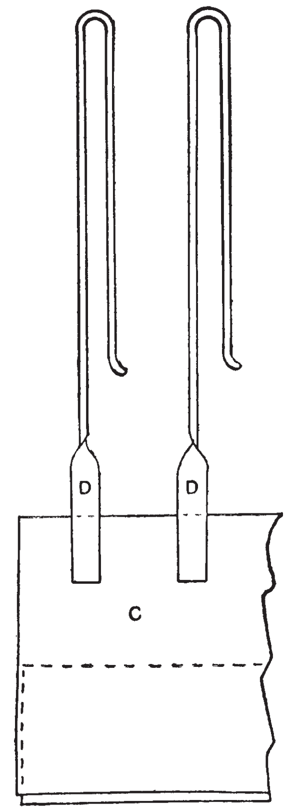


FIG. 34.

for more than one pick at a time, and that an even number of healds shall be employed. A "boat" consists of a piece of wood A, Fig. 34, about 2in. long, with a hole B bored through it large enough to fit on to pieces of iron about $\frac{1}{2}$in. thick, which are fixed to the framework of the loom. These support the " boats," and act as a fulcrum on which the " boat " can rock. Two pieces of leather C are nailed to the front and back of each " boat," and through these a series of hooked wires D are riveted.

If a plain selvage had to be formed on the four end twill shown at A, Fig. 35, the odd selvage threads would be passed under the hooked wires on the front side of the " boat " and through the loops (above the mails) of healds 1 and 3 ; while the even threads would be passed under the wires on the back side of the " boat," and through the loops of healds 2 and 4. When either of the odd healds are lifted, it will raise all the threads which are passed through its loop, draw up the side of the " boat " through which the odd threads are passed, and depress the opposite side, with the result that the even threads which have been raised for the previous pick will be drawn down

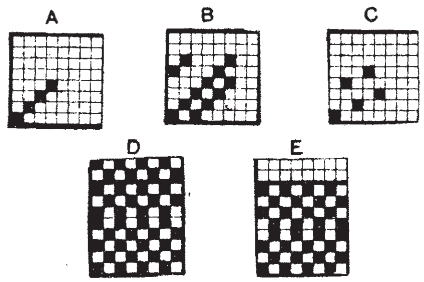


FIG. 35.

by the rocking of the " boat." To ensure that the threads which are not being lifted by the heald reach the shuttle race, the " boat " is fixed 2 to 3in. below the warp line, about midway between the bearer and the crank shaft. The reason why the threads are drawn through the top loop of the heald instead of through the mail, is that by this method the threads can be lifted by either of the healds as desired.

To make a plain selvage when the ground cloth is woven with the twill shown at B, Fig. 35, the odd

threads would be passed under the wires on the front side of the " boat " and through the loops of the odd healds ; while the even threads would be passed through the opposite set of wires and healds. For the five shaft satin weave shown at C, Fig. 35, the odd threads would be passed under the front series of wires and through the loops of the 1st, 4th, and 5th healds ; and the even threads under the back series of wires and through the loops of the 2nd and 3rd healds. The edge in this case would not be perfectly plain, but would be sufficiently near to serve the purpose, as shown at D, Fig. 35, where it will be seen that a double pick occurs at every round of the pattern owing to the odd threads being lifted by the 4th and 1st healds successively.

It is necessary when weaving semi-plain selvages of five or any odd number of healds to put catch ends through the mails of the two healds which form the double pick in order to prevent the picks which go into the same shed from being withdrawn at every alternate repeat by the returning shuttle. If the catch threads are omitted the double picks are drawn up to the body of the cloth, and the pattern of the edge would correspond with E, Fig. 35.

TEMPLES IN RELATION TO THE SELVAGES.

In weaving cloths where the weft yarn possesses great shrinking properties, or where the thickness or tension of the warp causes the weft to be bent considerably out of the straight line, there is a distinct difference between the width of the piece and the warp in the reed. Under normal conditions this difference in width will have a bad influence on the weaving qualities of the warp, especially near the edges, while the reed will also suffer from the extra side strain of the warp. The easiest method of overcoming this difficulty is the use of some kind of temple which will keep the cloth extended to the width of the warp in the reed for a short distance, and prevent the shrinking property from affecting the weaving qualities of the warp.

The greatest care should, however, be exercised in the selection of the temple for different classes of cloth. Broadly speaking, temples are made on the roller, the ring, and the star principles. Roller temples may have one, two, or three rollers arranged in suitable troughs. They are chiefly used for weaving light and medium fabrics that only need to be kept from shrinking, and in which temple pin marks must be carefully avoided. The number of rollers employed will depend upon the space between the breast beam and the reed, and upon the amount of power exercised by the contraction of the cloth.

Ring temples may consist either of a single ring with from three to five rows of pins, or of several rings with one row of pins each revolving round a fixed stud or spindle. Single ring temples are intended to act upon the selvage only, and are used for fabrics in which the threads would be drawn out of position if the pins entered the body of the cloth. Temples which contain several rings are used when the cloth requires a large amount of holding, and where the cloth is either set fine enough to prevent temple marks, or where the marks will be obliterated in the finishing process. When the cloth needs to be distended, inclined rings are used which will draw out the cloth to the actual width of the warp in the reed. These inclined rings may also be made to give an even tension instead of extending the cloth, and to gradually release the tension upon it by altering the position of the stud, and inclining the rings at a different angle. When arranged in this manner the temple marks are not so pronounced in the cloth.

Star temples are large horizontal rings with three or four rows of pins, and are used for fine goods, and only take hold of the selvages. This temple has good holding powers owing to the way in which the cloth is guided on to the pins. It also allows the whole of the cloth to be in sight of the weaver. The chief drawback to all temples which only take hold of the selvages is that the cloth is difficult to adjust after unweaving.

Temples should be supported in such a manner that they can be readily adjusted to the width of

the cloth which is being woven, so that they can be easily pushed back either when the shuttle is caught between the reed and the face of the temple, or when the weaver desires to inspect the cloth which is hidden by the cover; and so that they can be set to the required distance from the fell of the cloth. Care should be taken to avoid bending the temple pins, or the weft will be drawn out of the cloth and form little curls under the cloth. The pin pricks caused by the pins of the rollers striking too deeply into the cloth may be avoided by winding weft yarn evenly around the rollers so as to shorten the length of the pin available.

A method of making the rollers without pins and covering them with india-rubber tubing has been patented and successfully applied to the weaving of fine, light fabrics which are especially sensitive to temple marks by Mr. A. Wilson, of Waterloo Mills, Silsden.

CENTRE SELVAGES.

When two or more narrow pieces have to be woven side by side in a wide loom, it is necessary to make a selvage on each side of the respective pieces, and to leave a narrow space between the adjoining selvages in order to allow the pieces to be separated without cutting the warp threads. Cloths that have to be milled during the finishing process only require the edges to be plain, matt, or twill as desired, and three or more dents left empty; as the milling process will entangle the fibres and prevent the threads from fraying when the pieces are severed.

When cloths are woven with worsted, cotton, or silk wefts, however, they require the selvage threads which come next to the empty dents to be twisted or partly twisted round each other in order to keep them intact. This method, though inferior to a true edge formed by doubling the weft back into the cloth by the returning shuttle, is nevertheless very serviceable and extensively used in weaving split fabrics.

There are so large a number of appliances on the market for producing centre selvages of this type, each of which has its advantages and disadvantages, that it would be unwise to select one or two for special notice in this work. I shall, therefore, lay down the underlying principles involved in making this class of selvage motion, and deal with a few of the methods of working, the mechanism for which can be readily made and fitted up by the tuner himself. The simplest plan for plain cloths is to take a loop of worsted heald yarn with a smooth pendant mail, or better still, a small glass bead threaded on to it, and attach it to the top ridge band of the front heald. The crossing thread is first drawn through the mail of the back heald, and then through the bead; and the stationary thread passed over the crossing thread

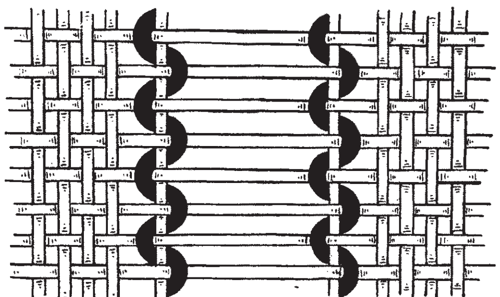


Fig. 36.

between the back heald and the bead. The stationary thread is always under the pick, but is bound to the cloth by the crossing thread, which lifts up one side of it when the back heald is raised, owing to the loop of worsted heald yarn being long enough to allow the bead to be drawn under the stationary thread until the crossing thread is lifted to one-half of the depth of the ordinary shed. Then it is drawn up the other side when the front heald is raised, owing to the bead dragging the crossing thread back to the opposite side of the stationary thread, as shown in Fig. 36. The centre selvage threads are kept on a level with the lay by being passed through suitable guide wires placed behind the healds below the warp line.

The position of the guide wires should be such that the threads will be at the same angle between the back heald and the guide wires as that of the warp between the back heald and the bead when the bead is lifted. This prevents the warp from being broken by the acute angle formed between the heald and bead.

The chief disadvantages of this method of working are that the crossing threads never make a shed more than one-half of the depth of that formed by the healds; that unless the length of the worsted heald yarn which supports the bead is accurately adjusted,

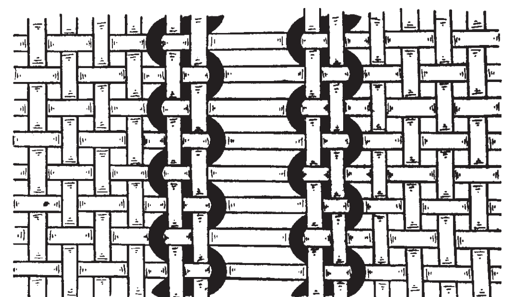


Fig. 37.

one of the sheds will be less than half the size of the other, and will therefore render the threads liable to be broken by the shuttle or passed over altogether, and a loose place caused in the selvage; that the friction upon the stationary threads caused by the leash passing from side to side is excessive, and results in frequent breakages both of threads and leashes; and that when either of these breakages takes place both the crossing and stationary threads weave loose. In some cases this latter fault is remedied by substituting two plain threads for the stationary thread as shown at Fig. 37, where the crossing thread would be drawn through the back heald and the bead, and the two intervening threads, drawn one through the first heald and the other through the back heald, passed over it. With this method it is only necessary to take the crossing threads through the guide wire behind the healds.

It is advisable, when more than one ground thread has to be bound in by the crossing thread, to have the latter wound on to a large bobbin, which can be separately tensioned to allow for the extra take-up, and to prevent excessive strain and breakage of the selvage threads; also to draw the crossing threads through a guide placed behind the healds and below the warp line, in order to get the same tension on to the crossing thread when it is lifted by the leash as when it is lifted by the back heald. The tension should not, however, be too slack, or the selvage will lack firmness.

Either of these methods will give satisfactory results when applied to plain cloths, and are exceedingly useful to the manufacturer who only requires to make split cloths occasionally, as they can be applied at little cost. When twilled or other cloths have to be woven where the lifting of the healds does not lend itself to the working of the crossing threads, or where splits are constantly being woven, it is best to use one or other of the patented mechanisms, the simplest usually being the most efficient.

For single lift jacquard or dobby looms a very simple and efficient method is to fasten three pieces of strong wire A, Fig. 38, into a small piece of comberboard B, and connect them together at the bottom. The guide wires C and D are then inserted into the same board, and the length of the latter adjusted so that the eyes will be on a level with the bottom line of the shed when the board B is fixed to the back of the ordinary comberboard in the jacquard loom, or to a suitable support in the case of a dobby loom. After this the large two-holed mail E is connected to separate hooks or heald jacks by means of the cords F, and to the spring G by the cord H. The stationary threads are then passed through the loops C and the eyes D, and the crossing threads through the holes in the mail E, which is dropped low enough to allow the crossing threads to lift up either side of the wire through which the stationary thread is passed. The

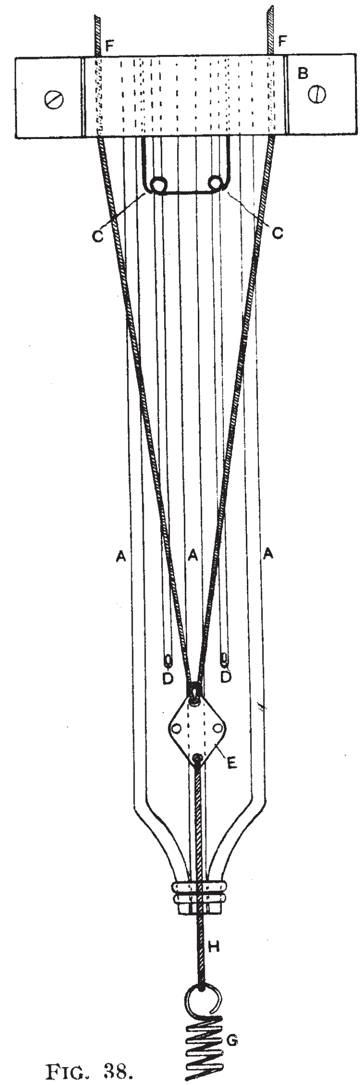


FIG. 38.

direction of the crossing is governed by the lifting of the cords F.

The advantages of this method are that the parts are simple and are not subjected to much wear and tear, and that the friction of the crossing is confined to the threads themselves, so that if these are made of suitable strength there is little difficulty in making a regular and perfect selvage.

A method of working which is easily applied to double lift jacquard looms, and which is similar in principle to that described for plain weaving, is shown in Fig. 39. A small supplementary comberboard, similar to those used for outside selvages, is placed at the part where the split is to be formed. The bulk of the harness cords in this supplementary comberboard are employed to make a plain selvage which will correspond with the outer selvages; while the four centre cords—two from each edging hook—are used to work the crossing threads which make the cut selvages firm. The stationary threads are made to form a line with the shuttle race by being passed through guide wires placed behind the harness, while the crossing threads are passed through small rings which are fixed in the centre of flexible chains, the ends of which are fastened to harness cords from separate hooks. The chains are adjusted to allow the ring to be exactly underneath the stationary thread when the rising and falling sheds are level with each other, so that the crossing thread will be lifted to one-half the depth of the ordinary shed by first one cord and then the other.

When chains are not at hand it is common to place two beads on each crossing thread, and to connect one bead to the back row of cords and the other to the front row by means of a loop of worsted heald yarn, and then pass the stationary thread over the crossing thread between the two loops. This arrangement will give the same kind of selvage as the chains, if it is adjusted in a similar manner; but it is more likely to cause faulty places, as the worsted heald yarn is constantly wearing out owing to the friction which arises from passing from side to side of the stationary thread.

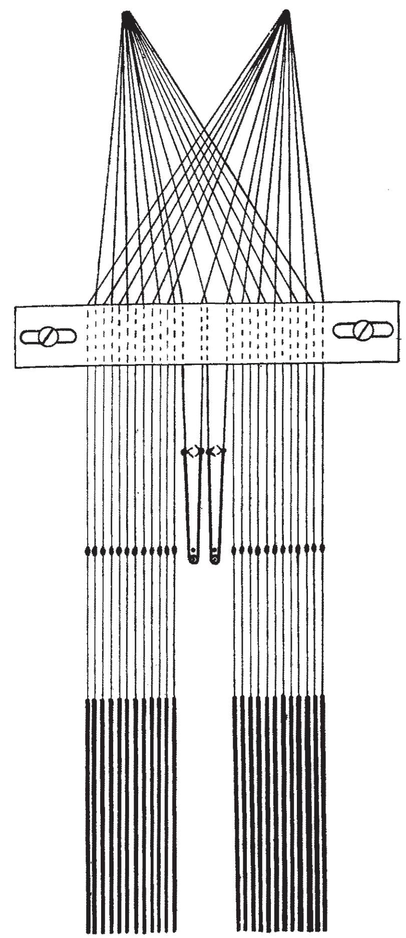


FIG. 39

CHAPTER IX.

DRIVING THE LOOM.

There are two methods of driving looms, the ordinary fast and loose pulleys, where the belt is guided from one to the other, and the friction clutch pulleys. The fast and loose pulleys are the best for light and medium looms, as they are the least expensive and much the easier to keep in repair. In the friction clutch type the loose pulley, which is constantly revolved by the belt, has the inner side of the flange bored out to fit on to a cone-shaped leather-covered pulley which is fastened to the driving shaft of the loom. The loose pulley is governed by the starting handle, and can be pushed in and out of contact with the fast pulley, as desired. The advantage of this kind of driving motion for heavy looms is that the full power and speed are attained immediately the pulleys are brought into contact, and there is therefore no necessity to pick hard in order to prevent the loom knocking-off at the first pick, nor for the weaver to help the loom forward to prevent this fault. It is also of advantage where short belts are used, as there is sometimes a difficulty in guiding a short and necessarily tight belt from the loose to the fast pulley quick enough to start the loom with a good pick.

The leather covering of the cone pulley, the neck of the loose pulley, and the traverse given to the loose pulley by the starting handle, should have regular and careful attention, because if these are not true the drive will be jerky, and there will be a tendency for the surfaces to touch and move the loom when it ought to be at rest for the purpose of repairing the threads or of changing the shuttles.

THE SPEED OF THE LOOM.

The speed of the loom naturally governs the amount of the production, but the greatest output is not always obtained by the fastest running loom. If a quick running loom causes more breakage, either of loom parts or warp threads, than a slower running loom, the latter will have the best record. If, however, a loom is properly constructed, there should be scarcely any limit to the speed attainable except that imposed by the class of material which is to be woven ; and a wise tuner will not hesitate to change the speed of his looms to meet the requirements of the warps, as by so doing he will both lessen the work of the weavers and increase the output of his looms.

In order to get the size of pulley required to give a required number of picks per minute the following formula should be used :—

$$\frac{\text{Speed of line shaft} \times \text{diameter of drum}}{\text{Required speed of loom}} = \text{Diameter of loom pulley}$$

There will, however, always be a certain amount of difference between the calculation and actual speeds owing to the slipping of the belt on the drum and pulley.

When the belt is made to work with its full width on the pulley the amount of loss should only be small ; but when it is run with only half its width on the pulley the loss will be considerable. In addition to the loss of power and speed which result from having the belts only partly on the pulley, there is a tendency for the loom to run unevenly, especially when patterns are woven which are irregular in lift, *i.e.*, where more threads are up for one pick than another. It is much better to run the loom with large pulleys and the belt fully on the face of the fast one than to only get the same speed from small pulleys with part of the belt in use. In arranging the looms in a shed it is advisable to place those which are heaviest and need most driving nearest to the main driving shaft, as this not only results in the looms running steadier, but saves a large amount of wear and tear on the shafts and bearings.

THE CARE OF BELTS.

In a loom where the various motions are of a more or less intermittent character, the belts should have greater care given to them than is usually the case; because unevenness of drive will seriously affect the working. The efficiency of a belt will depend upon how closely it hugs the pulley and excludes the air from between them; the size of the pulley and the pliability of the belt; the tightness or slackness of the same; and the nature of the belt fastenings.

To get a good grip the pulley should be smooth, and the belt put on with the smooth or skin side to the pulley, as this excludes the air and allows it to adhere closer than when the belt is put on with the flesh side to the pulley. A great amount of slippage takes place when the pulleys are small, and when the belt has become hard and dry and is of an impliable nature; and more speed will often be obtained by a larger pulley and a wide thin belt which will readily bend to the required curve. The pliability of the belt is of sufficient importance to warrant the use of a good belt composition at intervals. This should not, however, be of such a nature as to give a sticky surface which will gather dust or dirt, but fill the pores and render it smooth and pliable. Soap and resin should be avoided, and the weavers prevented from using them, for though they are efficacious for a short time, they serve to catch dust and dirt, which become glazed, and require to be scraped off or the belt loses its adhesiveness.

A belt should only be made tight enough to start the loom without difficulty, because when a belt is made too tight it sets up a large amount of wear and tear in the bearings of the line and crankshafts, and results in a great amount of power being lost in overcoming the extra friction. When belts are laced—especially if the laces are crossed on the underside—an uneven ridge or surface is formed which prevents the belt at that point from hugging the pulley as closely as the rest of the belt. This causes a slight loss of effectiveness, which is often sufficient in high-speed looms to cause knocking-off. A better way, which causes no unevenness, and one which does not need as many repairs, is to cut the ends square, bring them as closely together as possible, and fasten them by means of a curved malleable-iron belt hook. If one side of the belt is made tighter than the other, or if the loom shaft is not parallel with the line shaft, the belt will be liable to run off. The ends of the joints in a cemented joining should be run with the pulleys and not against them, or the ends will soon be torn up and the belt broken.

When the pulleys are changed the amount put into or taken out of the belt should be $1\frac{1}{2}$ times the difference in the size of the pulleys. In changing from 12in. to 10in. pulleys, $12 - 10 = 2 \times 1\frac{1}{2} = 3$in. of belt should be taken out. If the loose and fast pulleys are not of the same size, or if the loose pulley has considerable play on the shaft, the belt is often turned when the loom is started, by the belt fork pushing the belt suddenly against the side of the fast pulley. This is especially the case when the guide fork is placed very near to the pulleys.

THE FRICTION STOP BRAKE.

A considerable amount of time is lost by the weaver when the loom stops with the shuttle at the opposite side to the starting handle, both in changing the shuttle and in finding the pick. In order to avoid this, a suitably weighted brake lever is suspended from a three-armed lever which rests upon the pistol lever, and one arm of which projects behind the starting handle. When the loom is started the brake is lifted out of contact with the brake wheel, but when the weft fork mechanism draws back the pistol lever the starting handle is displaced and the brake lever dropped. The length of the drop and the weight on the lever should be adjusted to bring the loom to a stand with the shuttle at the right end of the loom and the cranks at their back centres.

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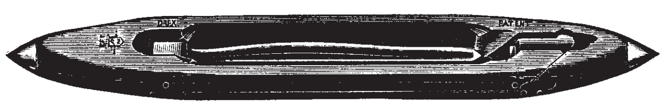

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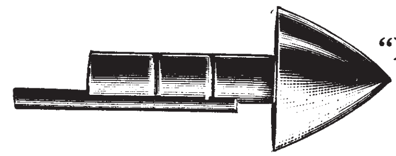

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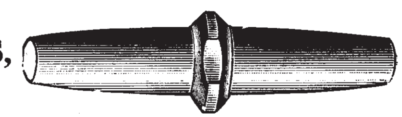
 **PINS,** 

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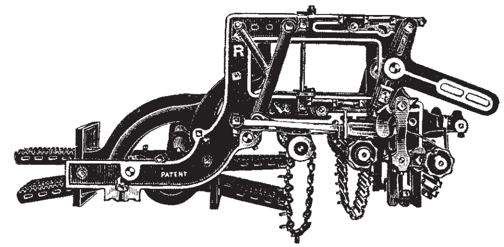

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