change, it has been customary to argue that it was one of the objects aimed at.

The actual travel of the pin with any given crank and arm and for any portion of the crank's revolution can be calculated from the formula already given; but it can also be readily shown graphically by a diagram such as Fig. 196, which is introduced to demonstrate principally the reduction in the velocity of the pin, or, in other words, the decrease of its travel for a given movement by the crank when approaching the full back position, which is due to the shortening of the arm. Let the line A B represent a connecting arm 12 ins. long, B C a crank of 3-in. radius; C 1 to C 6 six further positions of the crank B C, with 30 degrees interval between each; and A D the travel of the connecting pin $3 \times 2 = 6$ ins. By taking a radius of 12 ins. (the length of the arm), and the points 1 to 5, as centres in succession, the position of the connecting pin on the line A D when the crank is in these positions can at once be determined. Then, by taking the points on the line A D as centres, their respective positions can be readily transferred to the diameter line B 6 of the crank circle, and from there projected to the parallel line H. In a similar manner let E B represent a connecting arm 8 ins. long, B C the crank radius, and C 7 to C 6 other six positions of the crank of 30 degrees interval; while E F is the travel of the pin (6 ins.) actuated by the reduced connecting arm. By a process similar to that just stated, the new positions of the pin on the diameter B 6 of the crank circle are again found and projected to the parallel line I. The line G, as will be seen, contains the positions due to an arm of infinite length or a true harmonic motion. By a comparison of the three lines G, H, and I, the effect, first of the connecting arm of finite length, and then that of the short or reduced arm, is

at once obvious. From a careful measurement of actual-size drawings, and also by calculation, it is found that the difference or reduction in the travel of the pin, for 120 degrees of the crank's revolution, from point 10 to point 4 in the direction of the arrow, due to the introduction of the 8-in. arm as compared with the 12-in. arm, is 0·3 in. We have further projected each point on the three parallel lines to a scale of inches in order that the travel of the pin for any period represented may be roughly approximated.

Before leaving the question of beating up, it may be well to draw attention to the bad effects resulting from the reed being allowed to pass the vertical plane of the rocking shaft too far when full forward. In ordinary circumstances, where no reduced connecting arm has been introduced (and, as already stated, looms are to-day working satisfactorily with connecting arms and cranks of the same dimensions in looms of all widths up to 130-in. reed space), it is usual to find the reed at least 2 to 3 ins. in front of the connecting pin, with the latter, say, 2 ins. behind the vertical plane of the rocking shaft when the reed and the cloth are in contact. Even with these conditions obtaining, it is evident that the reed will pass the vertical plane of the rocking shaft by about 1 in., and begin to fall slightly when full forward. Here, however, the fall is so slight that no evil effects result. It is not unusual, however, especially in looms where the position of the rocking shaft is adjustable, to find it so placed that it is in the same vertical plane as the connecting pin when the latter is full forward and the reed therefore 2 to 3 ins. in front. Here it is evident that the reed will fall considerably before reaching the full forward position, and instead of meeting the cloth at a little less than a right angle, the two form a comparatively acute angle. Now in all looms, and more particularly in looms where the shedding is performed by a single-lift jacquard, the cloth and the warp threads form a gentle decline from the breast beam to the harness when beating up takes place. But the reed and the weft are in contact when the former has yet approximately 2 ins. to travel forward, while the latter has to travel up an inclined plane; and it is evident that the weft will be most gently treated if actuated by a body moving in the same plane as itself—*i.e.*, by a body moving in the straight line formed by the warp. Seeing that the reed is travelling in the arc of a circle, it is obvious that it is impossible to arrange this absolutely correctly; but a sufficiently near approximation to this movement is obtained when the position of the rocking shaft is so arranged that the reed in its forward movement is not allowed to fall. Where it is allowed to pass the vertical plane of the rocking shaft for any considerable distance, the reed, while moving the weft up an inclined plane, is itself actually falling, and in so doing is acting like a knife upon the weft. Further, due to the inclination at which the reed now is when it reaches the cloth, it presses on the cloth from above and causes the latter to run down the reed and to accentuate the objection referred to.

On page 361 we drew attention to the fact that the race of the lay should not be allowed to dip forward at any time, and suggested, as a means of preventing this, that the race should be made level when full forward. It will be observed that in the accompanying Fig. 190 this condition has been observed—the reed is inclined slightly towards the race, and the angle contained between the race and the reed is approximately 87 degrees. This condition of things is the most satisfactory for all classes of leaf work (dobby and tappet looms) where the leaves, as

they recede from the fell of the cloth, have an increased travel or "shed" imparted to them, and so preserve the angle of the under-shed line. In damask or harness weaving, however, the harness is almost invariably mounted so that the mails will be on a dead level from the front to the back when in their lowest position, and it is evident that the warp threads from the front mails and those from the back mails will form different angles with the horizontal. The average angle thus formed is a little less than in the case of leaf work, and on this account it will be found that the same inclination of the race of the lay will will not be suitable in both cases. In some districts the difficulty is overcome by drawing back the rocking shaft until the race of the lay is tilted forward to the proper inclination; but this results in the objectionable falling of the reed when beating up. The angle of the race ought to be corrected, not by interfering with the position of the rocking shaft or with the inclination of the reed, but rather by simply altering the race of the lay itself. By doing so the angle between the race and the reed is increased until an angle of approximately 92 degrees is reached.

Although we shall now begin to treat of what might be called the subsidiary or secondary movements of the power loom, it must not be concluded that the three primary motions have in any way been exhausted, or that the last word has by any means been said about the principles underlying the present method adopted for picking and for beating up. In picking, when due attention is paid by loom-makers to the proper formation of the picking wypers, and by tenters to their adjustment, we have in the cone overpick a motion that, although negative in principle, gives comparatively little trouble to the tenter, and, relatively, is productive of but a minimum expenditure of power. In certain districts, however, we find that wypers are still being made of a most absurd and antiquated form, and tenters are sometimes left with little option in the matter of their adjustment.

In beating up—or, rather, in the method of actuating the lay—it is the exception to find any departure from the standard cranked shaft and connecting arm, this arrangement being in use in its usual form in looms of at least 200-in. reed space. There are several devices—one or other of which is occasionally resorted to in looms of exceptional width—employed in order to produce a more protracted movement on the part of the lay while the shuttle is passing from box to box than would be obtained by the ordinary method. One of the simplest, and probably the most common, of these devices is the use of elliptical and eccentrically-set wheels, the driving one of which is so geared with the driven one (which is fast on the crankshaft) that the speed of the latter wheel, and therefore of the shaft, varies during one revolution, being slow while passing round the back centres, and quick while passing round the front centres. A further advantage of this reduction of the speed of the crank shaft at the proper moment is that in the case of the shed being formed by a crank on the crank or wyper shafts, a corresponding reduction of motion will be imparted to the movement of the shed at the same time. In shedding mechanisms we think those types have been treated which are usually met with in the weaving industry.

In special types of looms, such as those for weaving Brussels and Wilton carpets, certain kinds of hose-piping, etc., it has been found advisable to give a double beat of the lay and reed to every shot of weft, and the necessary modification of parts for this purpose as applied to looms

for Brussels and Wilton carpet-weaving is illustrated in Fig. 197. The crank A rotates as usual around the centre

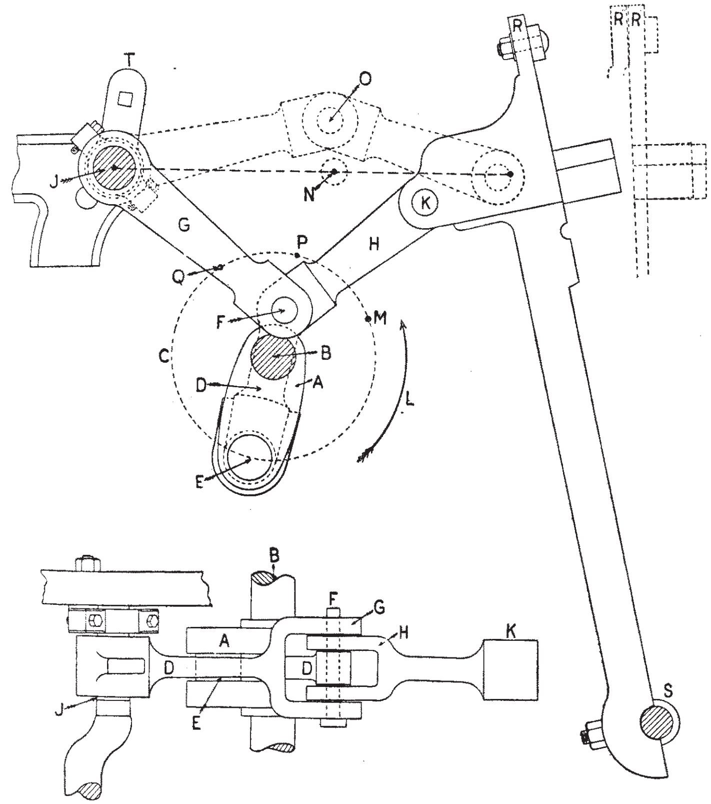


Fig. 197.

of the crankshaft B, and describes a path C as shown by the dotted circle. The usual strap, gib and cotter are employed to attach the connecting arm D to the crank arm A at E, while at the other end of the connecting arm E a pin F passes through E and also through the forked ends of connecting arms G and H. The opposite ends of G and H are fulcrumed respectively on a fixed centre at J, and on the sword pin K. The direction of motion is indicated by the arrow L. When the centre of crank arm E reaches the point M, the arms G and H are in one straight line, with the pin F at point N; the reed will therefore be in contact with the cloth. Further rotation of centre E beyond point M results in point F being raised from point N to a maximum height at O, at which time point E will have reached P. The crank arm continues to rotate, and when the crank E reaches Q, the two arms G and H will again appear in the same straight line with the reed touching the cloth. As the crank E moves from M to P, the reed recedes about $\frac{3}{4}''$ from the cloth, and then comes to again, the top R of the sword, during the oscillation of the latter about S, moving back from R′ to R″, and then forward again to R′. From the position of the parts it will be seen that the double beat is obtained by a minimum movement of the reed, thereby imparting the least possible amount of friction to the yarn. It will also be seen that a comparatively short stroke of the sword pin results from a large crank; indeed the stroke is less than the radius of the circle C described by the crank, whereas in the ordinary looms, as indicated in Fig 195, the stroke equals the diameter of the path described by the crank. In Fig. 197 the lay is full back, and the shuttle would, naturally, be crossing the shed at this time. The plan of the various arms and crank indicates the positions when arms G and H are in one straight line. The small projecting arm T is used for operating the let-off motion for the stuffer warp.

CHAPTER XV

LET-OFF MOTIONS

LET-OFF motions consist of the mechanical parts which determine the rate at which the yarn shall be drawn from or given off by the yarn beam. In conjunction with the uptake motion they regulate the travel or "pace" of the yarn, and, due to this fact, are sometimes termed pacing motions. These let-off motions may be roughly divided into two classes, negative and positive, the former of which simply exert a certain braking power over the yarn beam, the movement of the beam being in general due to the action of the uptake and the shedding motions, the first-mentioned motion taking away a certain portion of the woven cloth, and the shedding pulling a further supply of yarn from the beam. In some few cases the action of the reed in beating up is partly instrumental in withdrawing warp from the yarn beam. Negative let-off motions have no connection whatever with the uptake motion, and from a purely theoretical point of view might be considered makeshifts; nevertheless they are simple and effective, and for most classes of work may be said to give satisfaction. Indeed, amongst all the looms which are used for cotton, linen, jute, and silk weaving, there is probably not one loom in a thousand that is not fitted with one or other form of negative let-off motion.

In Figs. 198 and 199 end and back elevations respectively are given of a common arrangement of this type for light fabrics. The yarn beam A is supported in position by its arbors B being caught or held in suitable

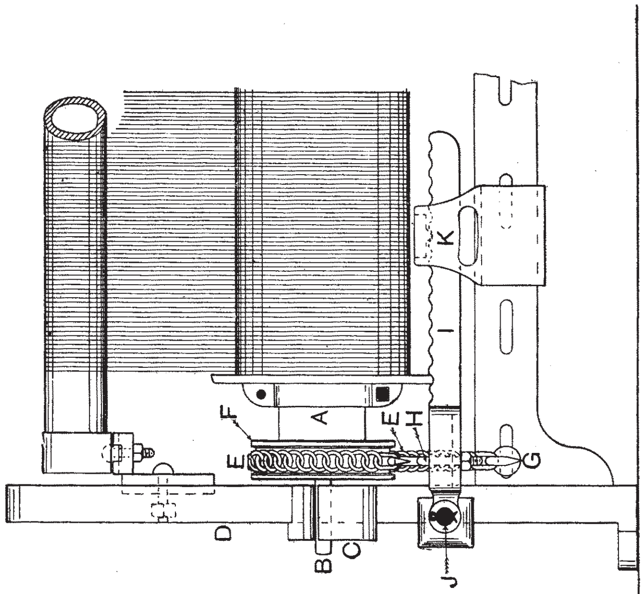


Fig. 199.

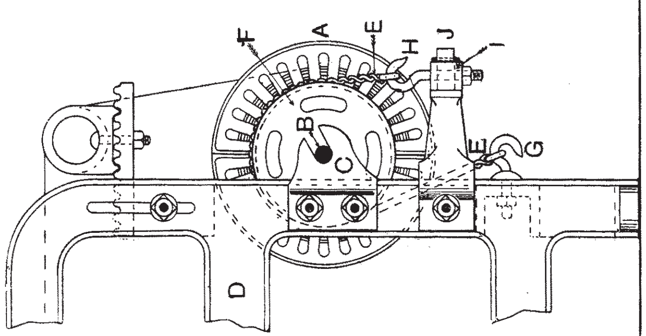


Fig. 198.

brackets C bolted to the loom frame D. The friction

necessary to retain the beam is generated between the arbor B and the supporting bracket C and by the chain or rope E, which is passed either partially or wholly round the beam head F, and is attached by one end to a fixed hook G, and by the other end to a hook H bolted in the lever I. The latter is fulcrumed on the stud J and has the necessary force imparted by means of a weight or weights K. As the beam A empties, the weights K require to be moved nearer to the fulcrum J, due to the reduced leverage with which the yarn is pulling round the beam. This motion is widely adopted, and for light fabrics is sufficiently powerful, but it is not suitable for heavy fabrics, nor can it be said to be highly satisfactory from the weaver's point of view, as the levers I and the weights K (and of the latter there are sometimes a considerable number) require to be lifted to relieve the beam every time the latter from any cause requires to be turned backwards.

To obviate the use of many and heavy weights, the beam head or drag head F is often made wide enough to permit of chain E being passed round a second time; and for the same reason the brackets C are sometimes enlarged sufficiently to take the outside diameter of the tubular yarn beam A. In such cases the arbor B is dispensed with, and the wrought iron tube A continued for a few inches beyond the drag head F to provide a larger frictional bearing surface than is possible with the arbor B.

Different motions have been introduced from time to time with the object of eliminating the cumbrous and clumsy lever and weight method of pacing. One of the most recent of these arrangements, Hempseed's patent, is illustrated in Fig. 200. Levers A are fulcrumed on studs B, suitably situated immediately behind the beam drag heads C, and are provided with two pins D which engage with the two ends of the hoop iron band E which passes round the drag head. The long arm of lever A is continued to the front of the loom, and there supported and controlled by a strong helical spring F, and a strap G, the latter being fixed to the periphery of roller H of about $2\frac{1}{2}$ ins. diameter, keyed on shaft J. In some looms the shaft J is most conveniently situated just under the

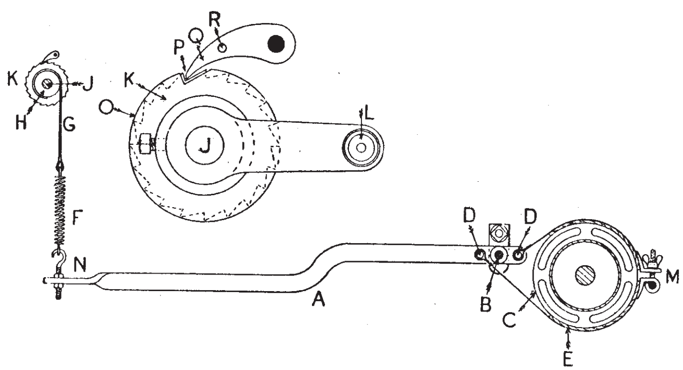


Fig. 200.

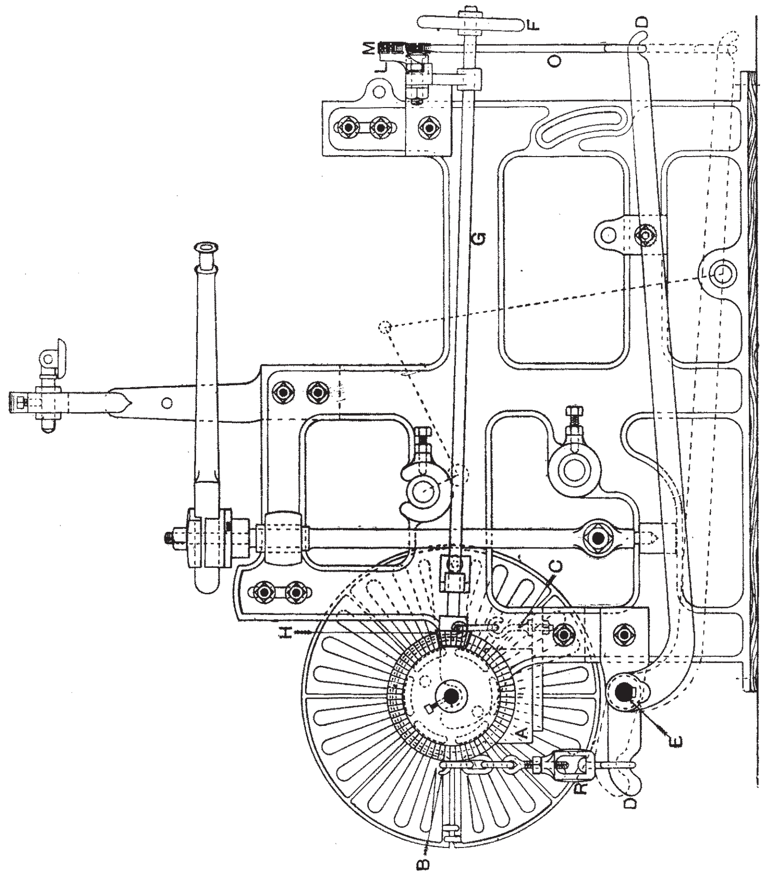
breast beam. The larger detached figure shows that at the ratchet wheel end of shaft J a handle L is provided, by means of which the shaft may be partially rotated, thereby lowering lever A, and removing the pressure from the drag head. Naturally any downward movement of the long arm of the lever A will cause both pins D to slacken band E, since the two pins are on opposite sides of the fulcrum B.

The hoop band E is leather lined to secure a true working surface on the drag head, and its continuity may be readily broken at M by means of a hinged bolt, so

that a change of pace, or a removal or replacement of a beam may be accomplished quickly. If desired the band E may be continuous, although this makes the change of beams more difficult, and, besides, causes all changes of pace to be made at the front of the loom at N. A shell O compounded with ratchet wheel K, see detached figure, enables the weaver to bring back the ratchet wheel exactly to its original position before restarting the loom. The shell O masks all the teeth of the ratchet K except one as shown at P. Retaining pawl Q, which may be lifted out of gear by means of pin R, is of such a breadth that it extends over the surface of the shell O as well as over the teeth of the ratchet; it will therefore retain the ratchet wheel by that tooth only which is exposed by the recess in the shell or mask O. The latter is of course set in its correct position by the tenter.

The motion is simple and inexpensive, and may be easily fitted to most looms which work with a negative let-off motion. It deals more gently with the drag heads of the beam than do chains; it is easily manipulated by the weaver, and does away entirely with the use of weights. It is essential, however, that the beam drag heads should be perfectly circular and not irregular as is the case with many. Spring F partially compensates for this defect in the drag head, but it is much better to turn up the drag heads to a true circle in order that the grip of band E or the pacing of the beam may be perfectly regular.

For the heavier linens and for most classes of jute fabrics it is essential that a powerful arrangement be adopted. Fig. 201 illustrates one of the most modern and successful types. It will be seen that the yarn beam is supported in position by resting the heads of the beam upon hard wooden blocks A, the upper sides of which are concaved to fit the curve of the beam head, and the whole



placed upon suitable brackets bolted to the framework. The beam itself is usually a malleable-iron or mild steel tube of about $5\frac{1}{2}$ ins. outside diameter, the heads being

shrunk on at either end and then turned down to standard dimensions. Passing about half-way round the heads and on the upper side is a wrought-iron band B (preferably leather lined on the under side), one end of which is linked, as shown, to a fixed hook C in the bracket, while the other end is attached by a chain and an adjustable screw to the short arm of the lever D fulcrumed at E. The lever D, as shown, is in two portions, each keyed to the shaft E, which extends across the loom and carries a similar short arm only, at the other end, for pacing that end of the beam. Since the long arm of the lever D is a fixture in ordinary circumstances, it is obvious that by the proper adjustment of the screw R practically any desired pressure may be made to bear upon the beam head. The long arm of the lever D is represented in its normal position by solid lines, but when through any cause the weaver wishes to turn back the yarn beam, this arm is allowed to fall to the dotted position, while the short arm rises in a corresponding degree and relieves the beam of all pressure. Under these circumstances the beam itself may be rotated in either direction by means of the hand-wheel F, the shaft G, and the bevel pinion H, which gears with a bevel wheel set-screwed on the beam arbor outside the loom frame.

The method of retaining the lever D in the normal position, and of relieving it when necessary, is seen in detail in Figs. 202 and 203, which show respectively the side and front elevations of the relieving motion. Centred on a stud J—which is supported in a bracket bolted to the framework—is the relieving lever K, which carries, cast near its fulcrum, a curved piece L round which the chain M is passed and fixed to L at N. The other end of the chain and the lever D are connected as shown by the link O. From the position of the centre of the stud J and the vertical plane in which the long arm of the lever D works, it is evident that any upward pull on the short arm, or downward pull on the long arm, will but serve to

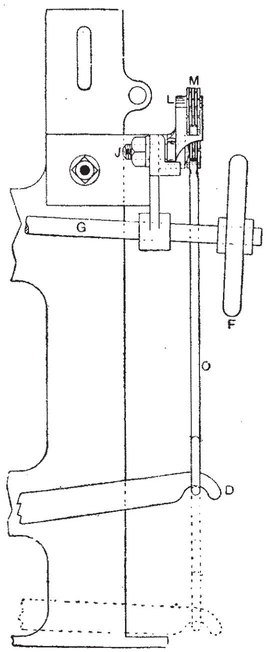


Fig. 202.

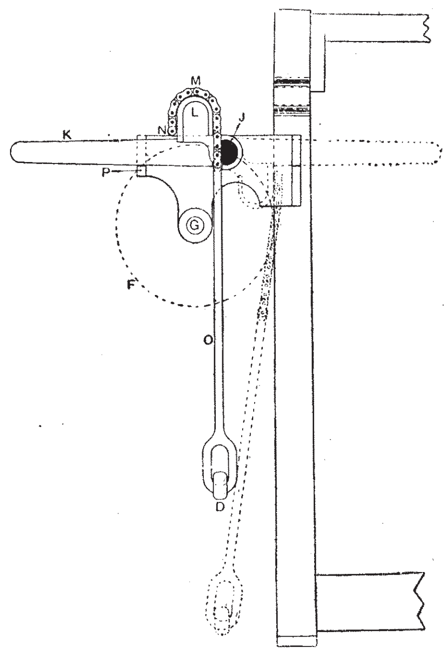


Fig. 203.

hold the lever K more firmly in its normal or proper position (*i.e.*, resting upon the projecting part P of the bracket) and make it impossible for any accidental relief to be given to the beam. This fact constitutes the great advantage of this method of arranging the relieving bracket over that of the common quadrant type, which,

not unusually, through worn parts and a defective spring, fails to keep its proper grip of the beam. A further advantage of this arrangement is the increased amount of relief which it gives. The dotted positions in both figures show the parts in their respective positions when the pressure upon the beam heads has been removed.

The two main objections to the foregoing negative let-off arrangements are: Firstly, the fact that the pressure imparted to the beam by weight or by screw has to be adjusted manually, and therefore somewhat irregularly, from the full to the empty beam; and secondly, that the yarn has to be forcibly pulled off the beam, and is thus subjected to a greater stress than is necessary for the sole process of weaving.

It is also sometimes urged as an essential feature of a let-off motion that it shall maintain the yarn at an equal tension whether the shed be closed or open; but as this condition is only possible in the case of certain shed formations, such as plain weaving and centre shedding, it is obviously absurd to make it a condition upon which a let-off motion shall be judged. In the cases mentioned it is possible to maintain an approximately equal strain upon the yarn whether the shed be closed or open, by causing the back rail of the loom to vibrate to the necessary extent in unison with the shedding mechanism, or by introducing a similarly actuated supplementary rail over which the yarn in the shed is caused to pass. But this may be, and is in many cases, done independently of the let-off motion. In open shedding, however, as well as in sheds of other types where a portion of the warp may be in tension for two or more picks in succession whilst another portion is changing, it is obvious, we think, that anything of this nature which is done to take up the slack of that portion of the yarn in motion will but increase the strain upon that portion at rest, unless, as is the case with the pile warp in Brussels and Wilton carpet weaving, each thread of the warp be paced individually.

To overcome the former of the above objections, that of manual adjustment, several devices have from time to time been introduced, but all of them have had but meagre support. These devices have been chiefly based upon the utilisation of the decreasing diameter of the warp beam in order either to shift the weights K (Fig. 198 and 199) proportionately nearer to the fulcrum of the lever I, or to allow the long arm of the lever D (Fig. 201) to fall gradually and the short arm to rise, and thus to reduce automatically the pressure upon the beam. The number of parts added, however, and the complications arising from their addition, have, as already indicated, prevented anything like even a fair adoption of any of those automatic arrangements.

Positive let-off motions have been introduced in which the central idea consists of drawing the warp positively from the yarn beam by means of a measuring and a pressing roller, and in this manner delivering it at a fixed rate to the further processes. This measuring roller is driven by gearing from the wyper shaft, the gearing being so arranged that one of the wheels of the train represents the picks desired per quarter, half, or one inch. In this motion the measuring and the taking up rollers are exactly alike in circumference, and a continuation of the gearing mentioned drives the latter roller practically in unison with the former, a simple mechanical means being available for slightly reducing the speed of the taking-up roller in conformity with any predetermined percentage of allowance for the contraction between the warp and the cloth lengths. The

warp beam in this motion requires to be "paced" only sufficiently to prevent too rapid unwinding of the yarn. Whilst an arrangement of this kind may make a certainty of the regular delivery of the warp, it is open to question whether the principle of so connecting the let-off and uptake motions that a given quantity of warp will always turn out a definite length of cloth will be beneficial to the weaving process, especially in the case of weak or inelastic fibres.

A positive let-off motion which is automatic in its character is much to be preferred to one of the type just described. The usual feature in these automatic motions is a sensitive back beam or rail which responds to the tension or stress in the warp yarn passing over it; while the difference between the various motions of this type lies in the method of taking advantage of and applying any degree of movement imparted to this sensitive rail in virtue of the increase or decrease of tension upon the warp due to the action of the uptake motion and the weaving process generally.

In Fig. 204 the general arrangement of a motion of this character as found in the Hollingworth and Knowles' loom is shown. Fixed to one end of the yarn beam A is a worm wheel B, which gears with and is driven by a worm C on the shaft D. About midway on this shaft a ratchet wheel E is fixed, the ratchet and shaft being rotated by the alternate action of the pawls F and G, while motion to the latter is obtained from the lay swords H by means of the rod I and the lever J. The shaft D is prevented from revolving too freely by means of a strap which partly encircles the brake pulley K, and is weighted at L.

Evidently, if the shaft D were to be rotated continuously at one fixed rate, the wheel B, and therefore the yarn beam A, would revolve likewise, and a continuous, although a slightly varying, supply of warp (due to the varying diameter of the beam) would be given off whether the cloth required it or not. In order to avoid this, and to ensure a steady and efficient supply of warp, a shield M (seen in

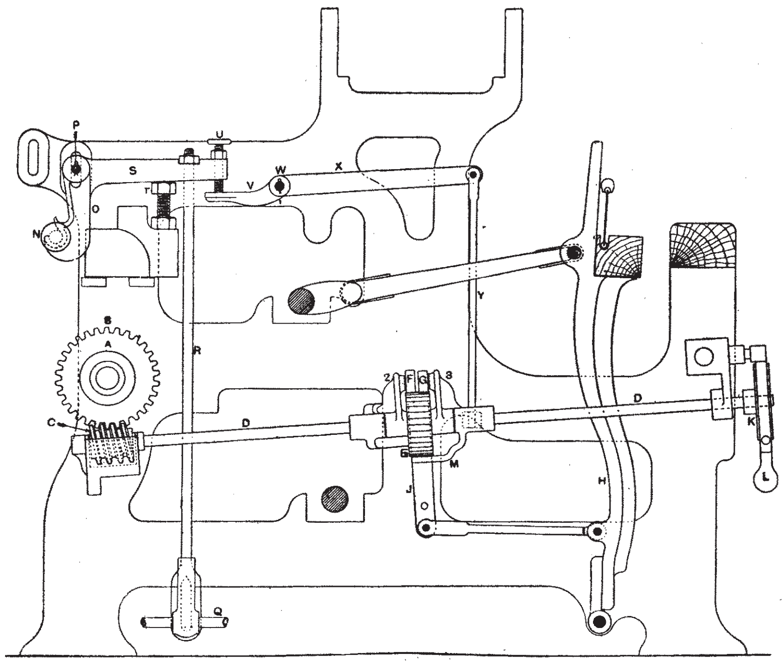


FIG. 204.

detail in Fig. 206) is mounted loosely on the shaft D and is caused to interpose between the teeth of the ratchet wheel E and the pawls F and G, preventing contact of the latter with the former, and therefore preventing the rotation of the shaft D and of the yarn beam when the yarn is slack; and, on the other hand, when the yarn is in tension, the

shield is caused to withdraw from between the ratchet and the pawls, and so permit the shaft D to be further rotated and the yarn to be given off. The shield M is controlled in the following manner: the back beam or roller N, Fig. 204, over which the warp passes, is supported in the swing bearer O, fulcrumed at P, and is continually pressed outwards and upwards against the warp by means of a weighted lever (not shown) fulcrumed on the shaft Q, and by the link rod R, and the arm S of the swing bearer. The adjustable screw T regulates the maximum extent to which this can be done. At the extremity of the arm S another screw U is adjusted, which, when the yarn slackens and the arm S falls, rests upon and depresses the arm V of the lever fulcrumed at W; the arm X of the same lever rises in a proportionate degree, and, by means of the rod Y and a bell-crank lever fulcrumed on the shaft D, raises the shield M and causes it to interpose between the ratchet wheel E and the pawls F and G. The further rotation of the shaft D, and therefore of the yarn beam A, is thus temporarily prevented or reduced in proportion to the extent to which the shield M is made to interpose. When tension upon the yarn increases, the roller N is drawn inwards, the arms S and V rise, while the arm X and the rod Y fall and withdraw the shield M, allowing further engagement of the pawls with the ratchet wheel.

From the foregoing description it will be seen that this let-off motion, while being perfectly positive in its delivery of the warp, is also entirely automatic in its action as to the quantity delivered, depending as it does wholly upon the slackness or tightness of the warp and the pressure which the latter exercises upon the back rail. The pressure necessary to cause the back rail N to swing inwards so that the shield M can fall is regulated by means of the weights upon the lever fulcrumed on the shaft Q.

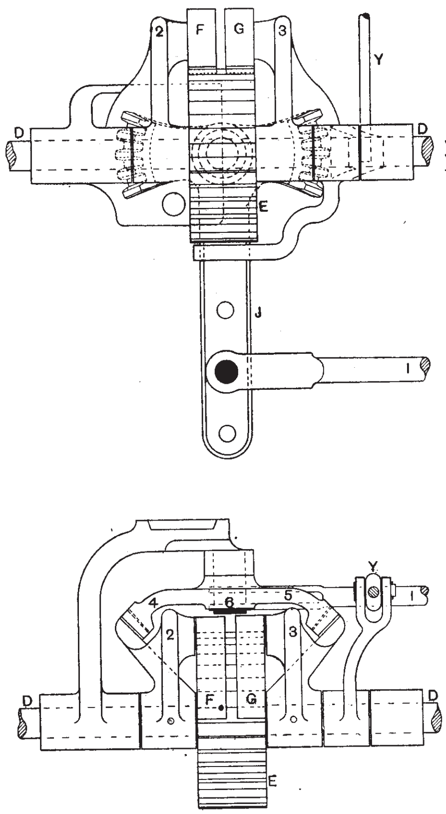


FIG. 205.

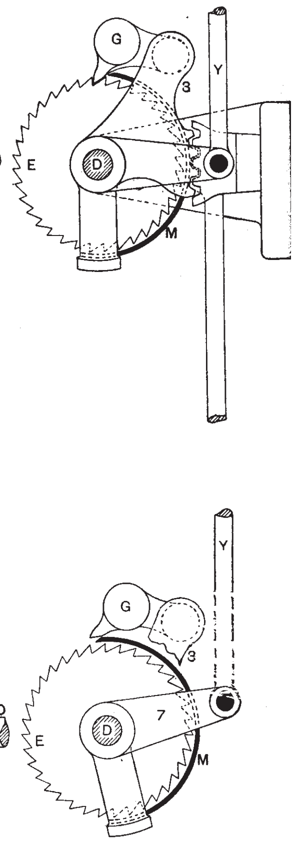


FIG. 206.

Detail views of the method of actuating the ratchet wheel E and the shield M are given in Figs. 205 and 206, the former showing a plan and elevation of the ratchet

wheel, while two positions of the shield, but only one pawl, are shown in the latter. Mounted loosely on the shaft D (Fig. 205), and on either side of the ratchet wheel E, are two semi-bell-crank levers 2 and 3 which carry respectively on one arm pawls F and G, while the extremity of the other arm of each lever carries a segment of a bevel wheel. Corresponding segments on the end of each arm 4 and 5 of the T lever J, fulcrumed on a stud 6, impart the necessary oscillating movement to levers 2 and 3, and therefore to the pawls F and G. Motion to the lever J is, as already stated, conveyed from the lay swords by means of the connecting rod I.

In the upper view of Fig. 206 the shield M is represented in its position of inaction, or that of allowing contact between the pawl G and the ratchet wheel E; while in the lower view, by the slackening of the warp yarn, the rod Y has been raised, and has, by means of the bell-crank lever 7, rotated the shield M until it has interposed between the pawl G and the ratchet E, preventing contact between them, or at least exposing fewer teeth of the ratchet to the action of the pawl.

About the only condition which it is necessary to impose upon this motion is that it shall be able to drive the yarn beam A at a sufficient velocity when at its smallest diameter. A notable feature of the motion is the ease with which slack yarn can be taken up by the yarn beam when picking back is necessary. Immediately the yarn is slackened, the shield M will interpose between the pawls and the ratchet, permitting the weaver, by means of the brake pulley K, to rotate the shaft D and the yarn beam in the required direction.

Fig. 207 shows the same motion applied in the case of a two-beam warp. All parts of the motion are duplicated with the exception of the connecting rod I.

A let-off motion of the above character is probably of most value for, and is most easily applied in, cases where the weave of the fabric is such that a more or less constant

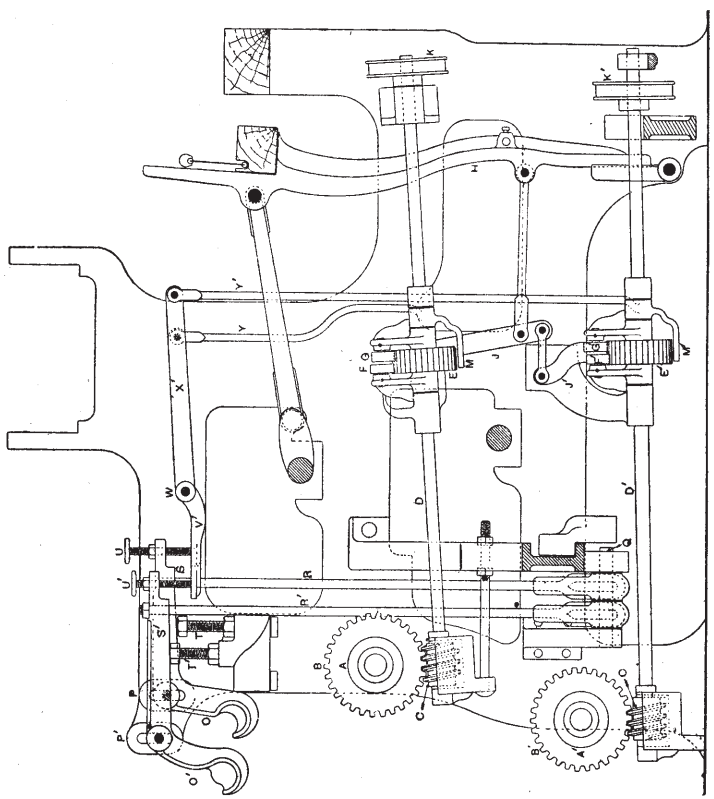


Fig. 207.

pressure will be exerted by the yarn on the sensitive back beam or rail. In other weaves, as for example the $\frac{1}{1}$ plain, or with a centre shedding mechanism, where the warp slackens considerably during the changing of each shed,

more trouble is experienced in the adjusting and working of such an arrangement. It is therefore generally advisable in such cases to introduce a second vibrating back rest, which will take up the slack referred to, and thus reduce the otherwise excessive vibration which would take place in the sensitive back rest which is employed for controlling the let-off motion. By this means also the pressure of the yarn upon the latter is kept more nearly at a constant value.

A motion of this type, frequently used in looms for plain linen weaving, is illustrated in Figs. 208, 209, and 210. Fig. 208 shows *inter alia* an end elevation of the yarn beam A, the sensitive back rail B, and the vibrating back rail C; Fig. 209 is a plan view of the continuation of the worm shaft D to the front of the loom with the connections at that end of the shaft; while Fig. 210 is a front elevation of shaft D and the same connections.

The yarn beam A is a heavy wrought-iron tube, open at the ends, and suitably supported in brackets, not shown; it is provided with a worm wheel E which gears with, and is slowly and intermittently rotated by, the strong worm F fixed on shaft D. Worm shaft D extends to the front of the loom, and is provided near that position with a ratchet wheel G, which is capable of being advanced one tooth or more every pick by means of the pawl H. The latter is mounted upon a lever J which is loose upon the shaft D, and which is always depressed to the same extent by means of the stud K, bolted in arm L, and therefore rocking with the rocking shaft M. As the lay comes forward, stud K is depressed, and, although it is loose in the vertical slot N of the connecting rod O, it ultimately reaches the bottom of the slot, and pulls down the pawl H partially every pick. Pawl H is, however, not

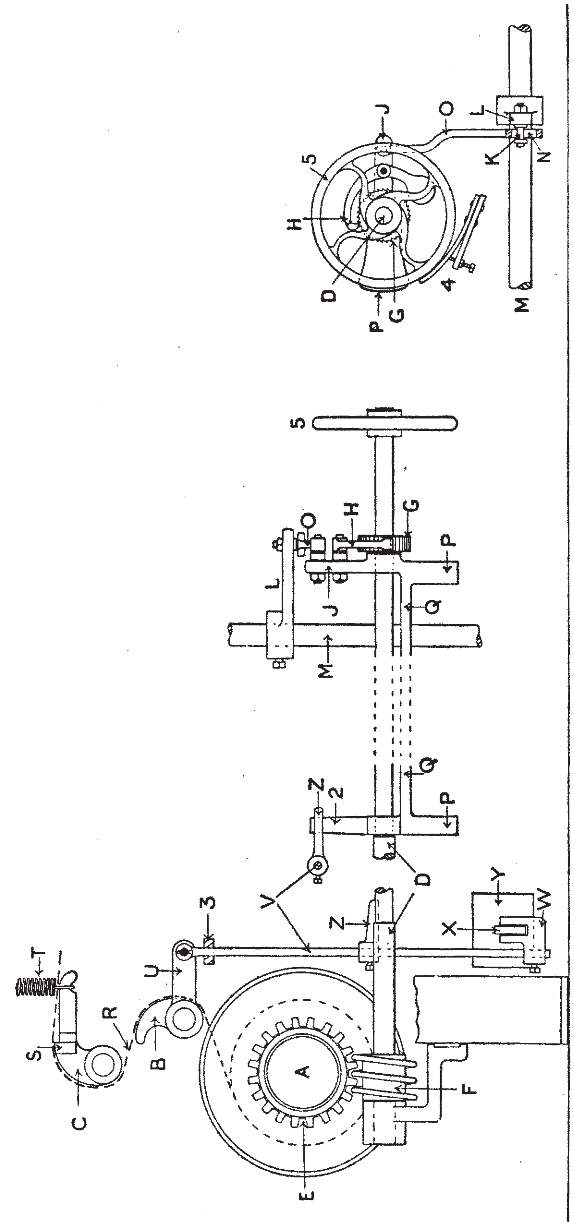


FIG. 208. FIG. 209. FIG. 210.

raised by the stud K, since the latter is free to rise in the slot N without interfering with the position of the pawl. Lever J, on which the pawl is mounted, is continued to the other side of shaft D, where it is heavily weighted by the two parts P and the bar Q which connects them; consequently as stud K rises, lever J is raised along with the pawl H by the gravitational action of these heavy parts.

The extent to which the pawl H rises, and hence the extent of movement which it will impart to the ratchet wheel G in its next downward movement, is limited by the action of the following parts, which are in turn controlled by the varying degree of tension upon the warp. The path of the warp, after it leaves the yarn beam A, is indicated by the heavy dotted line R to be first round the back of the sensitive back rail B, and then over the front of the vibrating rail C. The ends of both these rails are turned up to form true bearing surfaces, and both rails are supported in suitable brackets. Vibrating rail C is strictly limited in its movement of about half an inch in both directions by fixed stops which act on both sides of projections S at each end of the rail. Spiral spring T requires to be of just sufficient strength to return the rail to its full back position. Projecting from the near end of sensitive rail B is a short lever U, which, through rod V, and a stirrup bracket W, supports the free end of a lever X, the further end of which is fulcrumed in a bracket bolted to the opposite frame of the loom. Heavy weight Y is adjustably fixed upon the lever X, and through rod V, tends to pull lever U downwards and rail B inwards against the tension of the warp yarn. Adjustably fixed on rod V is a finger X, which projects over, and limits the upward movement of the part 2; since the latter is cast in one piece with the pawl lever J, the upward movement of the pawl H is also restricted by the position of this finger Z. Now it is evident that any increase of tension on the warp beyond the normal will move the sensitive rail B outwards, and rod V and finger Z upwards, with the result that the pawl H will rise higher upon the ratchet wheel G′; that more downward movement of the latter will take place, and that, therefore, more warp will be given off. Similarly, it is clear that an unusual slackening of the warp will permit rail B to move inwards, and rod V and finger Z downwards, until lever U might rest upon the adjustable bracket 3. In such a case, finger Z should be set so as to restrict the upward movement of the pawl at that time to such an extent that no further movement of the ratchet wheel G is possible until the warp is again more or less under tension, and the lever U raised clear of bracket 3.

A simple brake arrangement is provided at 4, Fig. 210, to prevent the overrunning of the worm shaft D, and hand wheel 5 serves admirably when it is necessary to take back the slack warp due to picking back. Although perhaps more difficult to set and adjust than an ordinary negative let-off, when once correctly adjusted, such a motion will work from beginning to end of a beam without alteration.

CHAPTER XVI

TAKING-UP MOTIONS

Of taking-up or uptake motions there are, generally speaking, only two kinds, positive and negative—*e.g.*, those in which the periphery of the taking-up roller, round which

the cloth passes, is caused to move positively through a certain fraction of an inch or other measure every revolution of the crank or the wyper shaft by certain gearing or mechanism, and those in which the said roller (which in this case is also the cloth beam) depends upon the pressure of the reed upon the fell of the cloth, as well as upon the pull of a spring in tension, or upon a weighted lever for that portion of movement which it is able to make.

By far the greater majority of looms are fitted with some type of the former class of motion, although in certain districts the impression still exists that for the making of the heavier numbers of flax canvas a negative motion is the best.

A representative arrangement of the negative type is illustrated in Fig. 211. Set-screwed on the arbor of the cloth beam A is a wheel B of 90 teeth, gearing with and driven by a small pinion C of 22 teeth, which is compounded with a ratchet wheel D of 116 teeth. The cloth in this case (represented by the line E) passes directly to the cloth beam without the intermediary of a taking-up roller. Concentric with, and fulcrumed on, the same stud as the ratchet wheel is a three-armed lever F, G, and H, the first arm of which carries a pulling pawl I in contact with the teeth of the ratchet wheel. Bolted to the arm G is a bracket J, to which one end of a strong helical spring K is fixed by an eyebolt and thumbscrews, as shown, while the lower end of the spring is hooked into an adjustable piece L set-screwed on the lever M, keyed to the shaft N. This shaft N extends inside the loom, and carries, keyed upon it, a lever O, which supports at its upper end an anti-friction roller P, the latter being kept in constant contact with the cloth upon the beam A as a result of the pull upon the spring K. Keyed upon the end of the rocking shaft Q is a slotted lever R, in the slot of which is bolted a stud S carrying an anti-friction roller in contact with the

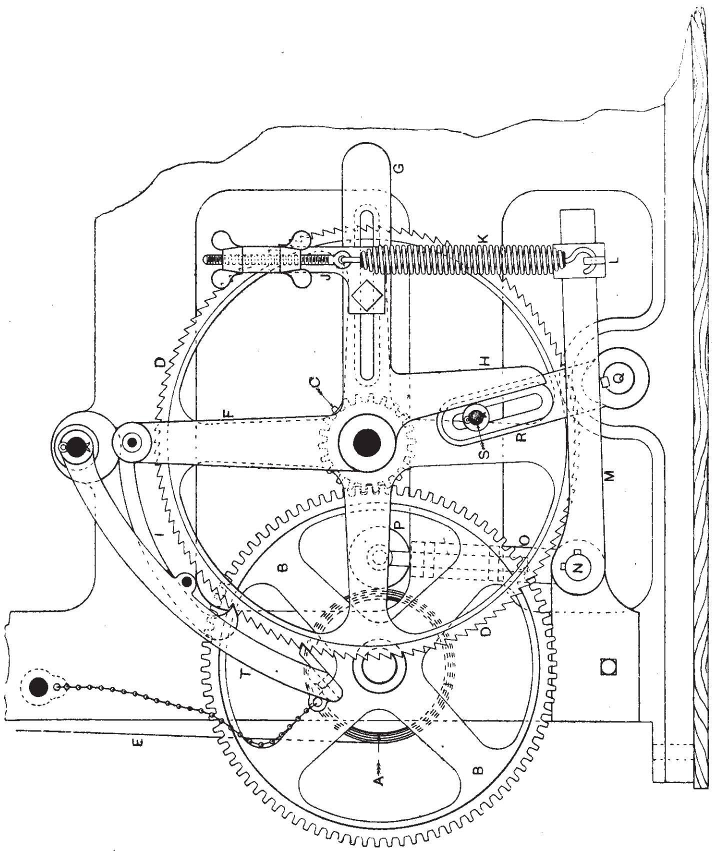


Fig. 211.

arm H of the three-armed lever. The lever R, being attached to the rocking shaft, moves in unison with the lay swords, and as the latter travel backward the stud S pushes the arm H in a similar direction, the arm G is

raised, distending the spring K, while the arm F moves in the forward direction and permits the pawl I to advance over one or more of the teeth of the ratchet wheel D. This continues until the lay swords begin the forward movement, when the stud S recedes from the arm H, leaving it and the other arms stationary with the spring K in tension, until the reed reaches the fell of the cloth. As a result of the pressure of the reed upon the fell of the cloth, the latter is slackened between the reed and the cloth beam A, but because of the pull of the spring K, the arm F and the pawl I rotate the ratchet wheel D, and by means of the pinion C and wheel B the cloth beam A is partly rotated, and the slack of the cloth taken up. The retaining pawl T prevents rotation of the motion in the opposite direction during the time the pawl I is moving forwards. In some cases the pawl T is composed of two or three sections, so that the rotation of ratchet wheel D to the extent of only one-half or one-third of a tooth respectively will be retained.

Eyebolt and thumbscrews in the bracket J permit of the direct adjustment of the strength of the spring K, while the slot in the arm G permits of its adjustment as to leverage. By the adjustment of the stud S in the lever R, the travel of the arms H and G, and therefore the extent of the stretching of the spring K, may be regulated.

In all motions of this kind there are what might be called two opposing forces. In the above case these are represented by what we may call the positive pull of the spring K and the negative pull of the cloth E. If the point L, to which the lower end of the spring is attached, were made practically a fixture (as in many cases it is), it is evident that the greatest pull of the spring would be a constant quantity from full to empty beam, unless an alteration of the strength of the pull were made by means of the thumbscrews on the bracket J. On the other hand, while the pull of the cloth E would remain constant, the diameter of the beam A would increase as the cloth was wound upon it, giving an increased leverage to the opposing pull of the cloth. It is thus obvious that it is a matter of considerable difficulty to adjust K so that it will cause an equal length of cloth to be taken up every time the motion acts. This fact constitutes the great objection to this negative motion, since with it it is practically impossible to have a consistently-shotted cloth. Fabrics in which the shotting requires to be spaced can scarcely be produced by it, and it is only in the heaviest of fabrics where it is really of any use. One of the various attempts to secure automatic regulation of the strength of the spring is indicated in the figure. As the cloth beam A fills, the anti-friction roller P is pressed outwards, and through the shaft N the lever M is depressed, and the strength of the spring K is gradually increased in proportion to the working diameter of the cloth beam.

Positive taking-up motions might be subdivided into two sections—(*a*) those which are intermittent in their action, and (*b*) those which are continuous. The former motion is practically the only one met with in looms for cotton, linen, and jute weaving, and besides being simple and efficient, may, we think, be considered to have an advantage in being intermittent.

Every other action in weaving is also intermittent, and the action of taking-up is but one of the sequence. Occasionally the motion is found so arranged as to be in action when the lay is receding, and, in taking up the cloth, is further straining the yarn, which is already probably sufficiently strained in the operation of shedding. This,

it may be observed, is a condition of things which it is impossible to avoid if the action be continuous, or if the motion be operated intermittently from the wyper shaft, and, therefore, only every second pick; but where the intermittent motion is so arranged as to be in action when the lay is moving forward, and when the warp is, for some time, slack or slackening, the cloth will be taken up with a minimum of strain upon the warp. It is, of course, impossible to avoid a certain amount of strain with the present arrangements, because the taking-up motion is in action for practically half a revolution of the crankshaft.

Intermittent positive motions usually consist of a train of five wheels (sometimes three or seven), of which the first is a ratchet A, Fig. 212, and the others a pinion B (termed the change pinion), an intermediate wheel C, a pinion D (the latter may also be used as a change pinion), and the roller wheel E. The wheel E is keyed on the arbor of the cloth roller F, which in some of the looms for the finer fabrics occupies a position immediately under the breast beam. For the finer classes of work the surface of the roller F is clothed with perforated strip steel, wound from end to end in spiral form, or from the centre to each end in right and left hand spirals; while for the heavier classes of work and terry towelling it has a series of sharp iron pins projecting from its surface in order in both instances to ensure a sufficiently positive grip between the cloth G and the roller. In some cases it is covered with card clothing. From the figure it will be observed that the cloth does not pass entirely round the roller F, but that it goes off at a tangent on to the cloth beam H, the latter being suitably supported in slide brackets (not shown) bolted to the framework, and driven by frictional contact with the cloth roller F. When the roller F happens to be made of badly seasoned wood, it generally warps and becomes untrue, with the result that the

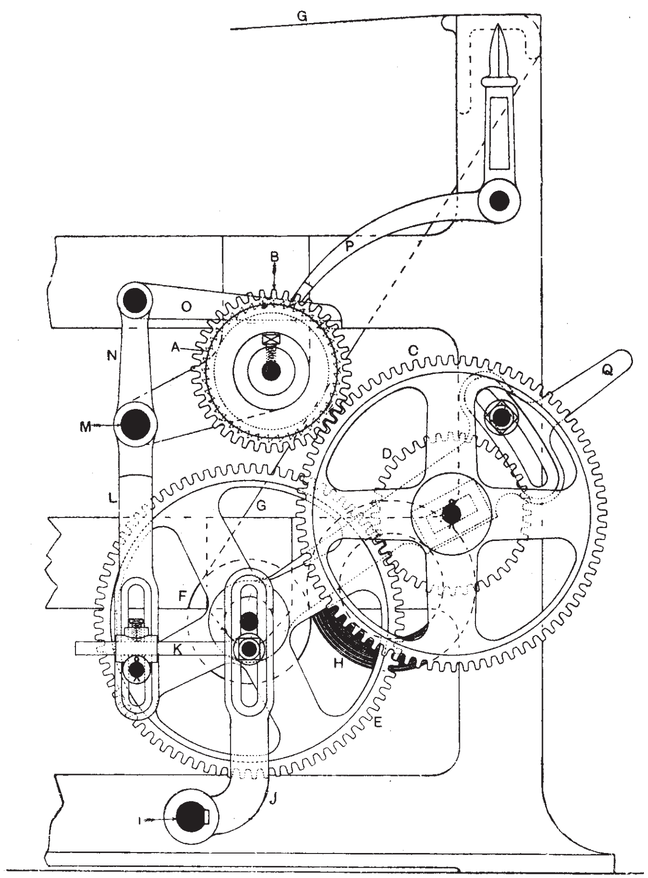


FIG. 212.

shotting of the cloth becomes irregular. To obviate this, and, in addition, to increase its rigidity for heavy work,

and in wide looms, the roller is now frequently a cast-iron tube covered in the same way with spikes.

In motions where only three wheels are used the change pinion B is sometimes geared directly with the roller wheel E. In such cases it is obvious that the direction of rotation of the ratchet wheel A must be reversed, and when the pinion B requires to be changed, it is necessary either to raise or lower the supporting bracket in order that the new pinion may gear properly with the roller wheel E. The unsatisfactory nature of this arrangement is at once obvious, and happily it is fast becoming obsolete. In general, where only three wheels actually comprise the motion, a fourth pinion is introduced between B and E in order to reverse the direction of the motion, and also to obviate the necessity of changing the position of the supporting bracket of pinions A and B when a change of pinion is required. This fourth pinion (termed a "carrier" or "single intermediate") simply conveys the motion from one pinion to another, and changes its direction; it has no effect upon the value of the motion, and therefore must not be included in any calculations.

The motion illustrated is actuated as follows:—Keyed to the rocking shaft I is a slotted lever J, which, through the rod K, imparts a swinging motion to the arm L of the lever fulcrumed on the stud M. To the arm N of this lever a pawl O is attached, which rotates the ratchet wheel A through one or two teeth as desired at each oscillation of the lever. The extent of the movement of the pawl O—as to whether one or two teeth of the ratchet shall be taken—is regulated by the position of the connections of the rod K in the slots of the levers J and L. If the rod K be raised farther from the fulcrum of J, and nearer to that of L, an increase of travel is conveyed to the pawl. The actual amount of shift necessary when changing the motion from taking one tooth of the ratchet to taking two teeth at a time, is always determined by trial. When adjusting the motion it is necessary to have it so set that the retaining catch P will clear the teeth of the ratchet wheel by about one-eighth of an inch when the lay is full forward. The intermediate wheel and pinion C and D are centred upon a stud in the bracket Q, which is arranged concentrically with the roller E. In some cases the lever L N, the ratchet wheels, and pawls are situated inside the loom framework, and lever L is actuated by a stud which projects from the lay sword; but it is more convenient for the tenter when all the wheels are outside the framework as shown.

If the ratchet wheel A be moving one tooth at a time—*i.e.*, one tooth for each beat of the lay or each shot of weft, —the application of the following formula will give the shotting per inch upon the cloth:—

$$\frac{\left\{\begin{array}{c}\text{Number of}\\ \text{teeth}\\ \text{in ratchet}\\ \text{wheel (A)}\end{array}\right\} \times \left\{\begin{array}{c}\text{Number of}\\ \text{teeth in}\\ \text{intermediate}\\ \text{wheel (C)}\end{array}\right\} \times \left\{\begin{array}{c}\text{Number of}\\ \text{teeth}\\ \text{in roller}\\ \text{wheel (E)}\end{array}\right\}}{\left\{\begin{array}{c}\text{Number of}\\ \text{teeth}\\ \text{in change}\\ \text{pinion (B)}\end{array}\right\} \times \left\{\begin{array}{c}\text{Number of}\\ \text{teeth in}\\ \text{intermediate}\\ \text{pinion (D)}\end{array}\right\} \times \left\{\begin{array}{c}\text{Circumfer-}\\ \text{ence of cloth}\\ \text{roller (F)}\\ \text{in inches}\end{array}\right\}} = \text{shots per inch.}$$

Or generally:—

$$\frac{\text{Product of teeth in driven wheels}}{\text{Product of teeth in driving wheels}} \times \frac{1}{\text{circumference of cloth roller in inches}} = \text{shots per inch.}$$

Substituting common values for the above in the case of certain looms for jute weaving, we have:—

$$\frac{40 \times 80 \times 80}{30 \times 40 \times \underbrace{(5\tfrac{1}{8} \text{ ins.} \times 3\tfrac{1}{7})}_{\text{circumference}}} = 13{\cdot}24 \text{ shots per inch;}$$

and in the case of some looms for linen weaving,

$$\frac{50 \times 90 \times 90}{21 \times 20 \times (5\tfrac{1}{2} \text{ ins.} \times 3\tfrac{1}{7})} = 55{\cdot}78 \text{ shots per inch.}$$

If the shots are reckoned by a glass or measure other than one inch, it is necessary to multiply the left-hand side of the equation by the size of the glass or measure, in order to find the number of shots in such unit. Thus:—

$$\frac{\text{Product of teeth in driven wheels}}{\text{Product of teeth in driving wheels}} \times \frac{\text{size of glass or measure}}{\text{circumference of cloth roller in inches}} = \text{shots per glass or measure.}$$

In practice, the approximate constant for any loom may be readily found by multiplying the number of shots per unit measure—inch or otherwise—in the cloth by the number of teeth in the change pinion in work, but, since the accuracy of this method is partially determined by the weight of the fabric being made at the time, and the tension on the warp beam, it is safer to find the constant from the value of the motion. Thus, using the above distinctive letters for the wheels, etc., we have:—

$$\frac{A \times C \times E}{D \times F} = \text{constant number for shots per inch;}$$

and

$$\frac{A \times C \times E}{D \times F} \times \text{size of glass} = \text{constant number for shots per glass.}$$

The constant number in every case is theoretically and approximately the product of the change pinion in work and the shots per inch, glass or measure.

There are three methods by which the necessary pinion for any required shotting may be found :—

(*a*) By inverse proportion. In the former of the above examples we find that a pinion of 30 teeth gives us 13·24 shots per inch, and we are required to find the pinion for $10\frac{1}{2}$ shots per inch. Since the change pinion is a driver, we shall require to use a pinion with more than 30 teeth, in order that the cloth shall be taken away more rapidly by the roller F, and that the weft threads will be more widely spaced :—

$$10{\cdot}5 : 13{\cdot}24 = 30 : x,$$
$$\text{whence } x = 37{\cdot}83, \text{ or say 38 teeth.}$$

(*b*) By substituting the shotting per inch for the value of the change pinion in the calculation—*e.g.*, required the pinion to give 45 shots per inch with the second motion :—

$$\frac{50 \times 90 \times 90}{45 \text{ shots} \times 20 \times (5\frac{1}{2} \text{ ins.} \times 3\frac{1}{7})} = 26 \text{ teeth for the change pinion.}$$

(*c*) By omitting the change pinion and the shotting from the calculation altogether, and finding by this means the numerical or "constant" value of the remaining parts of the motion as indicated above. This "constant," when divided by the shotting required, gives the change pinion necessary, and conversely, when divided by the value of the pinion, gives the shotting which it will produce. Briefly :—

$$\frac{\text{Constant}}{\text{Shots per inch}} = \text{change pinion ;}$$

or

$$\frac{\text{Constant}}{\text{Change pinion}} = \text{shots per inch.}$$

The constant for each of the given motions is as follows :—

$$\frac{40 \times 80 \times 80}{40 \times (5\frac{1}{8} \times 3\frac{1}{7})} = 397{\cdot}34$$

$$\frac{397{\cdot}34}{13{\cdot}24 \text{ shots}} = \text{pinion of 30 teeth.}$$

$$\frac{50 \times 90 \times 90}{20 \times (5\frac{1}{2} \text{ ins.} \times 3\frac{1}{7})} = 1171{\cdot}49$$

$$\frac{1171{\cdot}49}{21 \text{ pinion}} = 55{\cdot}78 \text{ shots per inch.}$$

In jute weaving it is not uncommon to find the shotting as low as 5 per inch, which would give for the former of the above motions a pinion of practically 80 teeth. As this pinion is too large for the motion, it is usual in these extreme cases to set the pawl O to take 2 teeth of the ratchet wheel A at every oscillation or stroke of the lay. The ratchet wheel is now equal to one of only 20 teeth, as it now makes one full revolution for 20 shots of weft instead of for 40 shots as formerly ; hence it must be taken as of 20 teeth in calculating for the change pinion.

In linen weaving, again, the number of picks per inch is often as many as 120, and in such cases the pinion necessary (about 10 teeth) is too small to be workable. A common practice under these circumstances is to disconnect the rod K from the lever J, and to connect it to a crank or eccentric of sufficient throw on the wyper shaft, giving one oscillation of the lever L and the pawl O for every two picks. Since this is equivalent to doubling the size of the ratchet wheel, it now makes one complete revolution for 100 picks, instead of for 50 picks as formerly ; the pinion necessary for 60 picks under ordinary circumstances will now give 120 picks per inch.

The necessary parts of a motion of this character are illustrated in Fig. 213, in which the connecting rod K and lever L are shown as being operated by the eccentric R on the wyper shaft S. Sometimes the eccentric R is replaced by the simple slide motion shown immediately under the eccentric. In this case the block W is fixed to the end of wyper shaft S, while rod K is connected to a pin X on the

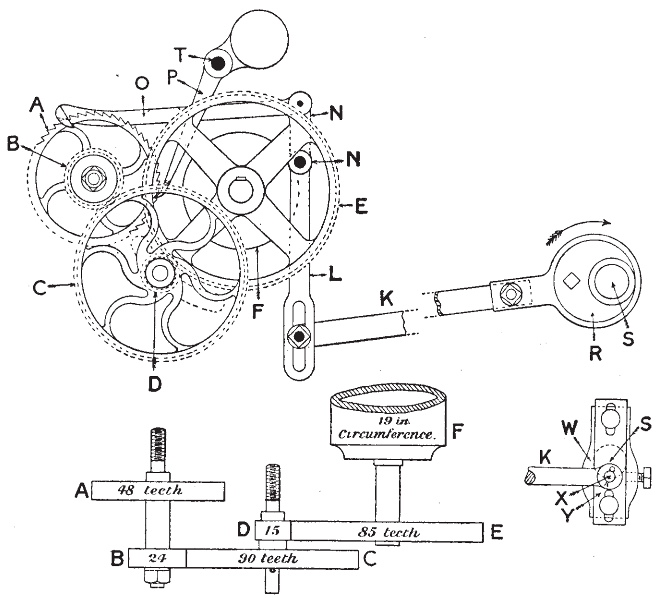


Fig. 213.

sliding block Y. The values of the wheels are different from those given in Fig. 212, but the number of teeth in each wheel is indicated in the distorted plan view of the motion in the lower part of the figure. Theoretically, the practice of connecting rod K with the wyper shaft is objectionable, as the cloth is taken forward only every second pick, but the arrangement is extensively used, and is

found to be quite satisfactory in practice for a large number of shots per inch. One advantage that it has over the above 5-wheel motion driven direct from the lay sword or the rocking shaft is that a greater variation of picks can be obtained. Thus the constant for this motion is

$$\frac{48 \times 90 \times 85}{15 \times 19''} = 1288{\cdot}4, \text{ say } 1288.$$

and it is evident that a pinion of 10 teeth would give $1288 \div 10 = 129$ shots per inch, while a pinion of 11 teeth would give $1288 \div 11 = 117$ shots per inch, if the motion were operated from the lay sword. No theoretical value between 117 and 129 is possible, although in practice certain intermediate values may be obtained in many fabrics by adjusting the weights. By adopting the method of driving indicated in Fig. 213, however, the constant of the motion is doubled, $1288 \times 2 = 2576$, and by using a pinion of 21 teeth it is possible to obtain a mean theoretical value between 117 and 129. Thus, $2576 \div 21 = 123$ shots per inch.

The above benefit derived from using a motion with a high constant is one of the reasons for the introduction of uptake motions with seven wheels, for the introduction of a second pair of intermediate wheels naturally increases the constant, and therefore offers facilities for more variation in the number of shots per inch.

In the 5-wheel motion illustrated in Fig. 213, the retaining pawl P is set-screwed upon rod T which extends across the loom to the weft fork lever. When the latter is pushed forward in the usual manner, on the expiry or breakage of the weft, it causes rod T to oscillate sufficiently, in a counter clockwise direction, to withdraw the retaining pawl P from the ratchet wheel A so that the cloth will not be drawn forward for the few picks during which the loom may still run.

Some positive uptake motions of the foregoing nature are of the type known as tooth-and-pick; that is, they are so arranged that the change pinion or wheel in the train is a driven wheel instead of a driver, and that the number of teeth which it contains will represent exactly the number of picks per inch, per half inch, or per quarter inch con-

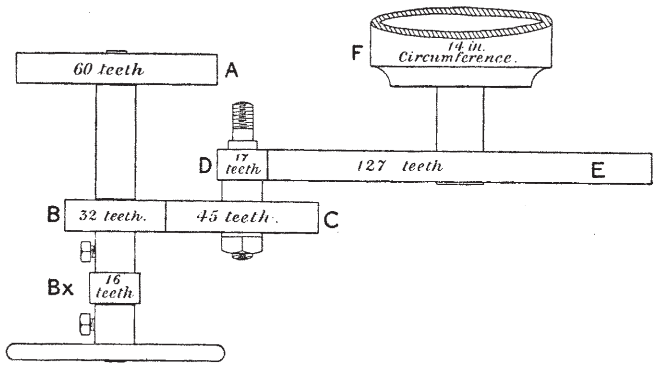


Fig. 214.

tained in the cloth. A distorted plan view of the train of wheels in a motion of this type is given in Fig. 214. The motion is operated in precisely the same manner as an ordinary uptake motion, but changes in the shotting are effected by removing driven wheel C and substituting another wheel containing a different number of teeth. If we introduce into a calculation the number of teeth in the wheels from the ratchet wheel A to the cloth or feed roller wheel E, and also add the circumference of the cloth roller, we obtain the picks per inch; thus:—

$$\frac{60 \times 45 \times 127}{32 \times 17 \times 14''} = 45 \text{ picks per inch,}$$

and this number is identical with the number of teeth in the change wheel C. In other words, the "constant" value of this motion should be unity, as will be seen by omitting the change wheel and picks from the calculation:—

$$\frac{60 \times 127}{32 \times 17 \times 14''} = \frac{7620}{7616} = \frac{1905}{1904} \text{ or practically unity;}$$

i.e.
$$\frac{60 \times 127}{32 \times 17 \times 14''} = \frac{\text{picks per inch}}{\text{change pinion}}.$$

For fabrics which contain a large number of shots per inch, it is often more convenient to state the shots at so many per half inch: in such cases a pinion B X is substituted for the pinion B, so that the number of teeth in wheel C may represent the picks in half an inch. In a similar manner, the number of teeth in wheel C may represent the number of picks in two inches provided a wheel of 64 teeth be introduced in place of the 32-teeth pinion B.

An example of the continuous type of positive taking-up motion is illustrated in Figs. 215 and 216, this particular arrangement being that adopted in the Hollingworth and Knowles' loom already freely referred to. In order that the motion may be continuous, it is of course necessary that it be actuated from some continually-revolving source by means of toothed gearing or its equivalent. In the case selected for description, motion is conveyed from the vertical shaft A, when the loom is working forward, by the bevel wheels B and C and the clutch D to the horizontal shaft E of the dobby mechanism, the gearing being so arranged that the shaft E makes one revolution for each revolution of the crankshaft, or for every shot of weft. Keyed to the back end of the shaft E is a chain wheel F, of

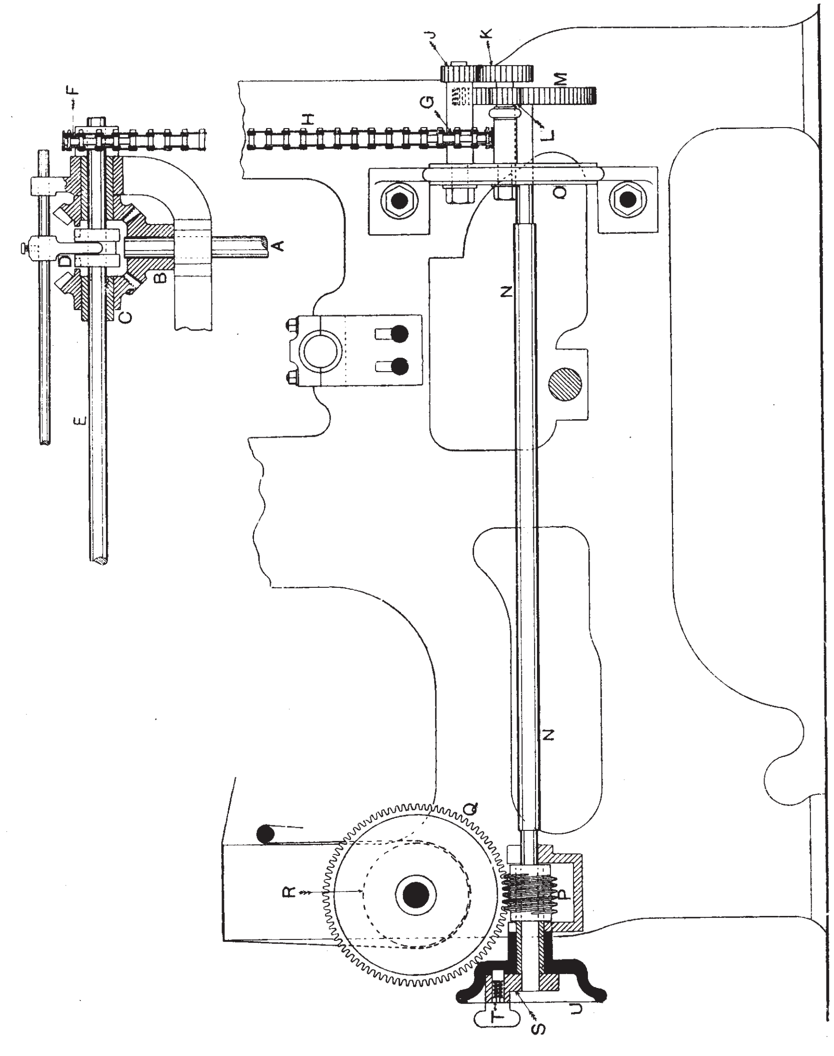


Fig. 215.

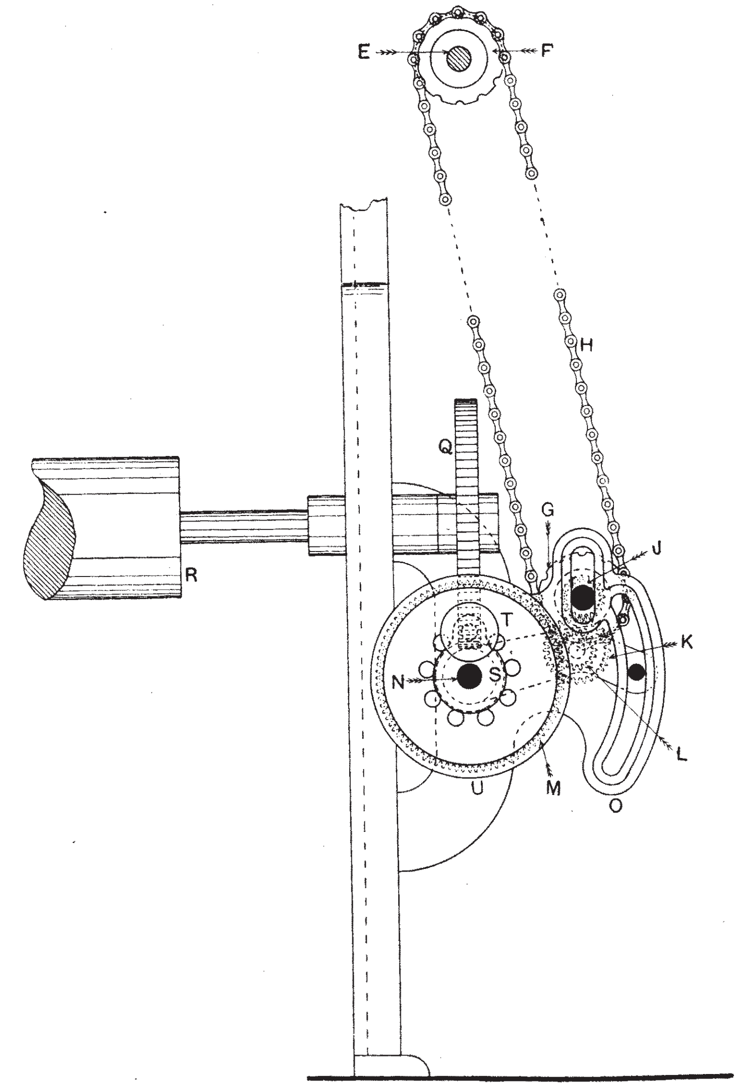


Fig. 216.

8 or 16 teeth, which drives a similar chain wheel G, also 8 or 16 teeth, by means of the pitch chain H. Compounded with the chain wheel G is a pinion J of 20 teeth, which gears with the change wheel K, the number of the teeth of which represents the shots per inch—or a multiple of them—upon the cloth. Compounded with the change wheel K is a pinion L of 18 teeth which drives the wheel M, of 84 teeth, on the horizontal shaft N. The stud supporting the pinions K and L is bolted in the bracket O, which is slotted concentrically with the wheel M to permit of the proper adjustment of larger or smaller change wheels at K. The shaft N extends to the front of the loom and carries near that end a single-thread worm P mounted loosely on the shaft and gearing with the worm wheel Q, 85 or 42 teeth, fixed to the arbor of the taking-up beam R, the latter being about $6\frac{1}{4}$ ins. in diameter. The worm P can be connected with or liberated from the shaft N in the following manner:—Keyed on the extreme end of the shaft N is a cranked piece S, the arm of which is drilled to receive a pin T which enters into one or other of a series of recesses in the face of the crown wheel U, and is held there by the action of a strong helical spring mounted on the shaft of the pin. This crown wheel U, shown in section in solid black in Fig. 220, and in front elevation in Fig. 221, is fixed upon the sleeve of the worm P, which is extended to receive it. Obviously, if the pin T be entered into any one of the recesses of the crown wheel U, the latter, and therefore the worm P, must move together with the shaft N, and the worm wheel Q and the take-up beam R will be rotated. If, however, the pin T be withdrawn from the recess of the wheel U, and rotated a little so that the face of the pin rests against the solid part between any two recesses, the wheel U is disconnected from the shaft N, and may, with the worm P and the take-up beam R, be rotated at will by hand in either direction. A feature of this motion is that when it is necessary on account of broken weft, or from any other cause, to reverse the shedding mechanism—done manually by the weaver rotating the shaft E in the reverse direction,—the take-up motion is also reversed and cloth is given off at exactly the same rate as it is unwoven.

Since the change pinion K in this motion is a driven wheel, and since the number of teeth in the pinion represents the shotting per inch upon the cloth, when the chain wheels F and G are equal, no calculation is necessary to find the pinion for any required shotting. Assuming, however, that a pinion of 20 teeth is the smallest that can be worked with conveniently, and that it is desired to obtain 15 picks per inch, this can be done by using a pinion of 30 teeth at K and making the chain wheel F double the value, 16 teeth, of chain wheel G, 8 teeth. By this means the speed of the motion will be doubled, as G will make two revolutions for one revolution of F, and the shots per inch upon the cloth will therefore be reduced by half. Or, again, assuming that a pinion of 80 teeth is the maximum that can be worked with at K, and that 160 shots per inch are required, this can be produced by reversing the values of the wheels F and G, making the former 8 teeth and the latter 16 teeth. In this manner the speed of the motion is reduced by one half, and the shots per inch will therefore be doubled, and an 80 pinion will give 160 shots per inch. For certain classes of work, where low shottings rule, the worm wheel Q is made with 42 teeth instead of 85; and, assuming that the chain wheels F and G are equal, this change, which is equivalent to doubling the speed of the take-up roller R, will make the shots per inch equal to only half the number of teeth in the change wheel K. Any alteration in the size of the chain wheels F or G necessitates an alteration in the length of the chain H, to or from which a few links have to be added or deducted as the case may require.

CHAPTER XVII

BOX MOTIONS

WHEN two or more colours of weft are required in the fabric, it is obvious that the necessary changing of the shuttle may be, and in some cases is, accomplished by hand. But as this primitive method necessitates the stoppage of the loom for every change of colour, production is in consequence materially reduced. Especially is this the case where the changes are of frequent occurrence. In order to obviate this reduced production, and to relieve the weaver of the extra labour and attention, as well as to minimise mistakes in changing, box motions are introduced. These motions are so varied and numerous that it is possible to describe only a selection of the best-known types.

The simplest, and what might be termed the original, drop-box motion for power looms is that shown in Figs. 217 and 218, and is known as the "Diggle's" motion. Movement is imparted from the crankshaft A by means of a spur pinion B of 22 teeth, which gears with the wheel C of 88 teeth. Cast on the inside face of the wheel C is a shell or bead D, which is broken at two points diametrically opposite each other for the insertion of pins E. As the wheel C revolves, the shell D slides on the lobes, and the pins E take into the slots of the star wheel F, and cause it

to be turned intermittently one-eighth of a revolution for

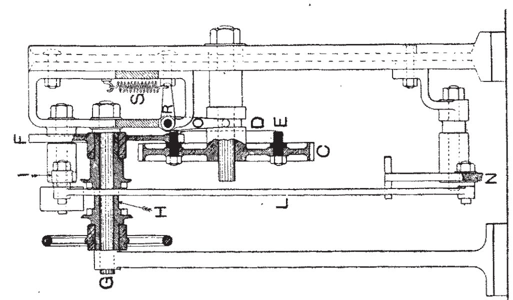


FIG. 218.

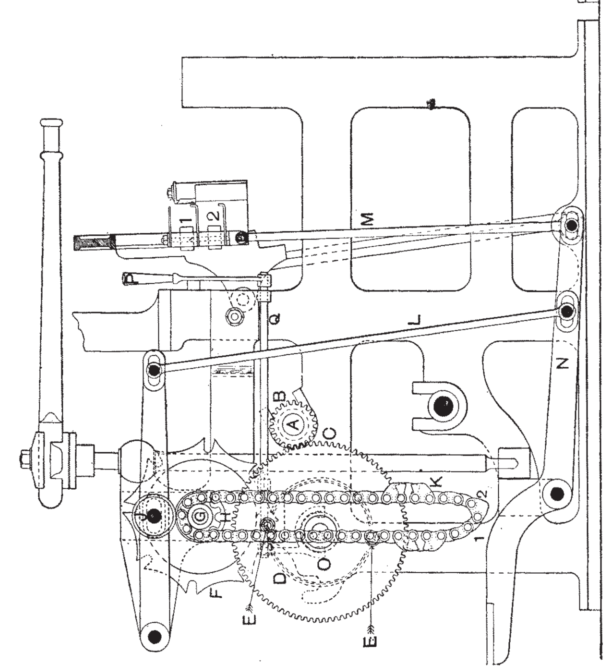


FIG. 217.

every two revolutions of the crankshaft. Compounded with the star wheel F is a chain barrel H of eight teeth for carrying the pattern chain K, the latter being shown only in Fig. 217. This chain is built of links of different heights according to the number of boxes to be actuated. In the example only two boxes are shown, and therefore links of only two different heights are required. As the chain barrel H revolves, the links are brought in regular succession under the anti-friction roller J attached to the lever I. The small links 1 allow the top box 1 to remain at the level of the race of the lay, but when the links 2 are brought under the roller J the second or No. 2 box will be raised to the level of the race by means of the levers and connecting rods I, L, N, and M, as shown. The pegs E are kept in gear with the star wheel F by means of the lever R and spring S, but when necessary they may be withdrawn by means of a handle P and clutch O from the star wheel F, enabling the chain to be turned by hand to any desired position, and retained in the same for any number of successive picks.

This method of producing long patterns necessitates the constant attention of the weaver, and also the frequent stoppage of the loom for the purpose of adjusting the chain. To prevent this loss of time and the constant strain on the weaver, a modification of the above motion has been introduced. This consists principally of a second or auxiliary chain which by means of suitable mechanism permits of the pattern chain K being moved only when a change of box is necessary.

Two views of this motion as made by Messrs. Charles Parker, Sons and Co., Dundee, are shown in Figs. 219 and 220. The mechanism, which directly actuates the shuttle boxes, although differing in detail, is precisely the same in principle as that already described. Thus the star wheel F which carries the pattern chain—the latter is not shown

in these figures—may be rotated intermittently one-eighth of a revolution for every two revolutions of the crankshaft

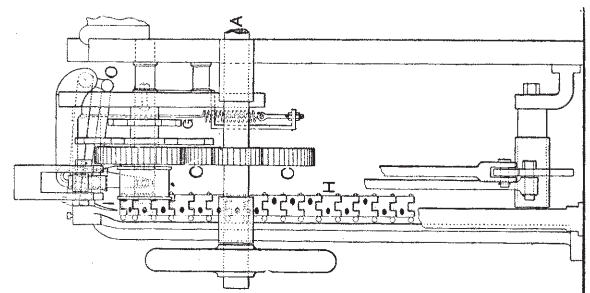


FIG. 220.

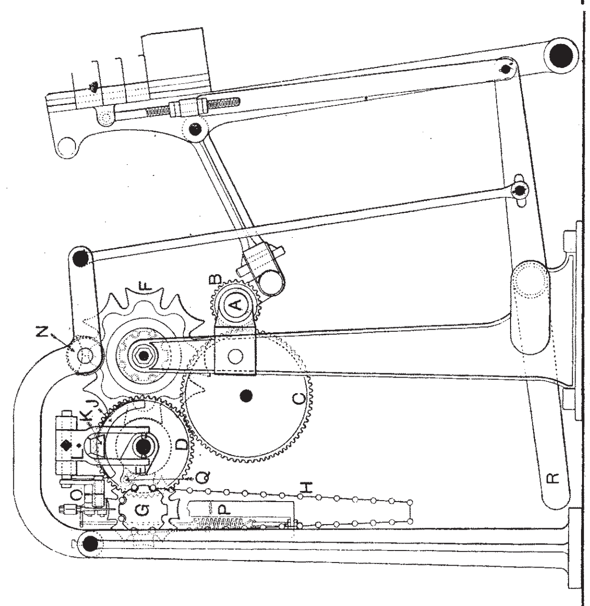


FIG. 219.

A by means of a spur wheel B, carrier wheel C, and pin wheel D. Since the relative values of the wheels B and D

2 F

are as 1 to 2, it is obvious that only one pin Q is necessary in the wheel D for the purpose of rotating F. Although the pin Q revolves in unison with the wheel D, it is in this instance capable of being drawn into a recess in D. This is in order to prevent, when necessary, the partial rotation of the star wheel F and the pattern chain. By this means any desired link of the box chain may be retained under the anti-friction roller N for any even number of picks. The method of controlling the movement of the pin Q in the wheel D is as follows:—

The auxiliary chain H, which consists of a series of flat iron links, passes over the chain barrel G, the latter being compounded with a second star wheel. This star wheel is rotated one-eighth of a revolution every two picks by means of a second but fixed pin M attached to the barrel, and the latter bolted to the wheel D. As shown in Fig. 220, the links of chain H may be so arranged as to present either a hole or a blank portion of the link underneath the finger I. This finger is connected by means of the levers O and clutch-fork L to the sliding block E (see Fig. 221), of which the pin Q forms a part. The spring P, Figs. 219 and 220, constantly tends to keep the finger I in its lowest position, and therefore the parts shown in Fig. 221 in the position indicated. When in this position, a portion of the finger I will have passed through the hole in a link of the chain H, and the pin Q will project beyond the inner face of the wheel D, and so engage with and partly rotate the star wheel F. If, however, the solid part of a link in the chain H be presented to the finger I, the latter fails to enter the barrel G, and at the same time the pin Q of the sliding block E is, by means of the levers O and the clutch-fork L, retained in the recess of the wheel D, and the star wheel F remains stationary. It is, of course, necessary that the pin

I be raised above the level of the links of the chain H before the barrel G begins to rotate. This is accomplished through the levers O by means of the bead cam J—cast upon the face of the wheel D—acting upon the anti-friction cone K which is attached to the clutch-fork L. Figs. 222

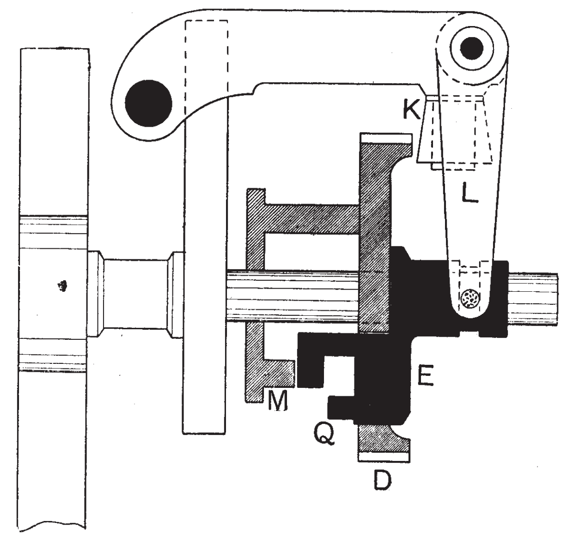


Fig. 221.

and 223 are further views of this motion, while Fig. 224 shows the chief units of it.

Motions of this type are only suitable in cases where the successive shots of each colour are a multiple of two. Since each link of the chain H serves for two shots of weft, it is clear that the number of links employed equals half the number of shots in a round or repeat of a pattern. It will be observed that in the above and similar motions the boxes are raised positively, but fall simply by virtue of

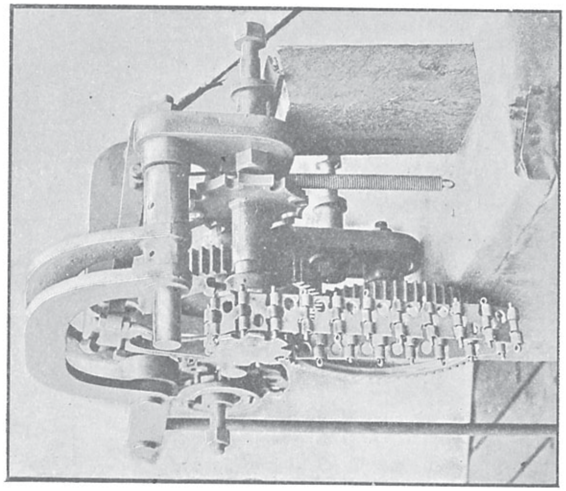


Fig. 223.

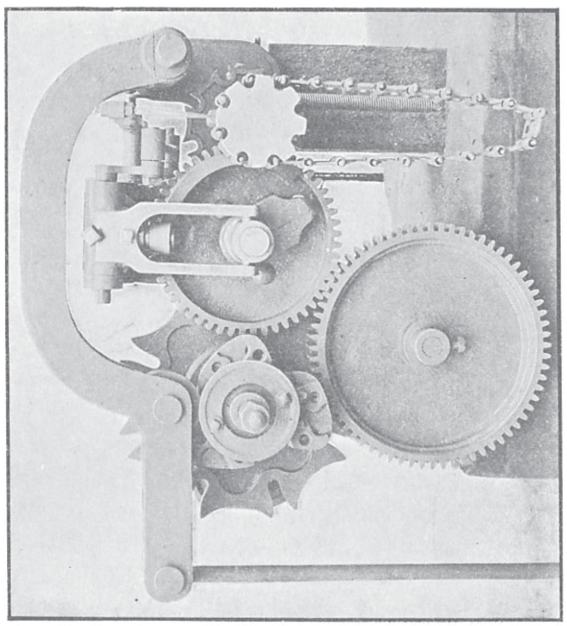


Fig. 222.

their own weight and that of the mechanism attached. This negative method of descent is the great fault of this type of motion, for notwithstanding counterbalance weights added at R, there still remains a tendency on the part of the shuttle boxes to rebound after a fall. When dropping through a distance of three boxes it is practically impossible to prevent this.

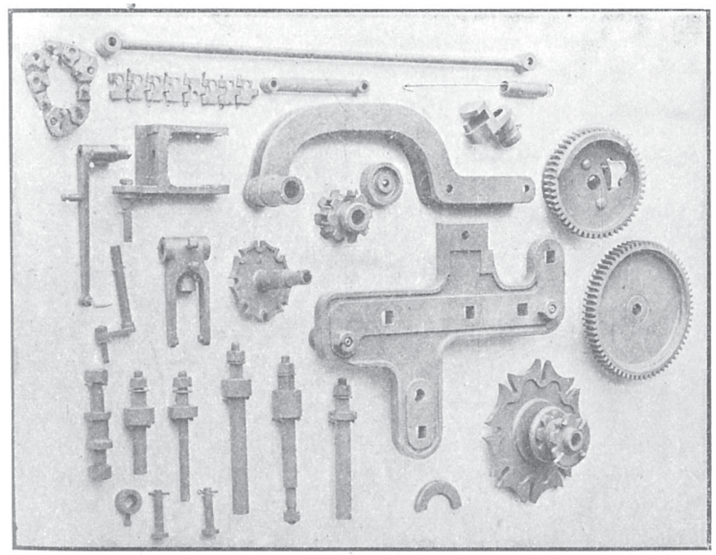


Fig. 224.

As a natural consequence of the tendency of the boxes to rebound when actuated by a motion of the Diggle's-chain type, a high speed in the loom is impossible, and production is therefore kept at a minimum. To obviate these defects it is evident that the boxes must either be positively actuated, or, at least, controlled in their descent as well as in their ascent.

Of purely positive motions there are different types, but that one which seems most worthy of attention is the Whitesmith principle of two or more compounded eccentrics, the one inside the other, each capable of independent movement and of controlling the position of the shuttle boxes proportionately to the extent of its throw. In the case of four boxes, two eccentrics are used, the inner, or smaller, one having a throw equivalent to the lift of one box; and the outer, or larger, one a throw equivalent to the lift of two boxes. By properly operating these eccentrics any one of the four boxes may be brought level with the race of the lay as desired; and due to the fact that the initial mover is an eccentric, the change is accomplished in an ideal manner.

Figs. 225, 226, and 227 show respectively the side elevation, back elevation, and plan of such a drop-box motion as made by Messrs. R. Hall and Sons, Ltd., Bury, while Figs. 228 and 229 illustrate a few details. Motion is carried from the wheel A of 17 teeth on crankshaft B to wheel C of 34 teeth. This ratio of 1 to 2 is necessary owing to the fact that the motion illustrated is arranged for boxes at one side of the loom only. Wheel C, which is keyed to the short shaft D, has two square recesses on one side diametrically opposite to each other, into which fit two corresponding projections E on the disc F. The combination thus effected ensures that disc F will move in unison with the wheel C. Since disc G performs similar functions to disc F and must rotate with it, the nave of F is extended along the shaft D in the form of a clutch to engage with disc G in such a manner that either disc or both may be moved laterally on the shaft without becoming disengaged or ceasing to rotate. A compound eccentric K, consisting of one small eccentric enclosed in a larger eccentric, runs

loosely on stud H. The eccentric strap L, which surrounds the larger eccentric and therefore encloses both, is connected to the shuttle-box lever N, fulcrumed at O, by means of

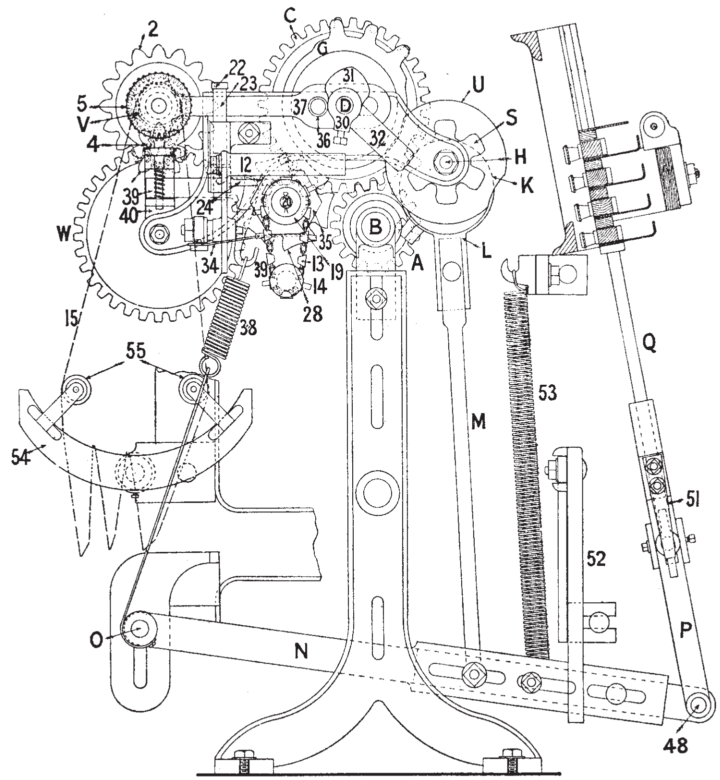


FIG. 225.

rod M, whilst the outer end of lever N is connected to the boxes by means of part P through the safety escapement mechanism and plunger rod Q. The double eccentric K is similar to that illustrated in Fig. 230.

Compounded with the small eccentric is a wheel S of 6 teeth, shown in Figs. 225 and 227; similarly the large eccentric is compounded with wheel R. T and U are the locking plates for R and S respectively, and these locking

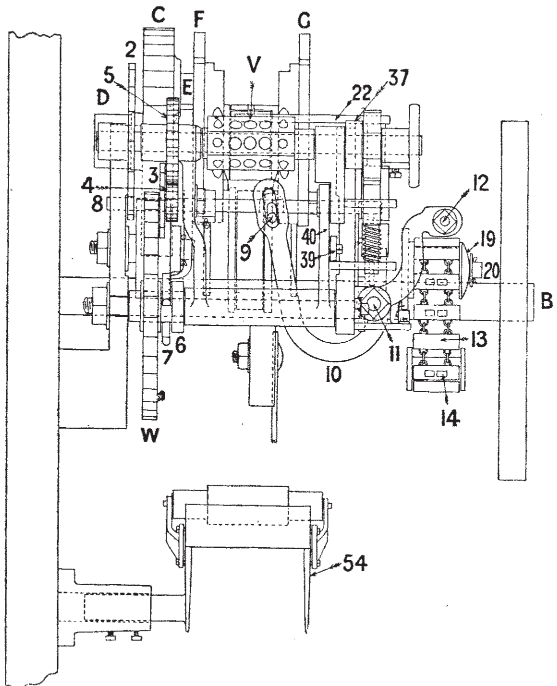


FIG. 226.

plates prevent all motion on the part of the eccentrics except when the teeth of R and S come into contact with the teeth on discs F and G.

V is the pattern card barrel or cylinder, 8-sided as shown, and capable of being driven clockwise or counter-clockwise as desired. It receives its two motions as follows:—The

large spur wheel C drives spur wheel W through intermediate wheel X (shown only in plan, Fig. 227); wheel W contains the same number of teeth as wheel C, and, consequently, makes one revolution for two picks. Projecting from the two faces of wheel W are pins Y and Z; the latter drives cylinder V clockwise directly by means of wheel 2, while the former drives the cylinder counter-clockwise by

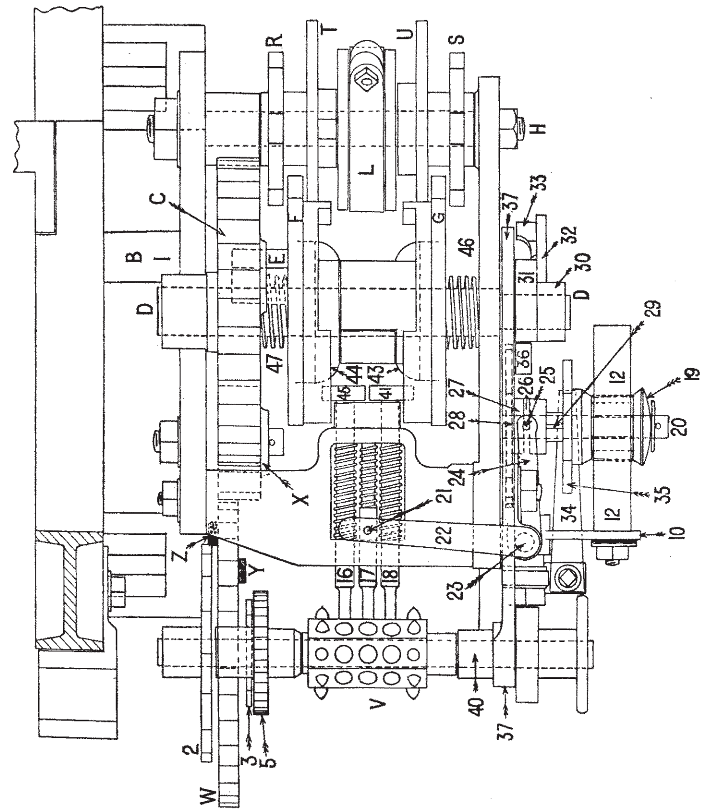


FIG. 227.

means of wheel 3 compounded with pinion 4, which in turn gears with wheel 5 on cylinder shaft. The two directions of motion of the cylinder are resorted to only when it is possible to weave a long pattern with a comparatively short chain, and, of course, in cases where the correct boxes can be brought into line by the reversal of the chains, as for example, in symmetrical patterns and in long lengths of the same colour where a few cards may be rotated forwards and backwards for the necessary number of times. The pegs Y and Z are brought into contact with wheels 2 and 3 by means of clutch (see back elevation Fig. 226), and fork 7 set-screwed on shaft 8. Projecting from shaft 8 is a pin 9 which enters a slot, as shown in the lever 10 fulcrumed at 11, the opposite end of lever 10 carrying a long stud 12 which rests upon, and is governed by, the lags 13 and pegs 14. The normal position of the stud 12 is down, where it remains on the lags in virtue of its own weight and the action of a spiral spring on shaft 8 between the fork 7 and the framework. The stud 12 is lifted from the low position, when desired, by pegs in the lags.

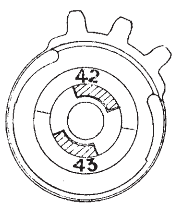


FIG. 228.

Metal cards 15 are formed into a chain, as seen in Fig. 225, and are operated in the desired direction on cylinder V. The cards have to operate three distinct needles, 16, 17, and 18, the middle one 17 being the one which governs the lag cylinder 19 centred on stud 20. Springs on the rear ends of needles 16, 17, and 18 keep them full out unless when pressed backwards by blanks in the cards. A vertical pin 21, fixed to and rising from near the middle of needle 17, enters the end of lever 22 fulcrumed at 23; near the bottom of this short vertical shaft 23 is set-

screwed a lever 24, from the end of which depends a short pin 25 which enters a groove 26 in the boss of the star wheel 28. This star wheel 28 is loose upon the cylinder shaft 20, and a small pin 29, projecting from the face of the boss 27, enters a hole in the hexagonal part 35 of lag cylinder 19, so that when the star wheel is moved the lag cylinder will move also. On the end of shaft D is set-screwed a boss 30 compounded with which is a cam 31 and an arm 32, from the inner face of which projects a pin 33. In the positions shown, the pin 33, while rotating round shaft D, will not come into contact with the star wheel 28. Should a blank in the metal cards 15, however, come opposite needle 17, then the latter will be pressed back, and, through lever 22, shaft 23, lever 24, and pin 25, the star wheel will be drawn into the line of the path of pin 23, and the star wheel 28 will be rotated one-sixth of a revolution, thus bringing forward the next lag under the stud 12. A flat spring 34 presses against the under face of the hexagonal part 35, and this steadies the lag cylinder in much the same way as the spring hammer steadies the cylinder of a dobby or a jacquard. Before turning the cylinder V in either direction, it is first necessary to withdraw it clear of the needles 16, 17, and 18. This is done by the cam 31, on the end of shaft D, pressing against the anti-friction roller 36 on arm 37. One end of arm 37 encircles the cylinder shaft, and, consequently, when the thick part of the cam 31 presses against the anti-friction roller 36, the cylinder V will be

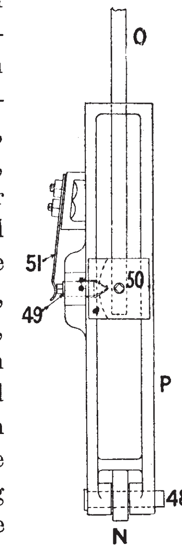


FIG. 229.

forced back and clear of the needles 16, 17, and 18. The spiral spring 38, and the hooked lever 39 attached to upright lever 40, Fig. 225, ensure the return of the cylinder V after the thick part of the cam 31 has passed the anti-friction roller 36. During the time that cylinder V is clear of the needles, either peg Y or peg Z will have rotated the cylinder V one-eighth of a revolution, and brought the next card opposite the needles.

The changing of the shuttle-boxes is accomplished as follows:—As previously mentioned, the two eccentrics K are compounded with the two wheels R and S, of 6 teeth each in this case, and these wheels are moved through half a revolution when required by the 3 teeth formed on the periphery of discs F and G, shown in Fig. 225 and in detached view in Fig. 228. Disc F is brought into line with wheel R when a blank in the card presses needle 16 in; disc G is operated similarly when a blank in the card presses in needle 18. When needle 18 is pressed in, the anti-friction roller 41 on the end comes into the line of the thin part 42, Fig. 228, of a cam cast on the inner side of disc G; as the disc rotates, the gradually increasing thickness of the cam 43 comes into contact with roller 41, hence the disc G is gradually forced outwards until the 3 teeth of the disc come into line with the teeth in wheel S. The latter wheel is then rotated through half a revolution, and the eccentric receives a similar rotation by means of which the shuttle-boxes are raised or depressed one box through rod M, lever N, and rods P and Q. In a similar manner, the large eccentric, which encloses the smaller one and rotates on it, is rotated by the anti-friction roller 45 on the end of needle 16 acting on the cam 44 of the disc F, and bringing the teeth of the latter into contact with those of wheel R. The discs are returned to their

normal positions, that shown in the drawing, by the springs 46 and 47.

The above motion is absolutely positive, and hence an escapement is necessarily provided between the end of lever N and the boxes, Fig. 225. This consists of the following parts, shown in detail in Fig. 229:—The rectangular part, P, is fulcrumed at 48 on the end of lever N. Fixed at a convenient part of this rectangular frame is a > shaped pin 49 which is held hard against a similar > shaped recess in part 50 by a flat spring 51. The plunger rod Q is set-screwed to part 50, and when working satisfactorily, all move in unison. Should a shuttle be trapped, however, the rectangular part P will still move either up or down, but in doing so the spring 51 yields and allows pin 49 to slip out of contact with the recess in part 50. A forked guide 52 keeps lever N in a vertical plane, while the weight of the boxes is in a certain measure balanced, and the mechanism is to a certain extent relieved, by a spring 53 hooked at the top to the framework, and at the bottom to the lever N. A cradle 54 is provided to support long lengths of cards, and the latter are guided to their proper positions by rollers 55.

The general method of compounding and enclosing the two eccentrics in the strap is illustrated in Fig. 230, which also represents an eccentric motion of a somewhat similar type to the foregoing, but without the reversing motion for the pattern cylinder. The small eccentric T is cast as part of the wheel R, but the large eccentric S is compounded with the wheel Q by a rectangular projection 6, as shown in detached view. This or some similar arrangement is necessary in all such motions in order to permit of free vertical movement on the part of the large eccentric when either S or T is actuated alone. The two wheels Q and R,

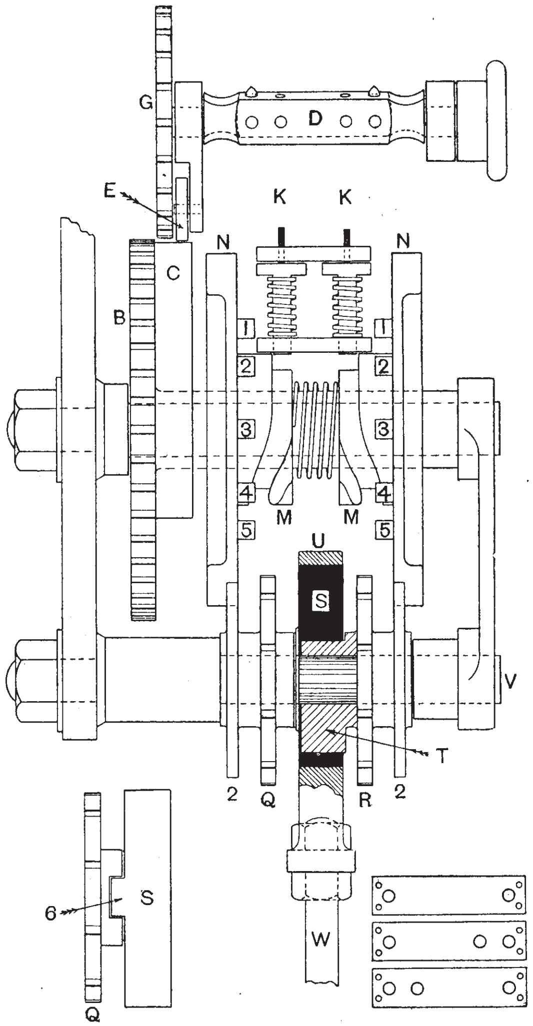


Fig. 230.

and the two eccentrics S and T, are operated when necessary by peg wheels N, the latter being caused to move inwards when needles K enter the grooved cams M as a result of the action of the steel cards carried forward by the card cylinder D. The latter is pushed outwards by the thick part of cam C on wheel B, and partially rotated every second pick by means of 3 wide teeth in B taking into the teeth in wheel G when the cylinder is moving out. The cylinder is returned to the needles by the action of a spring. When a peg wheel N is moved inwards, the projecting pegs 1 to 5 are brought into line and engage with and rotate the corresponding eccentric wheel Q or R, and thus turn the eccentric half a revolution. Locking plates 2 prevent any accidental movement on the part of the eccentrics. The three different kinds of cards for this motion are shown in the detached view in the bottom right-hand corner.

Fig. 231 shows diagrammatically the necessary positions and changes of the eccentrics S and T required to bring the shuttle-boxes 1 to 4 to the level of the race line A B. In the first position the thick portions of the two eccentrics are down; in the second position the small eccentric T has moved half a revolution, lifting up box No. 2; in the third position the eccentric T has returned to its original position, while the thick part of the large eccentric S has moved round, lifting up box No. 3; and in the fourth position the thick parts of the two eccentrics are up, giving box No. 4. In considering the effect of such changes it must be remembered that the large eccentric S utilises the small eccentric T as a shaft round which it revolves.

A comparatively recent development of a motion of the eccentric type is that known as Heyworth's Patent, and made by Messrs. William Smith and Brothers Limited, Heywood. It is shown in sectional end elevation in Fig. 232, and in front elevation and plan in Figs. 233 and 234

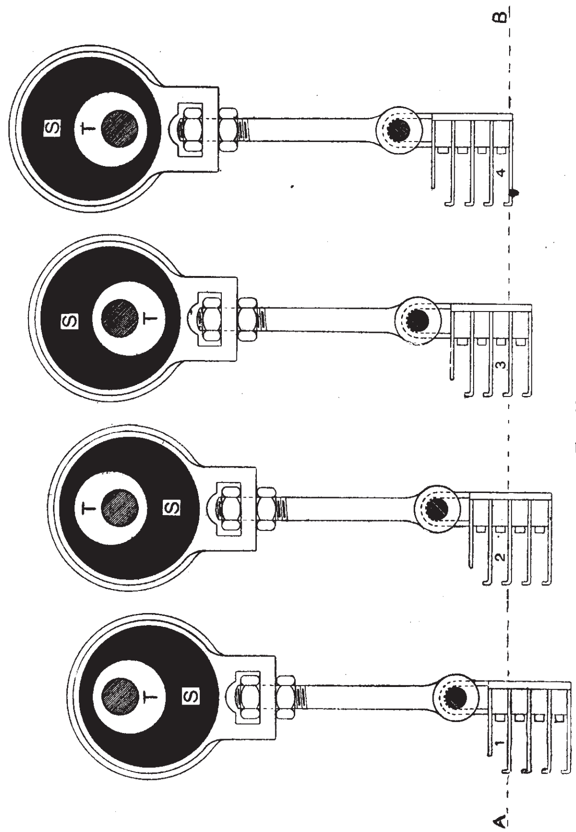


Fig. 231.

respectively. The eccentrics have, for obvious reasons, been omitted from Fig. 233. In this motion the drive is taken from the crankshaft A (Figs. 232 and 233) to the controlling mechanism of the eccentrics by means of equal

wheels B and C of 25 teeth each. The former is set-screwed to the crankshaft A, and the latter, of which the pitch line only is shown in Fig. 232, is compounded with the discs D, D, which rotate loosely on their central stud E and make one full revolution every pick. This method of driving permits the box mechanism to change every pick if desired—an essential feature in looms provided with boxes at both ends of the lay and arranged to pick at will from either end. Wheels B and C are slightly elliptical and are set eccentrically on their respective shafts in order that a variable rate of rotation may be conveyed to the discs D, D. If these discs moved with the uniform velocity of the crankshaft, too little time would be available for the actual changing of the boxes, but by adopting the above arrangement the speed of the discs D, D is very much reduced during the period of actual change, and proportionately accelerated between two successive changes of the boxes. A portion of each disc D, D forms a movable segment F which is carried by its respective lever G, to which a lateral movement may be imparted. The latter is fulcrumed on the stud H bolted to the inner side of its corresponding disc D, and the said segments F, F are retained in the peripheries of their respective discs by the action of the flat springs J, J and a suitable stop not shown.

The extremity of each lever G forms the segment of a toothed wheel and has 5 teeth, the first and last of which are extra thick and strong. Cast on the face of each lever G, G is a cam piece K, K which may or may not be acted upon by the inner end of the needles L, L as the discs D, D and levers G, G are rotated. The needles L, L are supported at the lower end of the pendant arms of the levers M, M. These levers swing upon the stud N and by

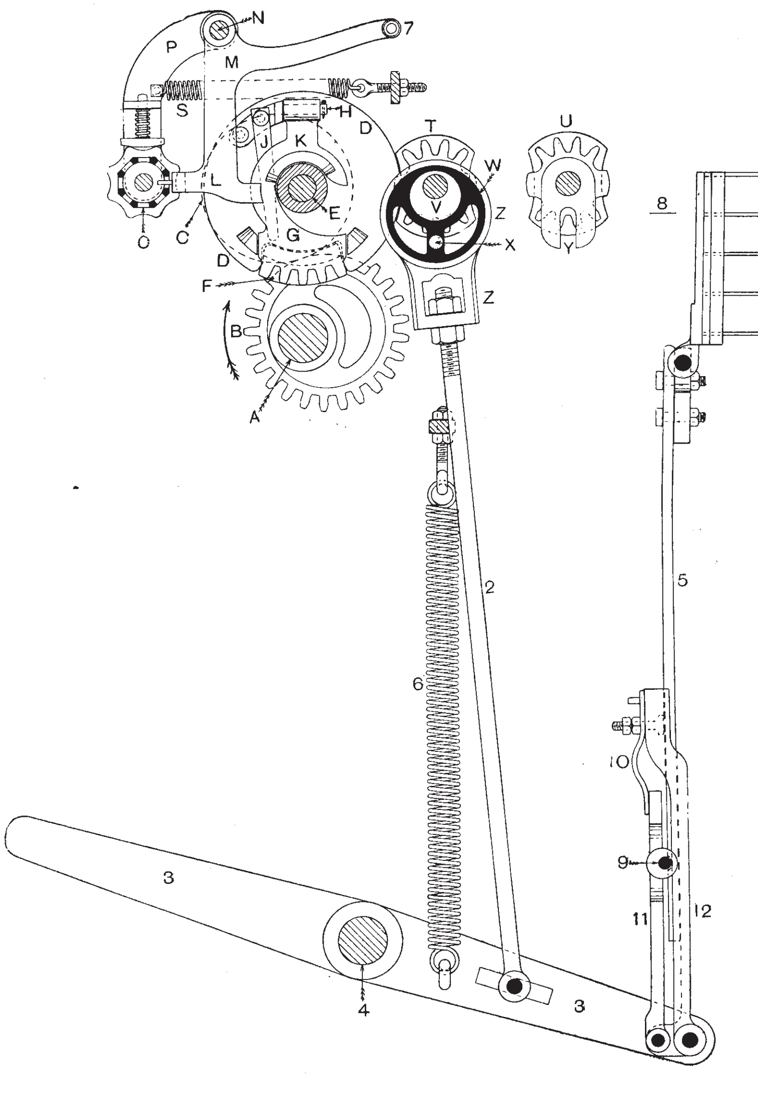


FIG. 232.

gravitation keep needles L, L clear of the cam pieces K, K when not otherwise controlled by the thin metal cards which are carried round by the chain cylinder O. The latter is carried at the extremity of the arms P centred on the stud N, and is pushed outwards, and partly rotated, each pick by the action of a cam cast upon the inside of the toothed wheel Q, the latter being rotated independently of the disc D by a further pinion R, also set-screwed on the crankshaft. Rotation of the card cylinder O is accomplished in the well-known manner by a fixed catch not shown, while O is returned into contact with the needles L, L by the action of spiral spring S. When holes in the card are presented to the needles L, L, the latter enter the cylinder O, as shown in Figs. 232 and 234, and no change of the boxes takes place; but if a blank or solid portion of the card be presented, the needles L, L are pushed backwards and their inner ends interpose in the path of movement of the cam pieces K, K as the latter rotate. Needles L, L are supported against lateral pressure by an inverted Λ-piece 13 (see Fig. 233), but when this lateral pressure is imparted to the curved faces K, K, the levers G, G are moved laterally until segments F, F are clear of the peripheries of their respective discs D, D. This breaks the continuity of the latter and brings the teeth of the levers G, G into the line of action with the teeth cast upon the inside of the locking plates T and U, in the concave portion of which the discs D, D rotate. Further rotation of the discs D, D causes the teeth of the levers G, G to take into the teeth compounded with the locking plates T and U, and to rotate the plates through 180 degrees, the latter being permitted to do so since the continuity of the discs D, D is now broken for that purpose. It must, of course, be understood that either or both needles L, L, and therefore either or both locking plates T and U, may be operated at will. The small eccentric V is compounded with the

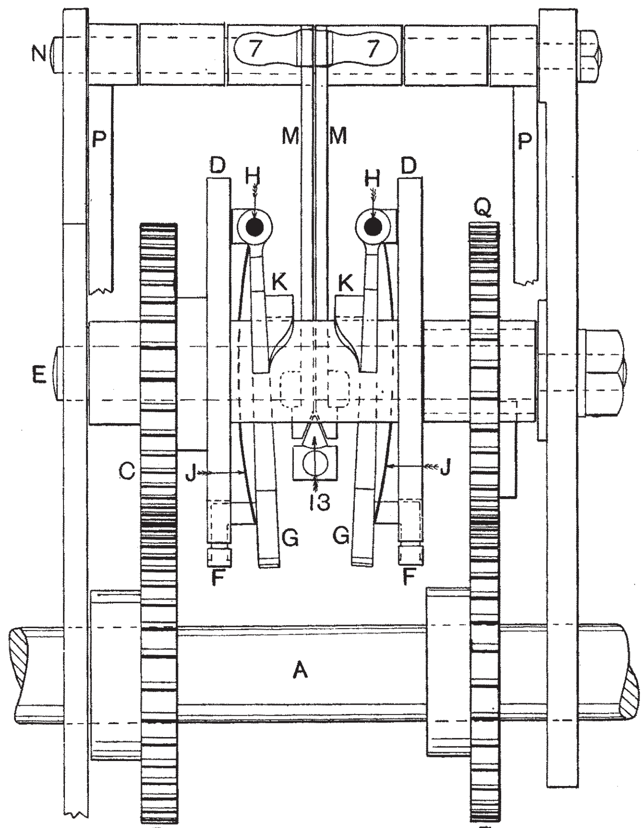


FIG. 233.

locking plate T, but the large eccentric W is actuated by a projecting stud X which enters the slot Y in a special driving piece compounded with the locking plate U.

This arrangement is shown in the detached view Fig. 232, and performs a similar function to that mentioned with reference to detached view Fig. 230.

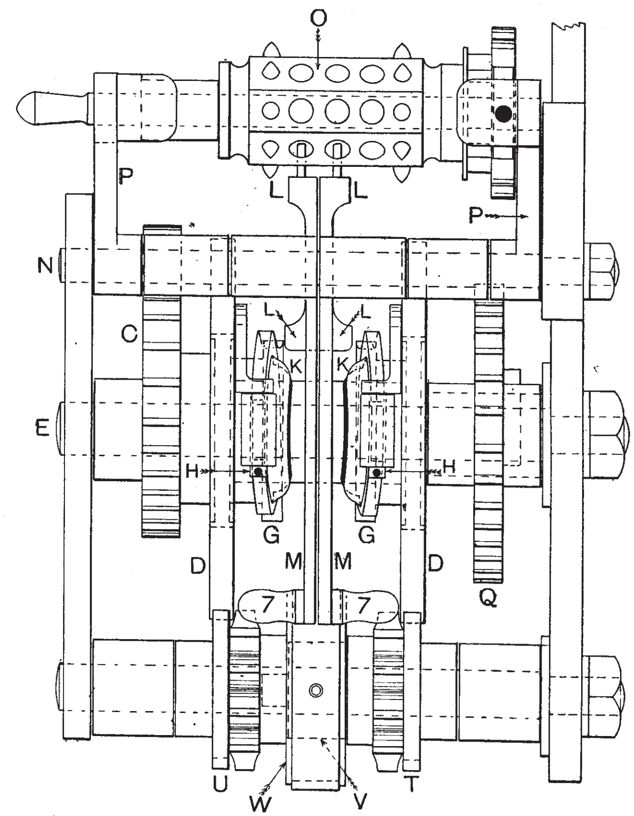


FIG. 234.

Further connections to the boxes are made by eccentric strap Z, rod 2, lever 3 fulcrumed at 4, and vertical rod 5. Spiral spring 6 assists in counterpoising the weight of the boxes and thus relieves the eccentrics of a portion of their weight. With boxes at each side of the loom duplicate sets of needles, discs, and eccentrics are required, but all are situated at one end of the loom. Lever 3 in Fig. 232 is mounted loosely on rocking shaft 4; two similar levers are required to impart motion to the boxes at the opposite side, but both are fixed to the rocking shaft 4, one immediately behind 3 and the other in a corresponding position at the other end of the loom.

Only two holes of the card cylinder O are shown utilised by the needles L, L, the third one being available for a similar needle arranged to control the pick-at-will picking motion referred to on page 344, and supplied by the same firm. Knobs 7 on the horizontal arms of levers M, M assist greatly in keeping the needles L, L in the position of inaction, and at the same time afford a ready means of controlling them by hand when it is desired to bring any particular box to the level of the race line 8, 8. In the event of excessive obstruction being offered to the free movement of the boxes—such as a trapped shuttle or the picker failing to clear the boxes in time—connections are broken in the following simple manner. Near the lower end of the box rod 5 a shallow cross groove is cut. The pin 9 is caused to fit firmly in this groove by the pressure of the flat spring 10 on the upper end of the arm 11 in which the pin 9 is fixed. Arm 11 is hinged at its lower end to a projecting part of the standard 12, which in turn is bolted to the extremity of the lever 3. It therefore follows that under normal conditions rod 5, arm 11, and standard 12 move as one piece; but if excessive opposition be offered to the upward or downward movement, the spring 10 yields sufficiently to enable the groove in rod 5 to slip past the retaining pin 9 and thus permit the

eccentrics to complete the full movement without breakage. Further additions may be made to this motion whereby any one or more links of the pattern chain may be brought into repeat operation by reversing the rotation of the pattern chain barrel, thus enabling the length of the pattern chain to be greatly reduced where a constant repetition of pattern is required. The motion may also be modified so that the same card always brings the same box to the level of the race irrespective of the previous position of the boxes.

With this motion a new type of shuttle-box swell is fitted which, while being suitable for single-shuttle looms as well, has the special advantage in a box loom of permitting the shuttle to be wholly in the box before it begins to arrest the progress of the shuttle in the slightest degree. This arrangement reduces to a minimum the possibility of having a trapped shuttle. The swell will be found described under "Warp Protectors," Chapter XVIII., page 492.

Since the eccentrics in all the foregoing motions move in only one direction, it is evident that similar cards presented to the card cylinder will not always produce similar results. This fact creates a difficulty in the building up of pattern chains for the motion, since it is always necessary to consider the previous positions of the eccentrics and boxes.

Messrs. Hacking and Co., Bury, have, however, successfully overcome the difficulties of chain building in connection with eccentric box motions of the following type. By the addition of a few simple parts they so control the movements of the main needles, and therefore of the eccentrics, that the presentation of the same or similar card always results in the same box being brought to the level of the race.

In its essential features the new motion is identical with that referred to in connection with Fig. 230, although the arrangement of the parts is slightly modified to accommodate the additional mechanism. In the new motion, the chief parts of which are shown in elevation—part sectional and part detail—in Fig. 235, the boxes, 4 in number, are situated to the right of the parts shown, and are controlled in the usual manner through eccentric rod W. This rod is attached to one extremity of the bottom lever, the plunger rod for the boxes is attached to the other end, and the fulcrum of the lever is between the two connections. This will be seen clearly by considering Fig. 236, which, although the opposite hand to that illustrated in Fig. 235, will enable the reader to understand the positions and functions of the various parts. With the connections to bottom lever as shown in Fig. 236, the eccentric rod is in tension when acting against the powerful spiral spring, whereas in those motions illustrated in Figs. 225 and 232, the rod is in compression in similar circumstances and must therefore be a little thicker.

In Fig. 235 only one cam M with its corresponding peg wheel N is shown—that one controlling the large eccentric. This permits the sleeve extension 7 of the nave of the wheel B to be shown in section, and the coiled spring 8, which tends to keep the cams M apart, to be seen in elevation. The large eccentric S is seen without obstruction, while the small eccentric is dotted behind its locking plate 2 and its star wheel R of 10 teeth.

The drive of this motion is obtained in much the same way as that shown in Fig. 225. Pinion A of 18 teeth is keyed to the crankshaft and drives, through the medium of an intermediate pinion, which is useful to change the motion slightly as to time, the stud wheel G of 36 teeth. The latter thus makes one complete revolution every two

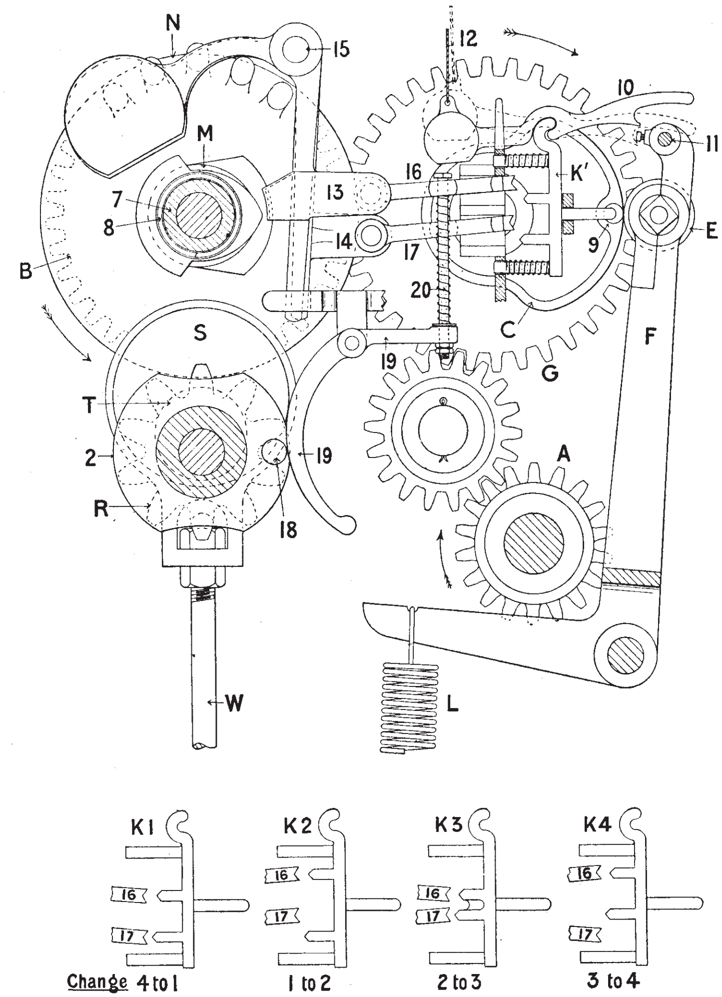


Fig. 235.

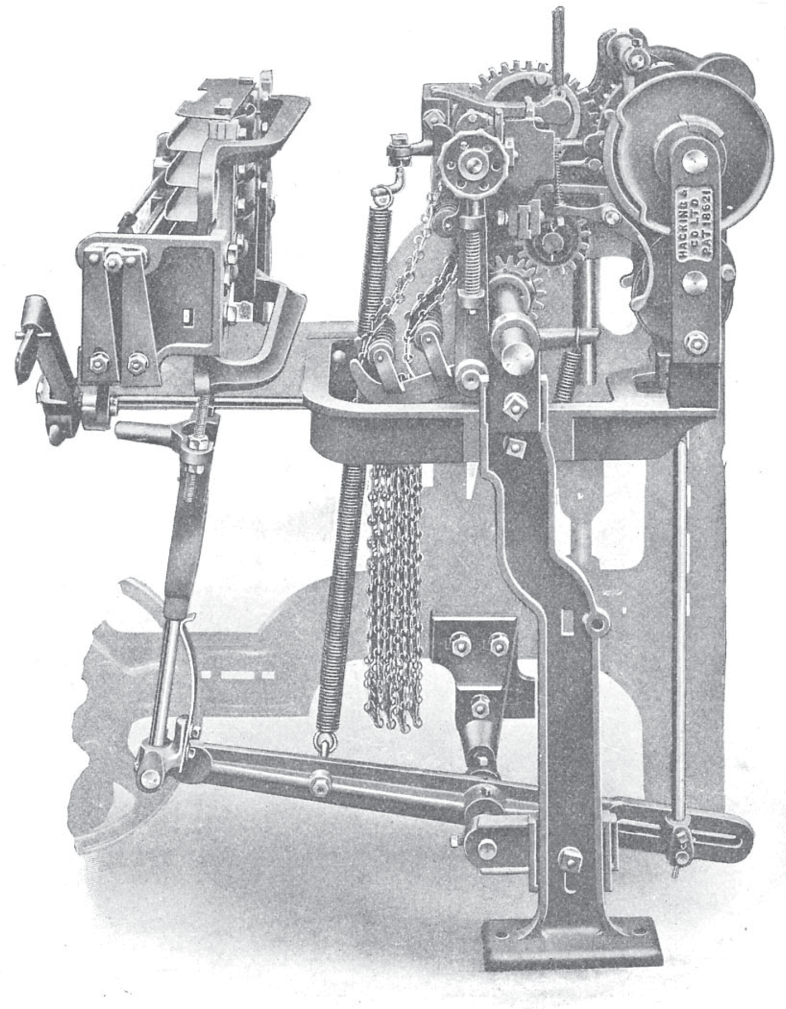


Fig. 236.

picks, and imparts a similar and equal movement to the cam wheel B of 36 teeth. Cam C is cast on the face of wheel G, and, as the latter rotates, pushes out the card cylinder arms F by pressure on the anti-friction roller E. Just before the cylinder reaches the position indicated on the drawing, stud 9, projecting slightly from the side of the cam, engages with one of the recesses of a four-lobed star wheel on the cylinder spindle, and thus moves the cylinder through a quarter of a revolution. This brings the cards in regular succession opposite the needles. Neither cylinder nor star wheel is shown in the illustration; they are unnecessary when the motion is arranged, as in this case, to work from a dobby or a jacquard through the levers 10 and spindle 11. The latter is moved inwards with the cylinder frame F under the influence of spring L as the cam C revolves and presents its reduced radius to the roller E.

Four needles K are provided, one for each box, as shown in detail at the bottom of Fig. 235, although only one, K^1, is shown in its working position. Similarly, four levers 10 are necessary, each controlled by its corresponding cord 12 from a lever of the dobby or a hook of the jacquard. Each needle K is provided with two pointed projections at the back, the top projection for actuating the controlling needle lever 13 of the small eccentric, and the lower projection for the controlling needle 14 of the large eccentric. These needles are fulcrumed on the stud 15, and, in virtue of their weighted arms, naturally tend to be in the inoperative position as far as the cams M are concerned.

Each needle lever is, however, provided with a horizontal pivoted extension 16 and 17, the free end of which is concaved as shown, and is broad enough to be acted upon by any one of the four needles K.

Each extension piece is also so controlled that it may occupy a high plane or a low plane according to the positions of the eccentrics and their locking plates for the time being. Since eccentric rod W and the plunger rod for the boxes are at opposite ends of the bottom lever, it follows that both the eccentrics will be at the top dead centre of their movements when the boxes are in their lowest positions with No. 1 box, the top one of the four, level with the shuttle race. This is the position indicated in Fig. 235, from which it will also be seen that at the same time locking plate 2 of the small eccentric will be in such a position that stud 18, cast upon the side of the locking plate, will have acted upon lever 19 in such a manner as to lift extension piece 16 to its high position through the medium of pin and spring 20. In a similar manner the needle extension 17 is raised to its high plane by a similar pin and spring, and lever actuated by a corresponding stud on the side of the locking plate of the large eccentric. To prevent confusion of the diagram, no attempt has been made to show these parts. Should either or both eccentrics be turned to the opposite dead centre—when of course the boxes would occupy an entirely different position—the corresponding extension or extensions 16 and 17 would occupy the low plane. As at present situated, however, it is clear that, although the needle K^1 be pressed inwards by the card cylinder directly or through bar 11 acting upon lever 10, neither eccentric will be actuated since the pointed projections at the back of K^1 will pass under the ends of their corresponding needle extensions. On the other hand, should needle K^2, K^3 or K^4 be pressed inwards, it is equally clear that in the first case, see K^2 in detached view of Fig. 235, the top projection would act upon needle extension 16 and so bring the small eccentric

into action to bring box No. 2 level with the race. At the same time the stud 18 would rotate through 180 degrees and extension piece 16 would drop to the low plane, see K^3 in detail view. If at this time needle K^3 be pushed inwards, it is evident that both of its projections will act, since extension 16 is now in the low plane, while extension 17 is still in the high plane. This will put both eccentrics into motion, and so bring box No. 3 level. At the same time extension 16 will again resume the high position, while extension 17 will drop to the low position, see K^4. Let us now suppose that needle K^4 is pressed inwards. Obviously the top projection only will act since extension 16 is in the top position opposite its needle, and extension 17 is dropped clear of its needle. The small eccentric only will therefore be put into motion, and the boxes changed from No. 3 to No. 4 as desired. This change will again cause extension 16 to drop and to occupy its low plane along with extension 17 as at K^1 in detail view. If while in this position the needle K^1 be pushed inwards, then both of its projections would act, and both eccentrics would rotate, and the boxes change from No. 4 to No. 1, and at the same time both extensions 16 and 17 would again be raised each to its high plane.

In a similar manner it might be shown that no matter what position the boxes may occupy, and no matter what change they are desired to make, the parts indicated are so arranged that if the corresponding needle K be pressed inwards that box will be brought level with the race. Should that box already occupy the level position, then no movement takes place although the needle be operated.

The levers 10 may be readily removed when the box pattern is in chain form on its own special cylinder as illustrated in Fig. 236, but, when the boxes are controlled from a dobby or a jacquard, these levers are raised by the shedding mechanism at their heavy ends, and swing about the head of the needle K until the recess of their free ends interpose in the path of bar 11 as the latter travels inwards. This is shown by the dotted position of 10. This principle of 1 card 1 box can be applied by Messrs. Hacking and Co. to the Eccles Box Motion illustrated in Figs. 241, 242, and 243.

The Anderston Foundry Motion.—Box motions embodying the central features of the Whitesmith principle of compounded eccentrics are fairly numerous, on account of their general utility and reliability, and their smooth or easy action at comparatively high speeds. These facts constitute the chief reason, if excuse were needed, for the introduction of a further motion of this general type. This particular motion is the production of the Anderston Foundry Co. Ltd., Glasgow, and, as made and illustrated, is capable of working at 140 picks per minute on a pick-at-will loom, although higher speeds may be obtained when the motion is applied in a modified form to alternate picking looms with boxes at one end only.

Fig. 237 gives a general view of the motion as arranged for control by a dobby or jacquard shedding mechanism, while Figs. 238 to 240 show detail and sectional views of the mechanism. Instead of two eccentrics being employed, as in the motions already referred to, only one eccentric is used, but it is combined with a crankpin of suitable throw which takes the place of, and is operated in the same manner as the large eccentric of the other motions. Variety in the motion lies in the method employed for bringing the eccentric and crankpin into action, and its good features are the general simplicity, solidity, and strength of the parts.

Motion is derived from the wyper or low shaft A of the loom to which the boss B, Fig. 240 in detail, is securely

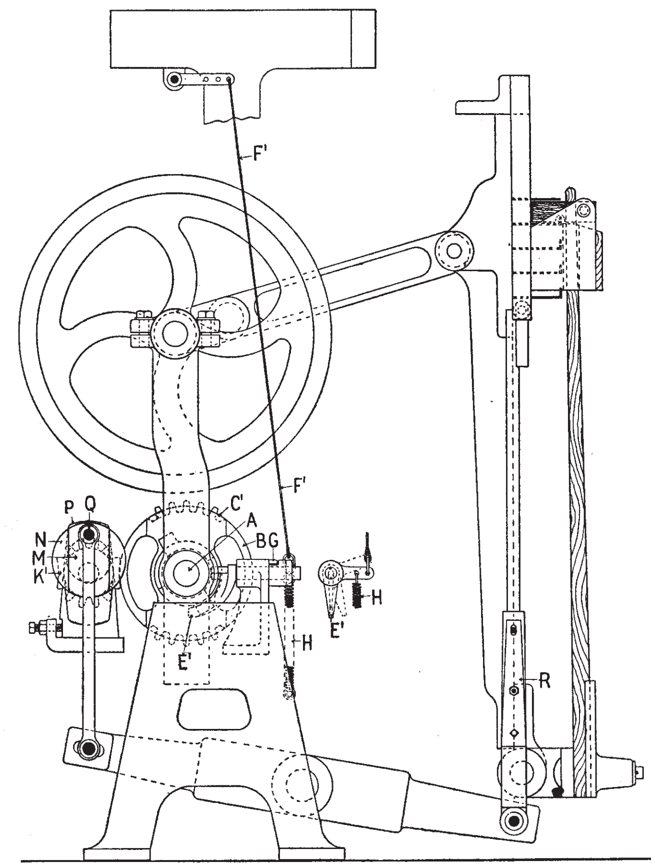


Fig. 237.

fixed. The boss is arranged to compound with and rotate two segmental pieces C and C^1, one being arranged at each side of the boss B for the small eccentric and the crankpin respectively. Each segmental piece C C^1 is capable of lateral movement on the wyper shaft as required, and is provided with 5 projecting teeth arranged at two diametrically opposite points in its periphery to enable it to act twice for every revolution of the wyper shaft, or once for every revolution of the crankshaft. Side extensions of the segmental pieces are also provided in which two cam grooves D are formed, and by which the lateral position of the piece itself may be changed. Immediately in front of the wyper shaft, that is nearer the front of the loom, are two curved indicating or selecting levers E E^1, which are supported in such a way that an extended portion of their working centres projects into one or other of the cam grooves D referred to, and so retains the corresponding segment in its lateral position for the time being. A second arm of the selecting levers projects at right angles to the curved arm, and is attached by a cord or wire F F^1 to a controlling hook of the dobby or jacquard. Each selecting lever is strictly limited as regards the extent of its movement by a stop projection G cast upon its supporting bracket. For this reason a helical spring is usually introduced into the connections between the jacquard hook and the selecting lever. A further spring H always ensures that the selecting levers E E^1 will be in the positions indicated when not acted upon by the jacquard or dobby. When in this vertical position it is clear that they will remain in the outer cam grooves D of the segment pieces C C^1, and that these will therefore be moved towards each other and remain in the position shown in Fig. 238 so long as the levers E E^1 are not lifted by the shedding mechanism.

Referring now more particularly to detail in Fig. 238,

which represents a sectional view of the motion from the back of the loom, it will be seen that the teeth J, J of the eccentric and crankpin star wheels K K^1, with their corresponding locking plate portions are not continuous in one vertical plane, but that one locking plate—the one in action for the time being—with the four lower teeth J are in one plane, while the other locking plate with the four upper teeth are in another vertical plane. These two

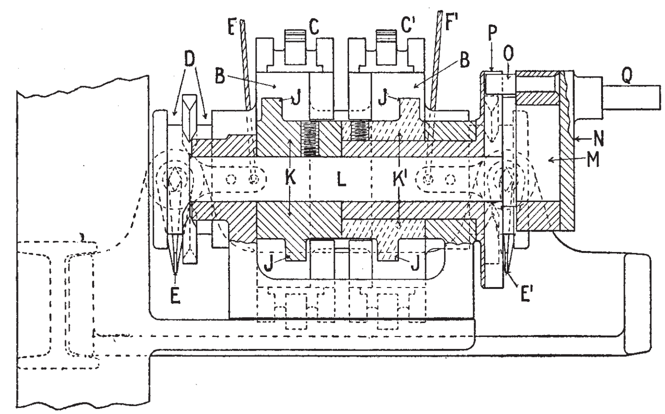


Fig. 238.

planes coincide with the two lateral working positions of the teeth of the horizontal pieces C, C^1, and thus reduce the necessary movements of these pieces to a minimum. If the teeth of the star wheels were arranged continuously in one plane it would be necessary to advance and to withdraw the segmental pieces every time a change of box was necessary; but with the arrangement shown it is clear that, if the cord F be raised and the curved arm of the lever E tilted over to enter the inner cam groove D of the sliding piece C, the latter will be withdrawn until its five rotating teeth coincide with the upper four teeth of the star wheel K, that the latter will be rotated, and that the four lower teeth will be rotated into the position of inaction if the segmental piece C is retained in its new and outer position. To ensure this the cord F must be raised every pick during which no change of the eccentric is required. Star wheel K is secured to spindle L by set screw as shown, and thus turns the small eccentric M directly. The latter has naturally the throw necessary for the movement of the

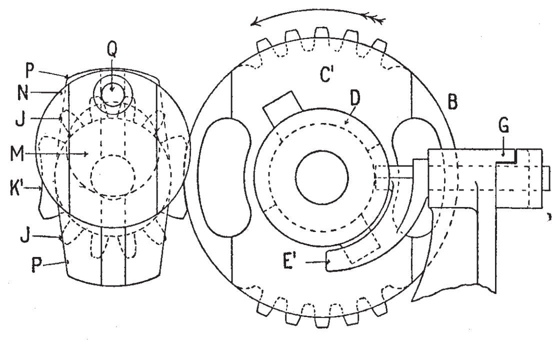


FIG. 239.

shuttles the depth of one box, and is encircled by the crankpin disc N, which may move the shuttles the depth of two boxes, and which is rotated by means of a projecting stud O. The latter enters a vertical slot in the rotatable plate P, the nave of which is centred loosely on the spindle L, and may be rotated with the star wheel K^1 to which it is set-screwed. Cord F is the means by which the crankpin Q may be caused to rotate from one dead centre to the other, and it is worthy of notice that, whenever these cords are not raised, and the levers E E^1 return to their normal positions as shown, the eccentric M and the crankpin Q also

return to their normal positions, and the boxes drop till No. 1 or the top box is level with the race. This is obvious since dropping the cords places the curved arms of E E^1 in their outer grooves, and throws both segmental

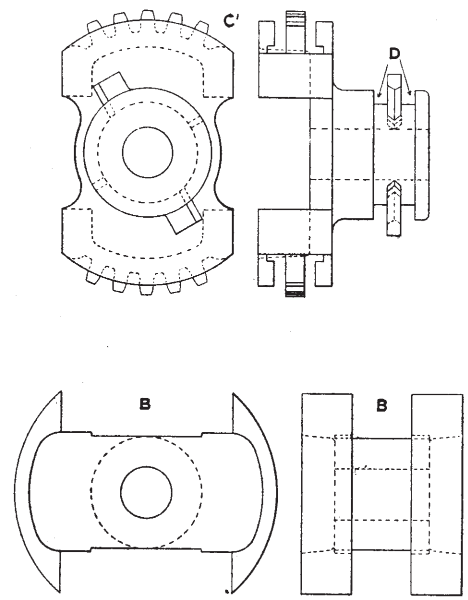


FIG. 240.

pieces C C^1 to the inner position. The usual type of escapement motion is provided at R.

The Eccles Box Motion.—Figs. 241, 242, and 243 are respectively side elevation, back elevation, and plan of the Eccles box motion as made by Messrs. William Dickinson and Sons, Blackburn, and Fig. 244 shows a few details of the mechanism. Motion is imparted from the low shaft A by eccentric B, which, through rod C, oscillates lever D

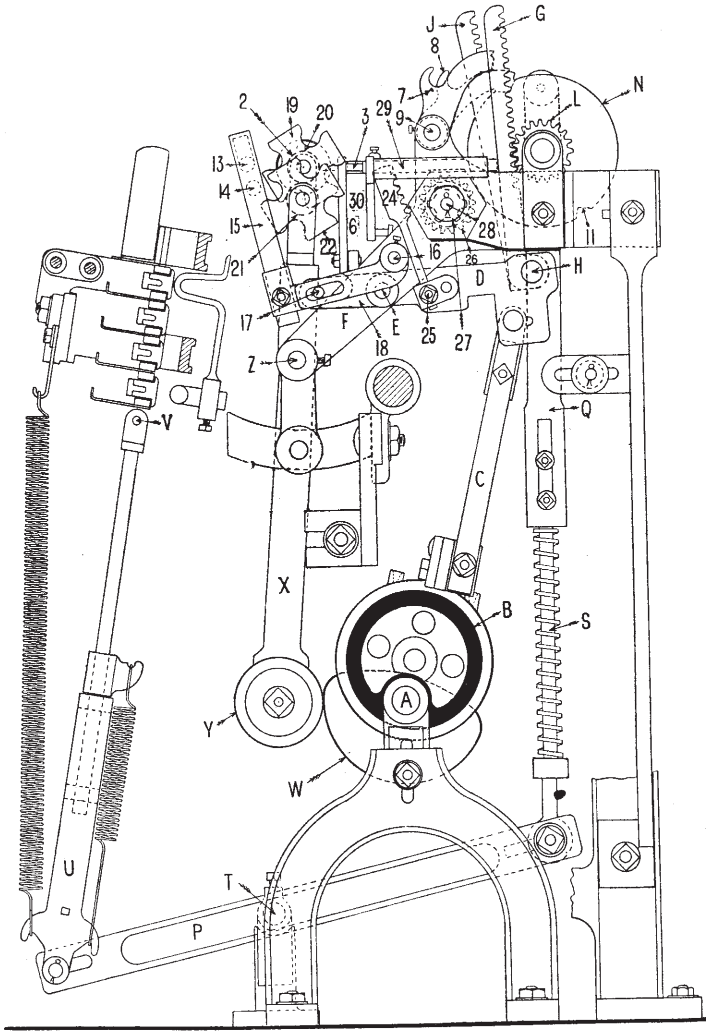


Fig. 241.

fulcrumed at E on the framework F. The shaft E extends to the other side of the motion. Rack G is supported at H, while rack J is supported in the same plane at K, see Fig. 242. The two racks G and J operate when required wheels L and M. These two wheels are compounded with disc plates N and O, and the connections between the disc plates N and O and lever P are made by parts Q, R, and S. Lever P is fulcrumed at T, and its opposite end is attached to the plunger rod U, which in turn is connected at V to the boxes.

On shaft A, and immediately behind the eccentric B, is set-screwed a cam W, which gives motion to lever X through anti-friction roller Y.

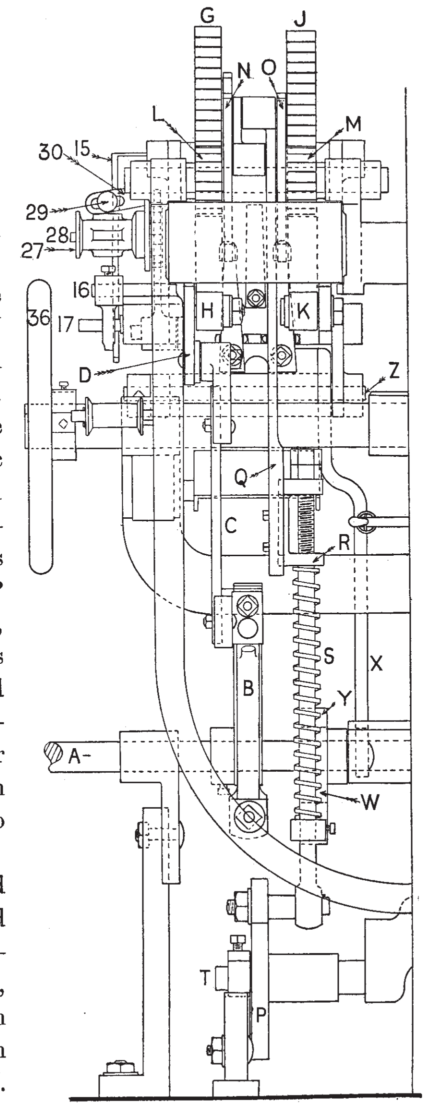


Fig. 242.

Lever X is fulcrumed at Z, and above this point possesses two arms, see Fig. 244, the extremities of which support the cylinder 2. It will thus be seen that as shaft A rotates, the cylinder 2 will be moved towards the needles 3 every two picks; a spring attached to the lower arm of lever X and to the framework keeps the roller Y in contact with the thin part of the cam W, and, hence, serves to withdraw the upper arm of the lever X and cylinder 2 from the needles. The needles 3 are supported at the end nearest the cylinder by the needle plate 6, and at the other end they pass through and are supported by the framework.

The back extremities of needles 3 and 5 are blunt and impinge against the backs of racks G and J, see Fig. 244, while the racks are kept in close touch with the ends of the needles by spiral springs—the normal or inactive position being that shown by rack J, Fig. 241. From Fig. 243 it will be seen that needles 4 and 5 have entered the cylinder, but needle 3 has been pushed back by a blank in the metal card. This action of needle 3 has clearly pushed rack G into close contact with wheel L, see Fig. 244. When the racks are full back, *i.e.* in their position of rest, the discs N and O are kept perfectly stationary by means of V-shaped projections 10 on locking levers 7 and 8 fulcrumed at 9. These projections fit into one or other of two corresponding V-shaped recesses 11 in the discs, and these recesses are diametrically opposite to each other.

It is essential that the locking levers should be withdrawn from the discs before the racks come in contact with disc wheels L and M. When a card presses back one of the outer needles, say 3, Fig. 244, the recess 12 in the needles, see detached view, pushes the lower arm of lever 7 to the right, and thus raises the V-shaped part 10 clear of disc N before the rack G reaches the wheel L.

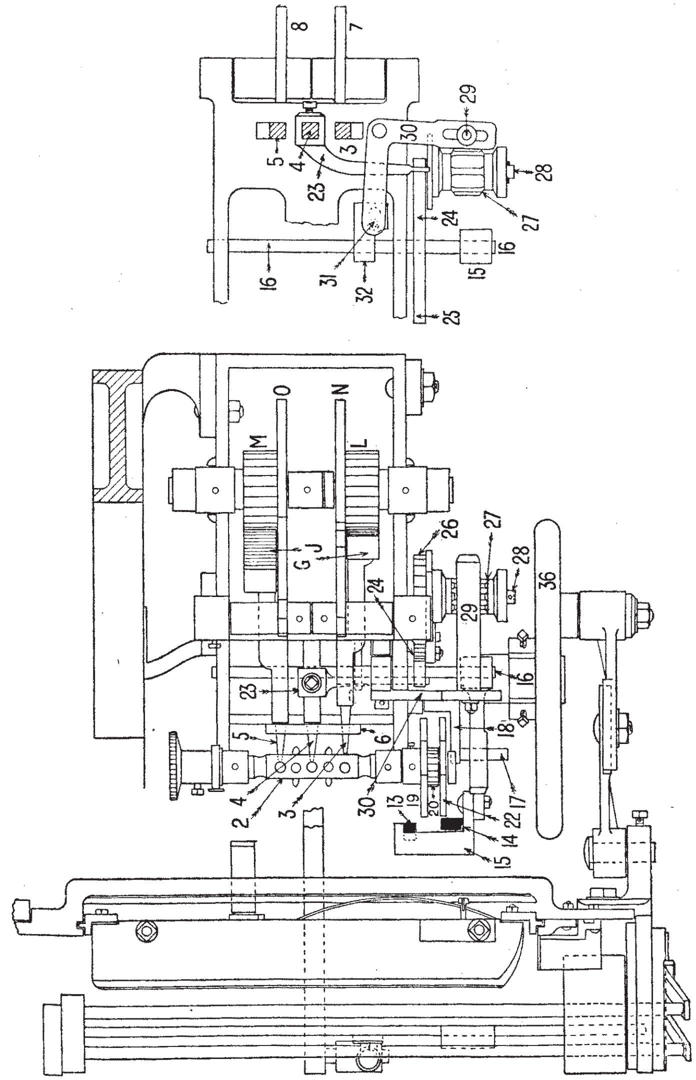


FIG. 243.

For short lengths of cards the cylinder 2 moves in the normal direction, *i.e.* clockwise in Fig. 241, but when it is necessary to weave patterns which are very long and symmetrical, as mentioned in connection with Figs. 225 to 229, provision is made for moving the cylinder alternately clockwise and counter-clockwise. In both cases it receives its motion directly from pins 13 and 14 which project from the long and short arms of L-shaped lever 15 fulcrumed at 16, while the lever 15 is in turn raised and lowered through the medium of a slot in its lower arm, and a pin 17 projecting from the short arm 18 set-screwed on and oscillating with shaft E.

At the end of cylinder 2 is set-screwed star wheel 19 and pinion 20. These are compounded, and the wheel 20 gears with wheel 21 to which is compounded star wheel 22. When the cylinder is moving clockwise, pin 14 enters one of the slots in star wheel 22 and rotates it counter-clockwise, but the connection between wheels 20 and 21 results in wheel 20, and therefore star wheel 19 and cylinder 2 being rotated clockwise.

To reverse the cylinder, *i.e.* to rotate it counter-clockwise, pin 13 and wheel 19 must be brought into line and contact, at the same time withdrawing pin 14 from line of star wheel 22. This is accomplished in the following way :—The middle needle 4 is pressed back by a blank in the card. Bracket 23, see also detailed view in Fig. 243, is set-screwed to needle 4, and therefore moves with it ; the end of the long arm of this bracket presses small rack 24, fulcrumed at 25, Fig. 241, into contact with wheel 26, and as the rack moves downwards in unison with arm D on eccentric rod C, it follows that the pilot chain cylinder 27 on stud 28 will be rotated one-sixth of a revolution.

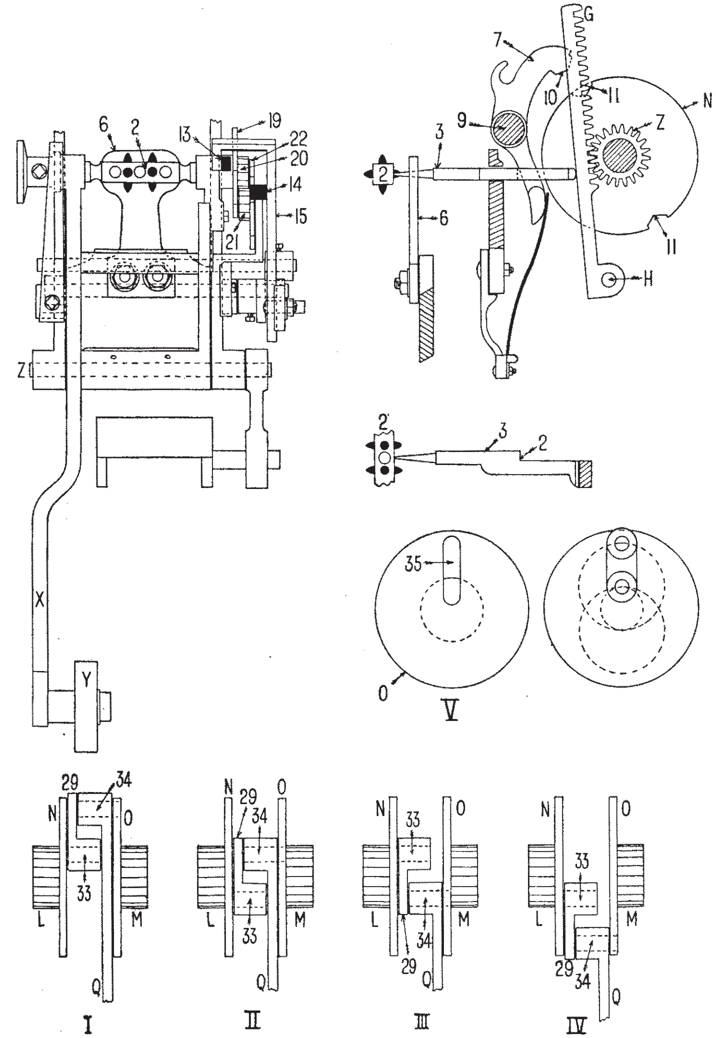


Fig. 244.

The long stud 29 rests by gravitation on the lags, but, if a peg be immediately under the stud 29, the latter is raised as well as the L-shaped lever 30, see detached view in Fig. 243. This causes the lower arm of L-shaped lever 30 to move towards cylinder 27. A small pin near the lower end of this lever enters a slot in bracket 32, which is set-screwed to rod 16; rod 16 therefore moves towards balance wheel 36, and in doing so it carries pin 14 from contact with star wheel 22, and places pin 13 in contact with star wheel 19. The same detached view in Fig. 244 shows the connection between the middle needle 4 and the small rack 24.

The four detached figures at the bottom of Fig. 244 indicate the positions of the part Q and its companion part 29 when acted upon by discs N and O and wheels L and M through racks G and J. Fig. I. shows the parts Q and 29 in their highest positions, and therefore the top box level with the race. Half a revolution of wheel L and disc N will take pin 33 to the position shown in II.; but since Q and 29 are attached, it follows that when 29 is forced downwards part Q must accompany it, and a slot in disc O, shown at 35 in V., permits this. The change from II. to III. is obtained by rotating wheel L so that pin 33 moves to the top again, but wheel M is rotated, and this carries 34 to the bottom. As the disc O rotates, part 34 rotates part 29 since pin 34 passes through both 29 and Q. A lift of two boxes is thus obtained. When both N and O are moved through half a revolution, the two pins 33 and 34 are in the lower position, and the 4th box is lifted.

The advantages of such motions as those described are, we think, at once self-evident. In addition to the special advantage, in one case of simplicity in building and reading the pattern chain, these motions have the general

advantage pertaining to mechanisms in which eccentrics are the means of converting a circular motion into a rectilinear one. This is, briefly, that the body moved—in this case the boxes—begins its movement slowly, increases its speed towards the middle of its stroke, and then gradually comes to rest. With a motion of this type it is possible to obtain the highest speed practicable, as it will make any change or skip of the boxes with perfect steadiness and regularity of lift.

A drop-box motion of a semi-positive nature is illustrated in Fig. 245. This motion, which works in conjunction with the shedding and picking motions of the Hollingworth and Knowles' loom, see pages 187 to 197, and 348 to 352, receives its motion direct from the toothed driving cylinders or gears A and B which, although compounded and rotating with those for actuating the shedding levers, do not necessarily act at the same moment. As a matter of fact, the gears A and B, which impart motion to lever E for the boxes, and to the corresponding lever for the picking, are, as regards time and action, adjusted independently of the position of the similar gears which impart motion to the levers for shedding. The vibrator lever C, which supports vibrator gear wheel D in both top and bottom positions, receives its motion from the box and picking chain J. Each rod of this chain for a 4-box motion has provision for five bowls or bushes—four for the boxes (two for the boxes at one side and two for the boxes at the other side) and one for the picking. The connecter E couples the wheel D to the simple box lever F, while a similar, but longer connecter is used for operating the compound box lever G from another wheel D. The lever F is fulcrumed in the bracket K, and at a point L a chain M is attached; this chain is passed over a flanged pulley on the end of lever

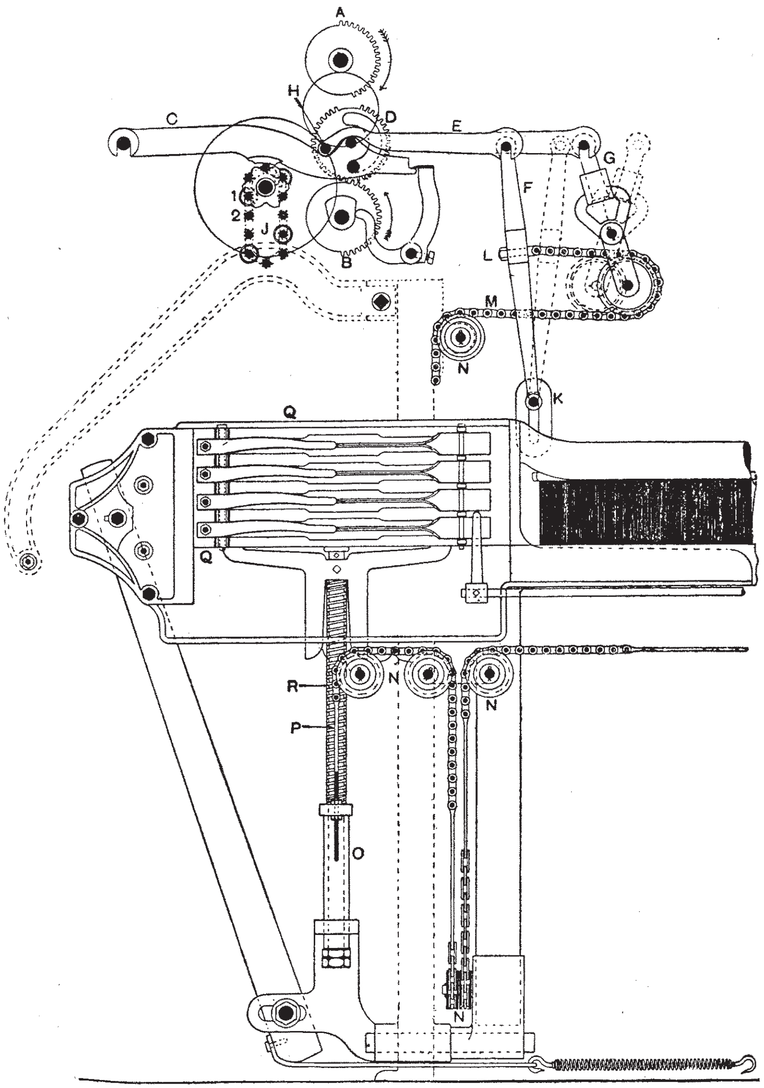


Fig. 245.

G, and is then taken over the guide pulleys N, and attached, by means of adjusting screws, as shown, to the projecting head of a long sleeve O which encircles the lower end of the box rod P.

As the driving gears A and B revolve in the direction shown by the arrows, the crankpin H in the gear wheel D will be rotated to the extreme left or to the extreme right, if the periphery of the wheel D presents that part with a missing tooth to the top or bottom cylinder respectively; but if the large gap in the teeth of D is close to the operating cylinder no change takes place; the movement is therefore identical with that in use for the shedding motion.

The position of the gear wheel D is determined by the pattern chain J, which is built of bowls 1 and bushes 2, and is carried round by the chain gearing. If a bush 2 be brought underneath the vibrator lever C, the latter will assume the position shown, the gear wheel D will be acted upon by the driving gear B, and the pin H will be rotated to the right. But if a bowl 1 be brought under the lever C, the gear wheel D will be raised into contact with the driving gear A, and the pin H will revolve to the left. By means of the connecters E, the movement of the crankpin H is conveyed to its corresponding lever F or G, and in turn to the box chain M. Any movement thus given to the sleeve O, through lever and chain and a strong helical spring R, is imparted to the shuttle boxes Q. The spring R has sufficient strength to support the boxes in their proper position under ordinary circumstances, but it yields to prevent breakage in the event of excessive obstruction—such as a trapped shuttle—being offered to the upward movement of the boxes. The latter fall in virtue of their own weight, and whilst in this sense the motion might be termed negative, all vibration or tendency to rebound is effectually checked by the chain M, which controls the boxes when falling as well as when rising. It is worthy of note that as the chain M is actuated by a pin or pins H (which move in a semi-circle from one dead centre to the other), the motion imparted to it, and therefore to the boxes, will be slow at the beginning and at the end of the movement, with an increase of speed towards the middle.

When the boxes are at their lowest point, the levers F and G assume the positions indicated by the dotted lines in Fig. 245, but, by moving the lever F into the position shown by the solid lines, a lift of one box is obtained—in other words, the travel of the lever F at the point L is equal to the lift of one box. If the lever F be retained in the dotted position and the lever G be taken to the solid position, a lift of two boxes is obtained. While the travel of the pulley carried by the lever G is equal to the lift of only one box, it is evident that in moving the lever both the upper and the lower reaches of the chain M will have increased in length by the lift of one box, giving a total lift of two boxes. It is now obvious that a lift of three boxes will be got by moving both levers F and G from the dotted positions to the solid positions, as shown in Fig. 245.

In Fig. 246 a diagrammatic representation is given of the boxes, levers, and connecters in all four positions. In the first position, both the crankpins H and H^1 are at the extreme left with box No. 4 in position on the race line X Y. In the second position, the crankpin of the lever F has moved to the right, allowing box No. 3 to fall into place on the line. In the third position, the crankpin of the lever G has returned to the left, whilst that of lever G has rotated to the right, allowing a further fall to box No. 2.

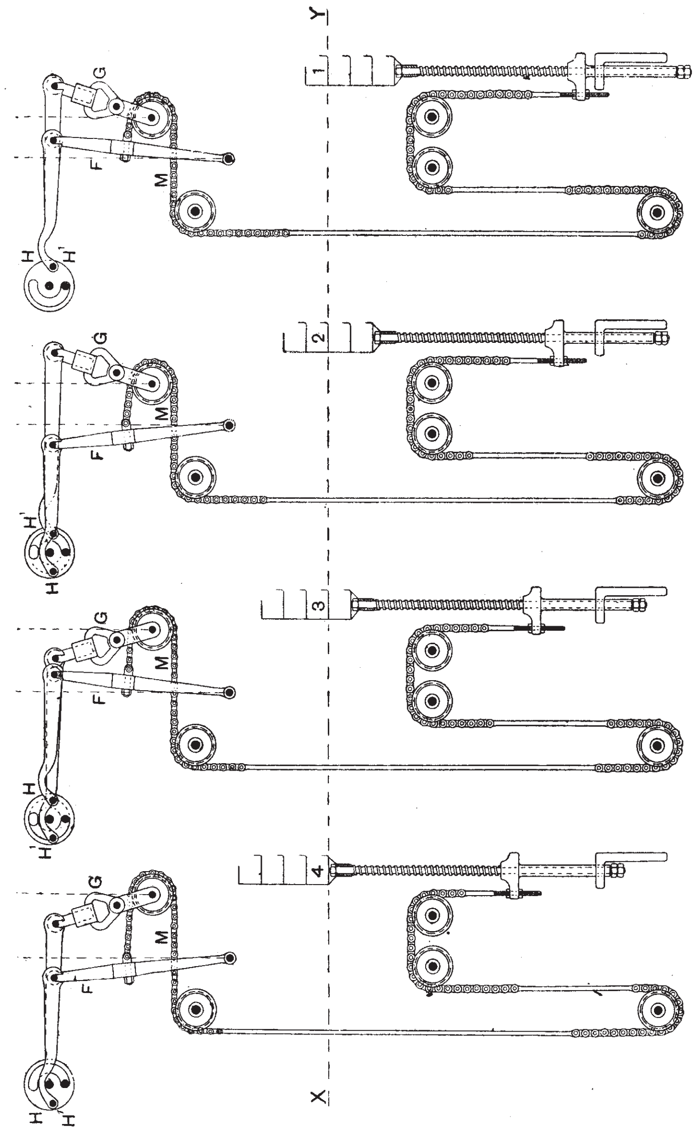


Fig. 246.

In the fourth position, both crankpins have moved to the right, allowing box No. 1 to reach the race line. Equivalent movements of levers from right to left result in corresponding lifts to the boxes.

A slight addition to the above motion has converted it into a perfectly positive motion; this will be seen by reference to Fig. 247. The chain M, which originally started at point L and moved as shown in Fig. 245, is now

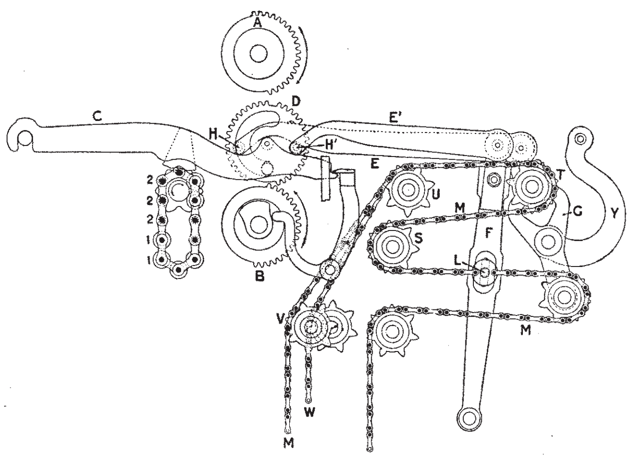


Fig. 247.

continued to the left, passed over sprocket wheels S, T, U, V, and similar wheels near the floor, so that it may be attached to the lower end of rod P, Fig. 245. It is obvious that the two chains attached at L will always move in unison, but since one chain is attached to the upper part of rod P, and the other chain to the lower part of P, it is possible to move the box positively either up or down by these chains. When either chain is moving the box, the other chain gives off a sufficient length to allow of such movement. The

chain M operates the boxes at one end of the loom, while the chain W, which is naturally carried on separate sprocket wheels and attached to its own set of levers, controls the boxes at the other end of the loom. Otherwise the movements are identical with those explained in connection with Figs. 245 and 246. In Fig. 247 it will be seen that the large gap in the wheel D is opposite the bottom cylinder B, and that the lever C and wheel D are in their lowest

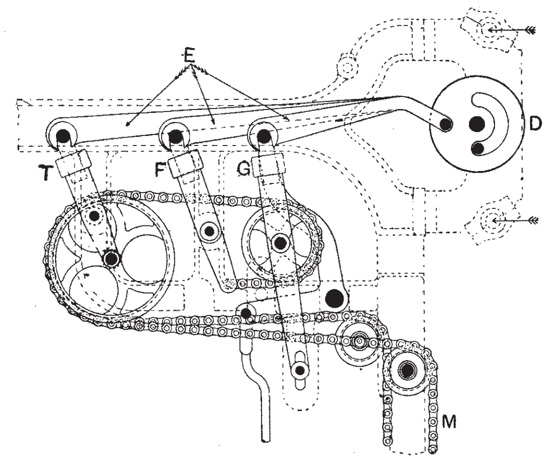


Fig. 248.

positions; but, since there are three more bushes (marked 2 on the chain) to appear in successive order under lever C, it follows that no movement will be given to wheel D, hence the box remains stationary for four picks. The lever Y is for the picking arrangement (see Fig. 186, and explanation on p. 351).

A similar principle arranged for six boxes is illustrated in Fig. 248. In this case three levers F, G, and T are necessary, each actuated as already described. The lever

F, although of a different kind from that shown in Figs. 245 and 246, again has a lift of one box, while the levers G and T have each a lift of two boxes, the three levers together, therefore, having a lift of five boxes. With the levers in their present positions, No. 1 (or the top box) is level with the race. To lift box No. 2 the lever F only is actuated. To lift box No. 3, the lever F is returned to its present position, and either the lever G or the lever T—say, G—is moved. To lift box No. 4—which, it must be remembered, is a lift of only three boxes,—the lever G would be retained in its new position, and the lever F would be pulled over in addition. To lift box No. 5, the lever F would be returned to its original position, lever G would be retained in the new position, and in addition the lever T would be actuated; whilst, to lift box No. 6, all the three levers require to be moved from the positions shown in the diagram.

Revolving Boxes.—These are so termed from the fact that the shuttles, usually six or seven, are arranged parallel to each other in separate compartments or boxes built in a circular framework, which is caused to revolve in either direction in order to bring the required colour or shuttle in line with the picker. The mechanism is generally arranged to rotate the boxes through the distance of only one at a time, although some motions are capable of rotating them through two or three compartments if desired. In Figs. 249 and 250, end and front elevations are given of the ordinary arrangement of Messrs. Hattersley and Sons Limited for six boxes, moving one at a time. The inner end of the circular framework A is conveniently supported by an iron band, and the outer end by a central spindle B. The latter is carried in a lengthened bearing C, which is fixed to the end of the lay, stiffened and supported by the

bracket D, and bolted to the lay swords E. Set-screwed on the outer end of the spindle B are two discs F, which support between them six horizontal pins G, arranged, as

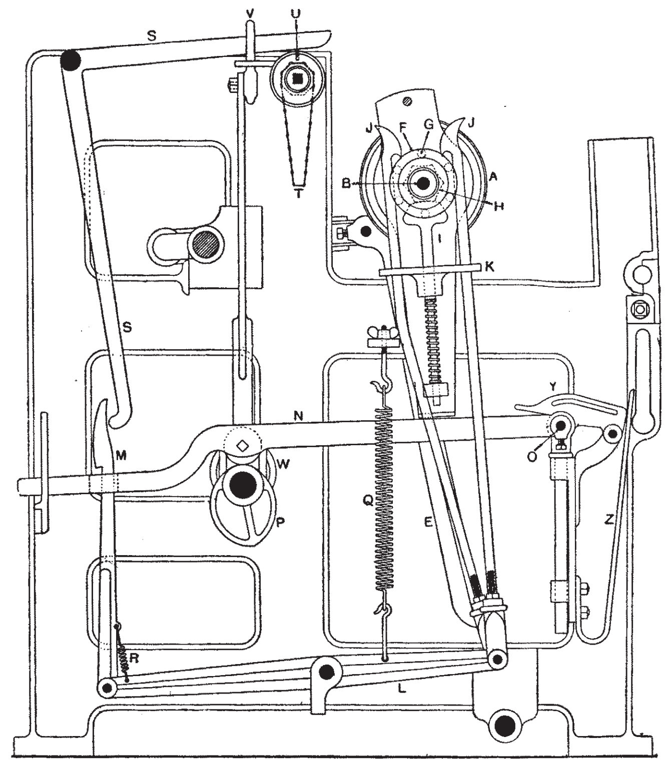


Fig. 249.

will be seen in Fig. 249, to divide the circle into six equal spaces. The nave of the inner disc is continued inwards to form a star wheel H, which is acted upon by a corresponding spring hammer I to bring the boxes level after

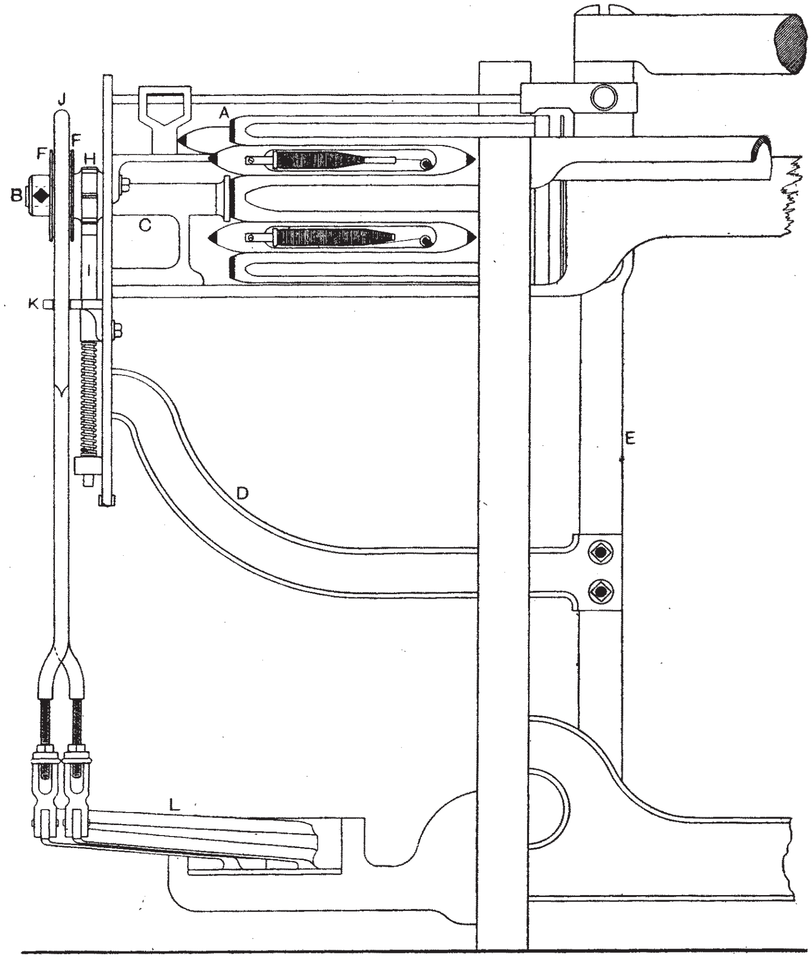


FIG. 250.

moving, and to prevent vibration when working. Situated

on each side of the spindle B, and in line with the pins G, is a long hook J, which is held upright by slots in the bracket K, and kept in touch with the pins G by the pressure of a flat spring, not shown.

It is obvious that the shuttle-boxes may be rotated to the right or to the left, as desired, by pulling down either the right or the left hook J. This is accomplished as follows:—Each hook J is attached at the foot to one end of a peculiarly bent lever L, which is fulcrumed near its middle point, and carries at its opposite extremity a vertical catch M. The upper end of this catch passes through a slot near the end of the horizontal lever N, which is fulcrumed at O, and has an alternate rising and falling movement imparted to it by the rotary action of the cam P fixed to the wyper shaft. Should the head of a catch M be pressed forward over the solid part of the lever N, the latter will in rising take M with it. Thus the corresponding end of the lever L is raised, the further end depressed, and the connected hook J pulls down and rotates the boxes in the desired direction. Each hook J is returned to its original position by a spiral spring Q, which is fixed at the top to a suitable bracket, and connected at the bottom to the corresponding lever L.

The catches M are retained in the position of inaction, or clear of the solid part of the lever N, by a short helical spring R, but are pushed forward as occasion requires by the pendant arm of the bell-crank levers S, the curved ends of which abut against the head of the catches M. This, however, takes place only when a hole in the card of the pattern chain T is presented to the peg U, which projects from the underside of the horizontal arm of the levers S. Under these conditions the peg U enters the card cylinder X, the horizontal arm of S falls, its pendant arm moves outwards and forces the head of the catch M over the solid part of the lever N, and as the latter rises the boxes are rotated. The horizontal arm of each lever S rests in the fork of a vertical piece V, which has a rising and falling movement imparted to it from an eccentric W on the wyper shaft—the upward movement to raise the pegs U clear of the card cylinder X when the latter is turning, and the downward movement to allow them to fall in order to actuate the shuttle-box should the card be so cut. The card cylinder X is rotated by means of a catch attached to and moving with V. This catch acts upon a ratchet wheel of 8 teeth on the inner end of the card cylinder, and moves the latter one-eighth of a revolution as V rises—that is, every second pick. In order to prevent the shuttle boxes from turning too far when changing from one box to another, a stud is inserted in each lever L near its point of connection with its corresponding hook J. Each stud projects either across or beneath the other lever L, and both are so placed that when one lever is depressed, it, or its stud, comes into contact with the stud of the other lever, or with the lever itself, and carries the latter down at the finish of its movement. The distance through which the second or inoperative hook is pulled down is just sufficient to cause it to prevent the shuttle boxes turning too far, since the hook comes into contact with one of the rising pins.

It must, of course, be understood that the levers L and S, and the catches M, are in duplicate—one for each long hook J. Under ordinary circumstances the fulcrum end of the lever N is fixed in the position shown by a retaining catch Y and the flat spring Z, but in the case of excessive obstruction being offered to the turning of the boxes, the spring Z yields, and the lever Y is thrown upwards, thus

allowing the lever N to rise at that end in order to prevent breakage. Rollers are provided which push the shuttle last in use into its proper position as the boxes revolve, and plates fixed at the box ends prevent the shuttle not in action from end-long movement.

One of the chief defects of the ordinary revolving box motion is its inability to bring any desired shuttle in the six or more chambers instantaneously into line with the shuttle race. Because of this fact, and of the character of many three-colour patterns, it is often necessary to duplicate the shuttles of one or two of the colours in the boxes, in order that the pattern may be correctly developed by a step-by-step movement of the boxes. For the same reason it is impossible to produce many patterns of the tartan variety composed of five or even four colours with a 6-box revolving motion of the ordinary type. When the checks are composed of narrow bands it is often an advantage to use two shuttles containing the same colour in order to obtain uniformity, but, in general, it is not desirable to increase the number of shuttles beyond that representing the different colours in the fabric. To overcome the necessity of duplicating the shuttles except for the above object Messrs. George Hattersley and Sons Ltd., of Keighley, early introduced a skip-box motion by means of which any one of the six chambers may be brought at will into line with the level of the race.

In many respects a 6-chamber skip-box motion as illustrated in Fig. 251 is similar to a revolving motion of the ordinary type. The revolver spindle A, however, is provided with a toothed pinion of 12 teeth so that it may engage with, and be rotated in either direction by, the double toothed rack C. This rack is shown in its position of inaction, and is retained there, when not required to move, by means of a spring D acting on and raising lever F and rod E. In this position the rear end of lever F rests upon adjustable bracket G bolted to the framework of the

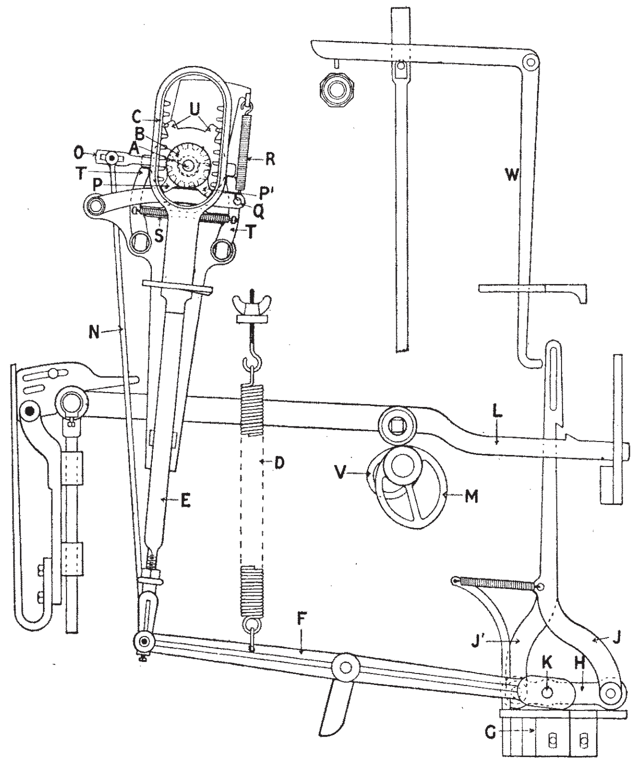


FIG. 251.

loom. Opposite ends of bracket G also serve as supports and fulcra for the ends of the short lever H which couples the lower ends of the vertical draw hooks J J^1, and also compounds the latter with lever F by means of pin or stud K.

Difference in the extent of the movement imparted to rack C, and therefore to the revolving chambers, is obtained by raising either hook J or J^1, or by raising both together. It will be observed that stud K is not situated midway between the points of connection of J and J^1 with lever H, but is nearer J^1 than J, the ratio of the distances being 1 to 2. It therefore follows that if hook J be raised by the action of the griffe lever L and the cam M, stud K will be raised only one-third of that distance, which is sufficient to move the revolving chambers the distance of one box. If hook J^1 be raised, stud K will rise two-thirds of the lift and the rack C will move the revolver two boxes, *i.e.* it will skip one box; while if both hooks J and J^1 be raised together, the stud K will rise through the same distance, and the revolver will be moved three boxes, *i.e.* it will skip two boxes.

Other two hooks similar to J are connected with a second lever F; rod N is attached to the end of this lever, as well as to lever O centred loosely on the nave of pinion B. These parts are provided to place either side of rack C in gear with pinion B and so determine the direction in which the boxes shall revolve. One of the hooks raises rod N, and the other hook lowers it, and a corresponding movement is thus imparted to the end of lever O. The opposite end of lever O is provided with two projections P P^1 which oscillate with the lever and act upon the inside of the rack C. When lever O is raised, projection P presses the rack to the left and causes the teeth on the right to engage with pinion B; the downward movement of the rack will thus rotate the boxes clockwise or "backwards." If, on the other hand, rod N be lowered, P^1 will force the rack to the right and the teeth on the left will engage with pinion B, and the boxes will be rotated counter-clockwise or "forwards" when the rack is depressed. Lever Q and spring R support the lever O in position, but yield when movement in the latter is necessary. A spring hammer S prevents rocking of the boxes, but further stops are provided by the two detents T which engage with two of the six projections U on the revolver head. Detents T effectually prevent rotation until a change is required, when they are pressed apart by the hammer head S as the latter is forced downwards through the action of the third lever F. All three levers F are accommodated on the same fulcrum; the first lever F, that shown in the illustration, rotates the boxes as described; the second lever raises or lowers rod N and determines the direction in which the boxes shall turn; while the third lever pulls down the hammer S, opens the detents T, and permits the revolver to move in the desired direction.

The griffe lever L is for the movement of the boxes, but a second griffe lever is provided for placing rack C in position and opening the detents T, and this lever is operated by cam V a little in advance of the griffe lever shown. Four bell-crank levers W are necessary and all are raised and lowered as in the simple motion by means of an eccentric on the wyper shaft. One of these levers determines the forward direction, the second is for the backward direction, the third is for one-box movement, the fourth for a two-box movement, while the joint action of the third and fourth is for a three-box movement. The cards for this motion have therefore sufficient space for four holes. Each bell-crank lever W or indicator lever acts upon its corresponding hook J, but a fifth hook J is provided for the opening of the detents T, and this hook is put in action always by either the forward or backward direction hook when a movement is to take place. Two hooks J thus act

on one lever F for turning the boxes; other two hooks on a second lever for determining the direction, and the fifth hook on the third lever for opening the detents.

Revolving boxes compare favourably with drop-boxes when goods of only medium weight are required; but as an ordinary warp protector or stop-rod cannot conveniently be actuated by them, they are invariably accompanied by a loose reed, and on this account are unsuitable for cloths of heavy weight. In general, looms fitted with revolving boxes can be driven at a higher speed than those fitted with drop-boxes, and as the movement is circular and the boxes are balanced, less power is required for changing. It is true that with a motion that can move only one box at a time equal facilities for changes of colour are not offered as with some positive boxes, but this is in great measure compensated for by the fact that a greater number of colours can be used without any material reduction of the speed being necessary. The reading and cutting of the pattern chain T, Fig. 249, as well as that for the skip-box motion illustrated in Fig. 251, is a simple matter when the position of the various colours in the shuttle-box is taken into consideration. The above motions have boxes at one end only, consequently single picks of any colour cannot be inserted; if, however, the loom has boxes at both ends, and a pick-at-will motion, almost any arrangement of shotting is possible. In the ordinary motions one card serves for only two picks in succession, the result being a lengthy chain when the pattern repeats on a large number of picks. In order to reduce the number of cards for such patterns, special motions of various kinds are added to the different types of circular-box looms.

CHAPTER XVIII

AUXILIARY MOTIONS: WARP PROTECTORS, WEFT FORKS, CHECK STRAPS, TEMPLES, ETC.

WARP protectors are motions introduced to stop the loom automatically should the shuttle through any cause fail to reach the shuttle-box in due time.

In all looms for jute weaving, and in the greater majority of those employed in linen weaving, the reed, when in position, is a fixture between the lay and the top shell or cap. If the shuttle fail to clear the shed at the proper time—a not uncommon event—it would, in virtue of the forward motion of the reed, be forced through the warp, unless means were provided for bringing the loom to a sudden and almost instantaneous stop. In some looms for light or medium fabrics, however, it is not unusual to find the reed so arranged that its lower rib yields and swings backwards to prevent breakages if at any time its forward movement is obstructed by the shuttle. Such an arrangement receives the name of the loose or fly reed (in contradistinction to the fast reed motions), and is, as already indicated, the almost invariable accompaniment of a revolving shuttle-box motion, although found in many cases where a single shuttle is used.

In common with all looms where a negative picking motion is employed, the shuttle-box of a fast reed loom is fitted with a tapered wooden or metal lever or swell A (Figs. 252 and 253—shown detached in the latter figure). This swell is fulcrumed in this case in a corresponding

horizontal slot in the back of the shuttle-box by means of a pin B. In some drop-box looms the swells occupy

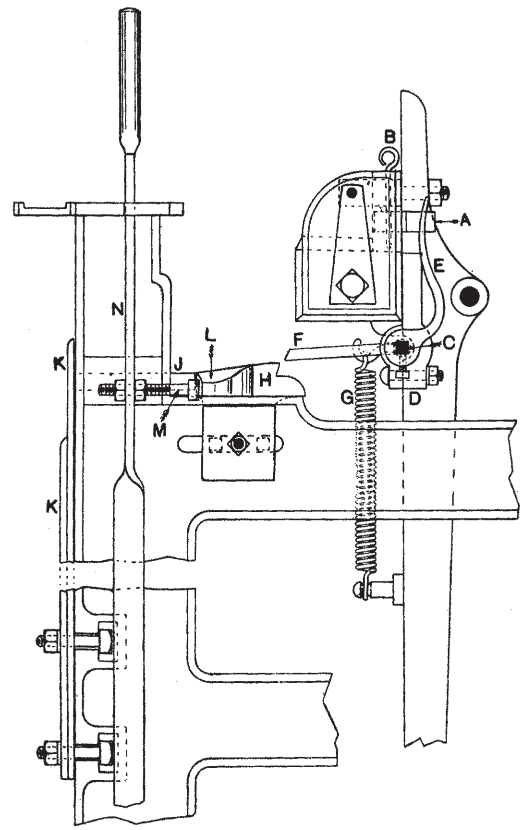


FIG. 252.

a position in front of the shuttle-box. Swells vary in thickness from $\frac{3}{4}$ in. to 1 in. according to the depth of the shuttle, and are arranged to act about midway between the top and bottom of the shuttle-back. Previous to the entrance of the shuttle, the bulge or wide portion of the swell projects into the shuttle-box, and the shuttle, in order to gain proper entrance to the box, is compelled to force back the swell. This swell, or bulge, should be so tapered that the shuttle may be well in the box before the back part of the swell is flush with the back of the box, otherwise the tongue F may be lifted before the shuttle leaves the warp, when the warp threads occupy practically the full width of the reed space. Inasmuch as swells must fit freely in the slots provided, the backward movement of the swell would be a simple thing to do if no further resistance than that of the weight of the swell were offered; but in fast reed looms this swell fulfils the double function of assisting in bringing the shuttle to a stop and of actuating the further portions of the protector motion.

Set-screwed on the square end of the stop-rod C—which extends along the under side of the lay, and is supported at each end in brackets D projecting from the lay swords—is a curved finger E, the top of which is situated immediately behind a portion of the back of the swell A. Welded near each end of the stop-rod is a projecting piece or tongue F, arranged in line with the end framing or gable of the loom. The spiral spring G fixed at the lower end to an adjustable stud in the lay swords, and attached at the top to a hook on the stop-rod, exerts through the rod C and finger E a certain pressure on the swell A, and at the same time tends to keep the tip of the tongue F in the lowest position. Supported on the framework of the loom is a sliding frog or knee H, one end of which is in constant touch with a wrought-iron pin J; this pin passes through the framework and abuts against the upper end of the heavy flat springs K. In some motions the pin J is a continuation of the frog H. From Fig. 253 it will be

observed that the frog H is extended sideways by a tapered piece L, which, when the loom is running, almost touches the head of an adjustable bolt M in the set-on handle N. In the position shown in the figures it is assumed that the

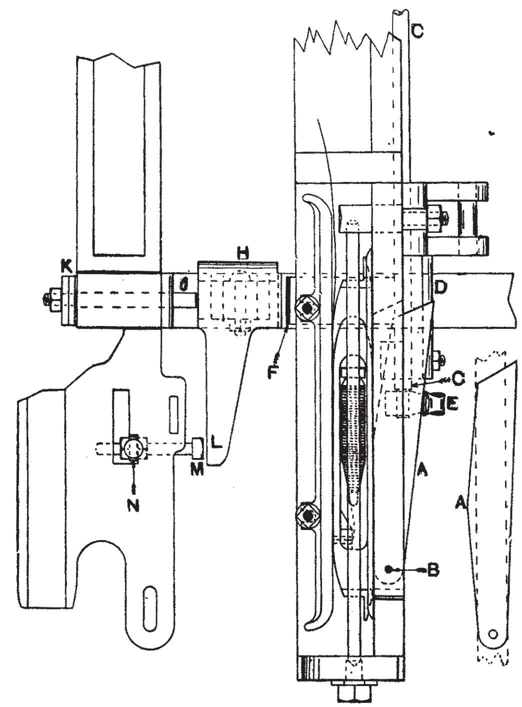


FIG. 253.

shuttle has entered the shuttle-box, has forced back the swell A and the finger E, and has therefore rotated the stop-rod C sufficiently to elevate the tongue F above the knock-off frog H. Under these conditions the loom continues to run; but should the shuttle fail to enter the box properly before the tongue F reaches the frog H (see Fig. 252), these two latter come into contact, the forward movement of the lay is imparted to H, the projecting piece L strikes the bolt M in the set-on handle N, and the latter is knocked out of its retaining notch, springs sideways of its own accord, and causes the belt fork to move the belt on to the loose pulley.

The force of the impact between F and H is almost completely taken up by the heavy flat springs K, which are bolted to the frame of the loom, as shown. In order to prevent twisting of the lay, tongues F and frogs H are provided at each end of the stop-rod C, and care should be taken in fitting these to see that both tongues are of equal length, and that they come in touch with their respective frogs at exactly the same time. The tongues F must be of sufficient length to prevent breakage of the warp threads should the loom knock off with the shuttle in the shed. Mechanics and tenters often determine this in practice by making the distance from the reed to the fell of the cloth, when the tongues F and the frogs H are in contact, a little less than the breadth, plus the depth of the shuttle. A more correct and general method can, however, be deduced from the fact that no tappet loom, much less a harness or dobby loom, should take more than half a revolution of the crankshaft in the passage of the shuttle from start to stop. In the case, therefore, of looms which pick about the bottom centre of the crankshaft, the shuttle should be home before the top centre is reached, and the tongue F should be of sufficient length to be in contact with the frog H just before the crank reaches this point. Where the loom picks on or about the top centre the reverse is, of course, the case, and tongues and frogs can be in contact here a little after the bottom centre is

reached. It will be seen that in the case of drop-box looms this time of contact between F and H determines, in a way, the time for changing the boxes, for however early the shuttle may be timed to reach the box, it is clear that F must have cleared H before or very soon after the boxes begin to change, otherwise the tongue F might be lifted clear of frog H by one shuttle, while at the same time another shuttle might be caught in the shed. Or, otherwise, it is obvious that should the boxes begin to move before F clears H, although the shuttle were home, the movement of the boxes might take away the support of the swell A from the lever E and allow the tongue F to fall into contact with the frog H, thus bringing the loom to a stop when it should continue to run. The tongues F should not clear the frogs H if the shuttle tip projects in the slightest degree across the reed or the weft fork grate, where looms are provided with such; they should, however, clear the frogs by $\frac{1}{8}$ in. to $\frac{1}{4}$ in. when the shuttle is properly home. The lift of the tongue F is regulated entirely by the extent to which the swell A projects into the shuttle-box, while its position can be modified by increasing or decreasing the bend of the wrought-iron finger E. The best position possible for the tongue when knocking off is one in the line of action of the stop-rod C, or, in other words, at right angles to an imaginary line joining the centre of the rocking-shaft with the centre of the stop-rod. This, however, is seldom attained in actual practice, but any variation above or below this line constitutes a leverage tending to turn the stop-rod when the loom knocks off. The springs G should be as easy as possible consistent with firmness and certainty of action. It is also important to see that the tongues are clearing the frogs properly when the loom is running, as inattention to this point results in worn frogs and blunt tongues, with the inevitable slipping over and a smash at some time instead of the proper protection.

Another type of knock-off motion is illustrated in Figs. 254 and 255. The stop-rod C carries, as usual, two

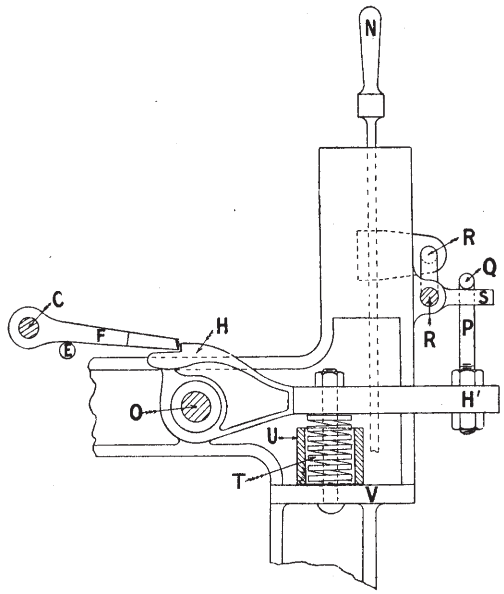


Fig. 254.

tongues F which are lifted when the shuttle is in the box by rod E which forms the lower cranked part of the finger. The action is almost identical with that explained in connection with Figs. 252 and 253 when the loom is running, *i.e.* the tongues F clear the knees or frogs H. In Figs. 254 and 255, however, the frog does not slide, but is capable of being slightly rotated upon the rod O. The

frog extends to the front of the loom, and the end H^1 carries a short upright rod P with a bent end Q at the top. When the set-on handle N is pushed into the "on" position, *i.e.* moved to the right in Fig. 254, it draws forward the rod R upon which is fixed the short arm S. This movement

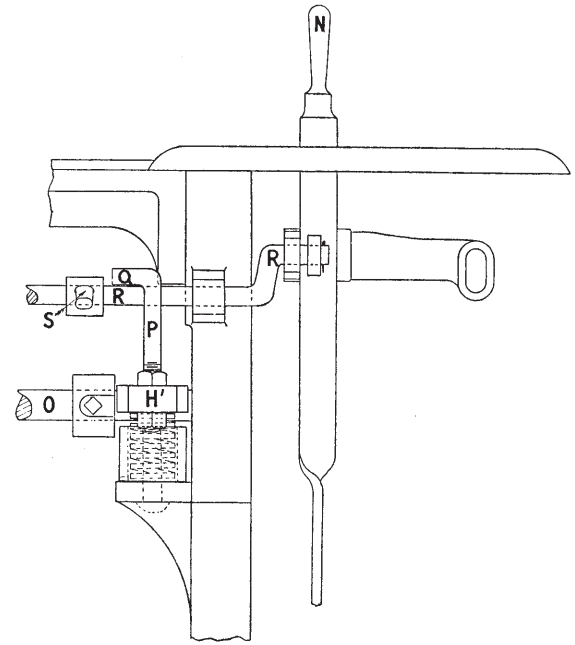


Fig. 255.

will clearly place the short arm S under the bent portion Q of the rod P. If the shuttle does not reach the box, the tongue F will come into contact with the front of the frog H, and the latter will, in moving slightly round O, cause the end H^1 to pull down rod P, and so cause the cranked end of rod R, Fig. 255, to pull the handle N out of its notch, and thus stop the loom. The heavy spiral spring T, in short tube U, returns the frog to its normal position, and keeps it there when the loom is running correctly. The height of the tube should be such that the arm of the frog will not touch it when the latter is in the lowest position, otherwise the bracket V, which projects from the loom side, and supports tube and spring, may be broken.

A swell of an improved type specially adapted for drop-box looms, although quite suitable for single shuttle-boxes, is illustrated at A, Fig. 256, in its position in the box. It

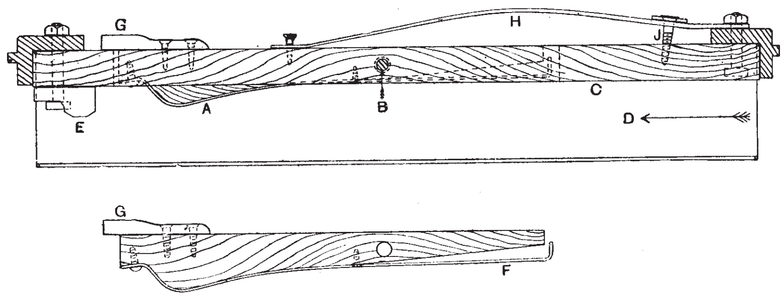


Fig. 256.

is also shown detached in the same figure. In general the fulcrum of a swell is placed near the inner end of the shuttle-box, and at one end of the swell, whilst the bulge of the latter projects into the box about half way from each end. The taper of the swell is also such that it begins to check the shuttle whilst a considerable portion of the latter has yet to enter the box proper, and is projecting along the lay. If such conditions obtain in a box loom, it is conceivable that with an ordinary swell the shuttle might be so checked that it would fail to enter the box properly before the latter had begun to change. A trap would thus be caused and the boxes thrown out of gear. The main

object of this improved swell is to prevent such a result. It is apparent from the figure that the fulcrum pin B is situated about midway in the length of the swell A, and that the bulged portion of the latter is now placed near one end, thus acting near the inner end of the shuttle-box. The swell is so tapered that its narrow end is entirely within the slot in the box back C when the box is empty, thus permitting the shuttle, when entering in the direction D, to be entirely within the box before it is checked in the slightest by the action of the swell. The shuttle is further checked at the inner end of the box by a raw-hide buffer E. While the broad end of the swell A is pressed outwards by the shuttle, the narrow end enters the box slightly, and grips the shuttle by means of a flat spring F, screwed to the face of the swell. This effectually prevents the shuttles moving about in the boxes while the latter are changing. A further point which is considered by many, but perhaps erroneously, to be an advantage is that in picking the shuttle is relieved from all pressure of the swell immediately after it begins to move.

A cast-iron stop G, screwed to the back of the swell, limits the latter's entrance into the box, and also actuates the usual stop-rod lever. When the boxes are not in line with the race of the lay, pressure upon the back of the swell is obtained by means of a flat spring H and adjusting screw J.

In looms fitted with a loose reed motion there is no necessity for a proper swell, but something is required which will aid in bringing the shuttle to a stop and in preventing its tendency to rebound. Pressure in this instance is generally obtained by means of an internal flat spring which acts against the back of the shuttle. The further parts of a loose reed motion, as obtaining in some looms, are as indicated in Fig. 257.

Situated beneath the lay in a position similar to and

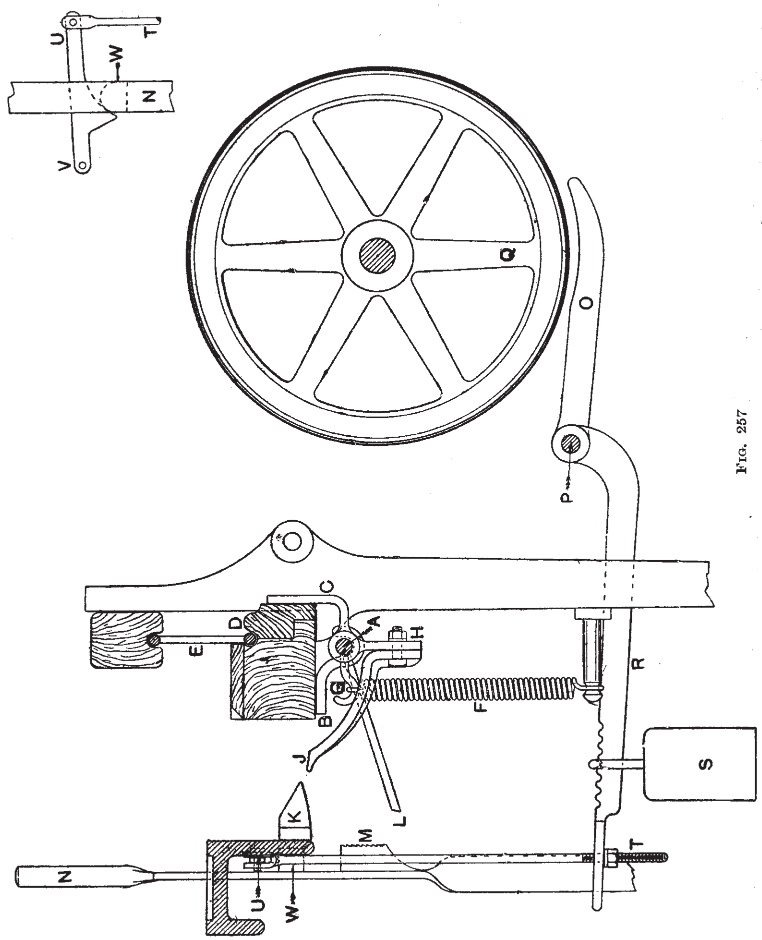


FIG. 257

fulfilling somewhat similar functions as the stop-rod in a fast reed loom, is a rod A supported near each end by

brackets from the lay swords, and also at intervals along its length by brackets B fixed to the under side of the lay. Fixed to rod A at various points are several ⌋-shaped brackets C which carry a wooden clamp or bar D, the latter being caused to press upon the lower rib of the reed E by the action of the spiral spring F acting through the hook G on the rod A. Fixed also on rod A, and at intervals of about 25 to 30 ins., are several levers H, which carry further curved levers or fingers J. As the lay moves forward under ordinary circumstances, each finger J is carried underneath its corresponding tapered frog K, which is bolted in this case to the face of the breast beam. The parts are so adjusted that the upper faces of the fingers J press against the underside of the frogs K in order to ensure the reed being held firmly in position at the time of beating-up. Should the shuttle, however, remain in the shed, then immediately the pressure between the shuttle and the reed exceeds the tension of the spring F, the lower rib of the reed E is forced backwards—the upper rib in the groove of the top shell acting for the time being as a pivot on which it turns—and the bar D is forced outwards, rotating the rod A sufficiently to raise the extremity of the fingers J above the points of the frogs or heaters K. Further movement of the lay forces J farther up the inclined part of K, and the bar D is thus made to give greater freedom to the backward motion of the reed. At the same time the tongue L, set-screwed to the rod A, is elevated in line with the roughened face of the piece M fixed on the front of the set-on handle N, contact ensues, and the set-on handle is knocked out of its retaining notch, with the result that the belt is moved on to the loose pulley. In ordinary circumstances the tongue L moves underneath the piece M.

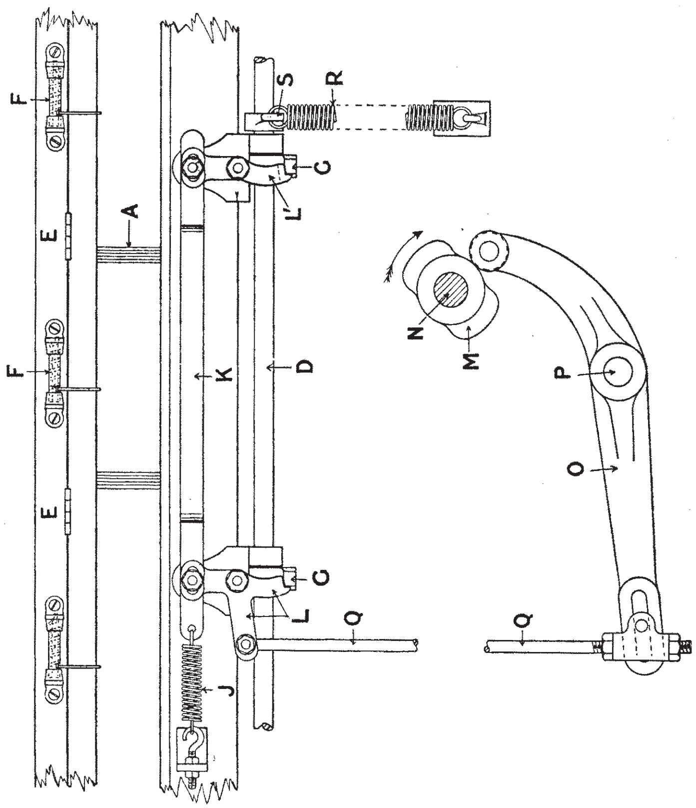
It will be seen that while the tongues J and the frogs K are apart, the reed is held steady in its position by the action of the spiral spring F alone, and this, taken together with the fact that rigidity in the reed for beating-up purposes depends entirely upon the stiffness of the fingers J, levers H and C and the rod A, make the motion unsuitable for use with large heavy shuttles or for the production of heavy fabrics.

In conjunction with the loose reed motion shown in this figure, although not necessarily an accompaniment of it, is indicated one of the different methods of applying a brake to a power loom. The brake itself consists of the short arm or paw O of the lever fulcrumed upon the projecting stud P. This arm is curved to fit and act upon the rim of a fly-wheel Q which is keyed upon the crankshaft between the driving pulley and the usual spur pinion, while the other arm R extends to the front of the loom, is notched to receive a drag weight S, and is then flattened and drilled to receive the lower end of a rod T. An adjustable nut on T supports R so that arm O is clear of the fly-wheel Q when the loom is running. The upper end of the rod T is attached to the extremity of a short curved lever U fulcrumed at V (see detailed view at right of figure), the under or curved side of which rests upon a projecting piece W on the face of the set-on handle N. In moving this handle into the "on" position the piece W acts upon the under side of the lever U, and through the rod T raises the arm R and relieves the fly-wheel Q from the arm O; but as the handle N springs back into the "off" position, the lever U falls and allows the weight S to act upon the arm R and bring the arm O into contact with the wheel Q.

Loose reeds and brakes form part of the usual furnishings of light, high speed looms, but considering the number of looms that are in constant and satisfactory use in jute and linen weaving in which no brake whatever is applied, it appears open to question whether one is desirable in any case unless say for automatic looms. In the method under consideration one of the most obvious defects is that when the loom is "off" the brake is "on," offering resistance to the weaver in her efforts to turn the loom into any desired position; but in most cases, however, the connections to the brakes are so arranged as to enable the weaver to make the brakes inoperative should she desire to turn the loom by hand.

One of the most efficient loose reed motions is illustrated in front and sectional end elevations in Figs. 258 and 259. In this arrangement the lower rib of the reed A is supported as usual in an angle iron bar B carried by a series of arms C which are keyed on the stop-rod D. The upper rib of the reed is, as is also usual, held in position by the upper shell E, but in this case the front lower section of the upper shell is hinged to the main part at intervals along its length, and is kept firmly in its normal position by means of contained springs F.

Near the extremities of rod D tongues G are keyed, and these are locked in the position shown in Fig. 258, as the lay H approaches the full forward position, by the pull of the spiral spring J fixed on the lay front acting through rod K and levers L L′. If necessary in wide looms a third tongue G and locking lever L may be provided at an intermediate position. Levers L L′ are fulcrumed on brackets fixed to the lay, and lever L is provided with a third arm by which the tongues G, as well as the reed A, are set free as the lay recedes through the action of the double throw cam M adjustably fixed on the wyper shaft N, the lever O fulcrumed on stud P, and the connecting rod Q. In the drawing, wyper shaft N, cam M and lever O have been turned through an angle of 90 degrees from their true



vertical plane, using rod Q as a centre. Should the shuttle fail to clear the shed in due time, pressure between the warp, shuttle and reed A causes the latter to swing back at the bottom and so tilt the extremities of the tongues G

that they cannot be locked when the cam M permits spring J to act. Spring R, hooked at the lower end to a convenient part of the lay sword and at the upper end to a short hooked lever S on the stop-rod D, ensures that the reed A, when back with the lay, will be sufficiently rigid to support the shuttle as the latter is crossing. The hinged part of the upper shell E, while holding the reed A sufficiently rigid for the ordinary purpose of beating-up, gives the reed greater freedom of movement should a shuttle remain in the shed; indeed, the reed may come out of the upper shell entirely, but this arrangement permits of its replacement without requiring to remove the upper shell and slip the reed into its groove endwise as is sometimes the case.

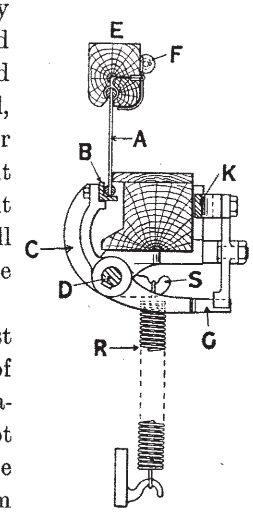


Fig. 259.

The Weft Fork.—Probably the most simple and yet most delicate piece of mechanism found in general application in practically all looms except those for jute weaving is that of the weft fork or motion to stop the loom if the weft be run out or broken. It is a simple and inexpensive motion, can be fitted to any existing loom, and when properly adjusted is certain in its action and gives little or no trouble to the weaver. It is in fast-running looms of the hessian type where its benefits are best appreciated, for in numerous cases it prevents the loss of time due to picking out, to turning back, and to taking up broken selvages. Where no weft fork is in use, it frequently happens that the weft breaks and catches on again without a stoppage of the loom, and if in this interval the shuttle makes a few journeys without leaving any weft in the cloth, a broken pattern results. The loom may continue to run for some time before the fault is detected, and thus a considerable amount of weft may have to be picked out. In these cases there is also a certain amount of waste, and always a faulty place the entire width of the fabric.

Figs. 260 and 261 show in elevation and plan the side weft fork motion. The chief parts are the upright grate A (see also Fig. 265), the three-pronged fork or lever B fulcrumed on the pin C, the fork rod D set-screwed on the set-off lever E which is fulcrumed at F, the hammer G and the lever H compounded at J and both moving on the stud K, and the lifting cam L set-screwed on the wyper or second shaft M. The grate A has three openings, is about the height of the reed, and is situated slightly behind the face of the latter just at the entrance to the shuttle-box at the driving end of the loom. The lay is grooved across the race at that point about $\frac{3}{4}$ in. deep by $1\frac{1}{4}$ ins. broad to receive the grate and to permit of the passage of the prongs of the fork B as the lay moves backwards and forwards. These prongs—three in number, corresponding with the openings in the grate A—are bent downwards almost at right angles to the body of the fork, and dip to about $\frac{1}{4}$ in. from the bottom of the groove. The fork B is balanced on its fulcrum pin C so that the moment of force or tendency to turn is always in favour of the straight (or left) arm. Such being the case, if no obstruction be offered to the passage of the prongs through the grate A when the latter advances with the lay, the hook on the extremity of the straight arm of the fork will continue to rest in the position shown on the head of the hammer G. As the wyper shaft M revolves in the direction of the arrow, the

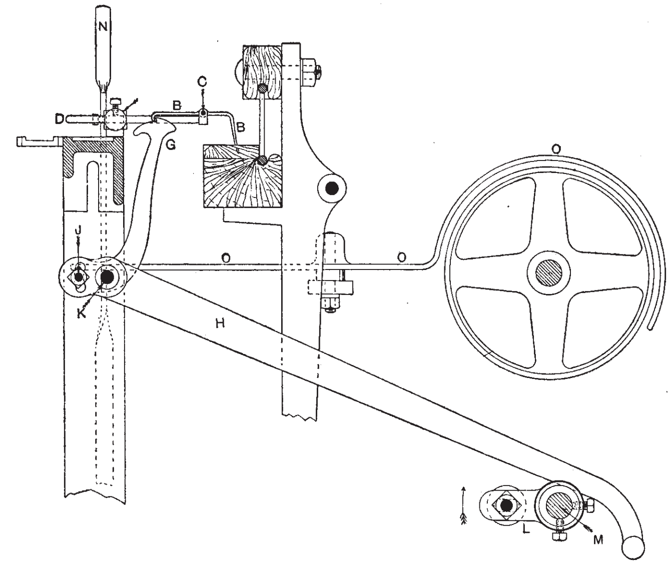


Fig. 260.

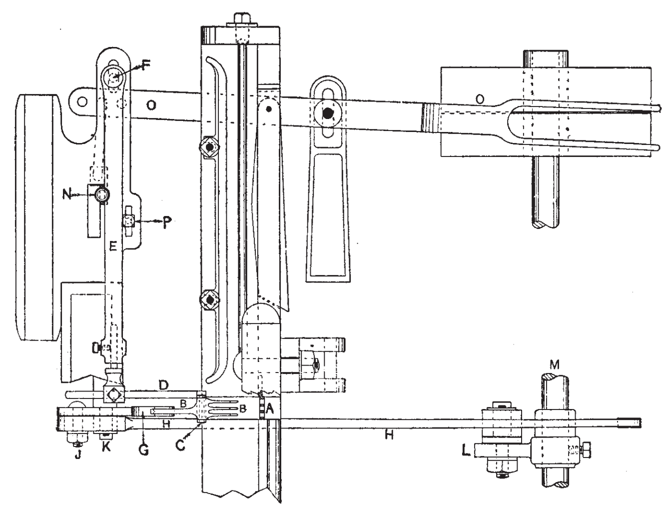


Fig. 261.

anti-friction roller of the cam L raises lever H and moves forward the head of the hammer G. The latter takes with it the fork B and its supporting rod D which is set-screwed in the end of the lever E. This lever is situated immediately behind the set-on handle N, and in moving forward with the weft fork forces the handle out of its retaining notch, allowing the latter to spring sideways and move the driving-belt on to the loose pulley by means of the belt fork O. If, however, the unbroken weft be present and crosses the path of the fork prongs, it obstructs their passage through the grate A, in consequence of which they are deflected by the further forward movement of the grate; the straight arm is raised clear of the head of the hammer G, and the latter moves forward without disturbing the position of the lever E, so that the loom continues to run.

The cam L has to be set so as to begin to move the hammer G forward just as the reed begins to travel backward. The fork B must be adjusted so that the prongs pass freely through the grate A if no weft be present, otherwise it may be damaged, besides allowing the loom to run instead of fulfilling its proper function. It must also be set so that the hook on the end of the straight arm clears the catch on the head of the hammer G by about $\frac{1}{8}$ in. when the latter is at its farthest back point with the set-on handle N in its "on" position. Sufficient opportunity is given for the adjustment of the fork in the lever E and rod D, and of the position of the hammer G by the concentric slot at J. The travel of G is modified by altering the position of the anti-friction roller and stud in the cam L, and the time of movement by the adjustment of the latter on the wyper shaft M. Sufficient travel to force the set-on handle N entirely out of its retaining catch is all that is required. The bolt head P acts as a stop to the backward

movement of the lever E when the handle N is "set on." The fork B should not tilt more than necessary to clear the head of the hammer G when weft is present.

From the position of the parts, and the fact that the hammer G is actuated from the second or wyper shaft, it is obvious that the motion will act only every second pick, and on this account three picks at most (two in general) may be missed before the loom is brought to a stop. To avoid forming a thin place in the cloth by the omission of these two or three picks, the retaining catch of the uptake motion is withdrawn from the wheel by means of a vertical lever fulcrumed near K and actuated by E. To prevent the fork from drawing the weft from the shuttle, and so possibly stopping the loom when weft is present, shuttles are sometimes made right- and left-handed—that is, for a left-hand loom similar to that illustrated the eye of the shuttle would be at the left-hand end, and for a right-hand loom the eye would be at the opposite end of the shuttle. This arrangement of the shuttle eyes also reduces the tendency of the weft to fly over the fork.

Centre Weft Fork.—A weft fork similar to that described above may be used in drop-box looms where the boxes are fitted at only one side; but in looms with boxes at both sides, and arranged to pick at will from either, such a weft fork is practically useless. It is obvious that if two or more shuttles were collected at the driving end of the lay, the fork might, and probably would, be actuated by the weft of one shuttle whilst another might be running empty. In such looms a delicate and ingenious contrivance termed a centre weft fork is sometimes fitted. It is arranged to feel and act for every pick, and, as its name implies, is situated at the centre of the lay instead of at one end.

Figs. 262, 263, and 264 show respectively front and side elevations and a plan of such a motion. Fig. 263 is partly sectional in order to illustrate the parts more clearly. On the front of the lay A a bracket B is secured which carries a sliding piece C and the fork lever D—the latter being supported on its axis E by two centre studs F, F screwed in the ears of bracket B. Sliding piece C is kept in a vertical position by the heads of two screws G, G which pass through a slot in C and enter the bracket B. A ledge along the under side of B serves as a support for C, and also provides a surface on which the latter slides to right and to left in unison with the backward and forward movements of the lay. This endwise movement of C is obtained by means of a stiff wire J, which is attached at one end to the piece C, and at the other to a bracket bolted to the breast beam K. As the lay recedes, the sliding piece C is drawn to the right until the cam H, cast upon its upper edge, tilts up the lever D. When this occurs the prongs L (thin flat wires about $\frac{1}{8}$ in. deep and carried by lever D) are elevated sufficiently to permit the shuttle to pass.

The forward movement of the lay causes the sliding piece C to move to the left when the cam H passes from under the fork lever D, and the latter falls until, when weft is present, the prongs L are arrested by the weft (see Fig. 263). Under these circumstances the upper end of the arm M of the bell-crank lever (centred freely at N in the sliding piece C and having a heavy arm O) passes clear underneath the fork levers D as the sliding piece C moves to the left. If weft be absent, however, the prongs L sink immediately into a transverse groove P (about $\frac{1}{2}$ in. broad and $\frac{1}{2}$ in. deep) cut in the lay to receive them, and in which position they are supported by a crosswire Q (see low dotted position Fig. 263). If this occurs, the fork lever D interposes in the path of the upper end of arm M (see Fig. 262), which is

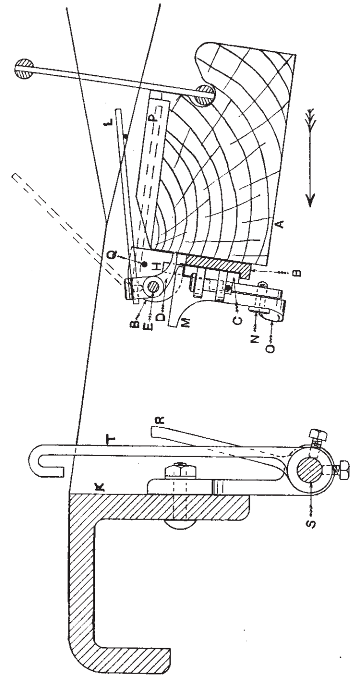


Fig. 263.

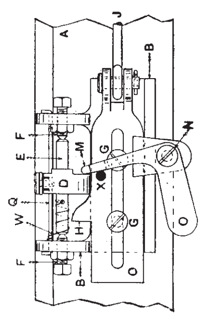


Fig. 262.

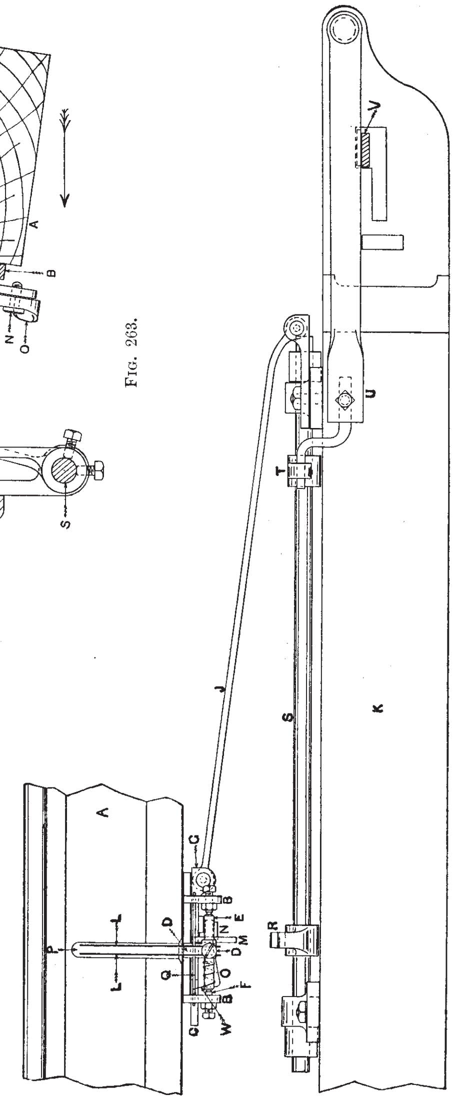


Fig. 264.

thus retained in that position—swinging on its centre N—as the lay moves forward and the piece C slides farther to the left. Under such conditions a projecting part at the extremity of the arm M strikes finger R; the latter is set-screwed on rod S, which is supported in brackets bolted to the breast beam K. Rod S, as well as lever T, is thereby partially rotated. T is connected at its upper end to the extremity of an ordinary set-off lever U, which is thus actuated sufficiently to push set-on handle V out of its retaining recess. A light spring W, coiled round the axis of D, ensures a practically certain action on the part of the latter, whilst a stop X, projecting from the face of C, prevents the upper arm of lever M O from falling too far forward.

The following points require careful adjustment :—

1. The travel of the sliding piece C, which is controlled by the travel of the lay and the length of the wire J.
2. The position of the finger R must be so adjusted that M will pass it when weft is present, but will strike it when weft is absent, and also move it sufficiently to drive out the set-on handle.
3. That at the commencement of each backward movement of the lay (*i.e.* when the fork lever D rests upon the upper end of arm M) the prongs L will not be elevated sufficiently to strike the under side of the cloth.
4. That when weft is present the prongs L will not be withdrawn from the support of the weft until arm M has moved underneath the fork lever D.

Buffers and Martingales or Check Straps.—In all looms with negative picking motions the mechanism employed for

the purpose of actuating the picking arm and propelling the shuttle is entirely independent of the means adopted to arrest the forward movement of the arm after it has ceased to act upon the shuttle, and to stop the latter when it has entered the shuttle-box.

For the former of these—that of arresting the forward movement of the picking arm K and the picker J (Fig. 265)—it is the general practice to employ a buffer B, located on the spindle C at the spindle head D. In picking, the picking cam causes the picker to be moved only a portion of the length of the spindle C (probably to about the point indicated by the letter C in the figure), but the momentum imparted to the stud, arm, and picker is such that they continue to move after the pick-

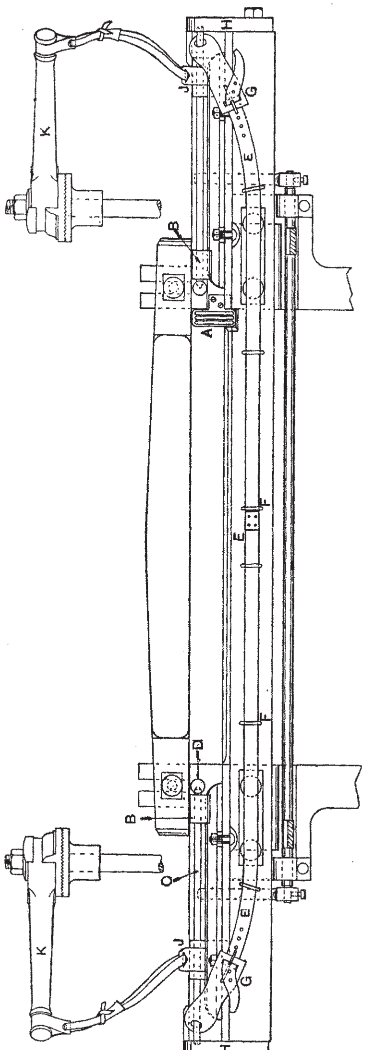


Fig. 265.

ing cam has ceased to act upon the stud. Then, as occasionally occurs, if no buffer is interposed between picker J and the spindle head D, the former strikes the latter with excessive force, the arm and strap are checked suddenly, with the result that the picker is unduly damaged, and breakages of the strap or arm inevitably result. The head D also gradually wears slack, and the spindle C begins to move about and erratic picking ensues.

Various forms of buffer are in use, that indicated consisting of two plies of heavy leather, 2 ins. broad, with the ends brought together and riveted in the form of some pickers, an aperture being left for the entrance of the spindle. Sometimes a length of strapping is taken, and holes punched in it at regular distances along its whole length, it being then doubled and threaded on the spindle. This leather, when first adjusted, forms an effective buffer, as it opens out along the spindle after the receipt of every impact, and thus forms a kind of spring which the picker has to compress. But this elasticity is not permanent, as with constant and after lengthened use the leather ceases to perform this desirable function. A serviceable buffer, and one which constitutes a satisfactory use for old belting or strapping, consists of a series of leather washers fitted on the spindle at the proper point. These can be readily made for the purpose by a simple punching machine. The main point is to secure a moderately compressible cushion between the picker J and the head D.

In addition to the swell arrangement in negative picking looms, a martingale or check strap is now almost universally used for receiving and checking the shuttle. It consists of a piece of strapping E about 1 in. broad and of suitable length, which is passed along the front of the lay and supported and guided at intervals by heavy iron staples F.

Each end of E is attached by a rough buckle to a leather tab G, about 6 ins. long and 2 ins. broad, which is rounded at one end and punched to receive the picking spindle C. The tab G is placed on the spindle between the back of the picker J and the box end H. Midway on the lay, two of the staples F are fixed from 5 to 6 ins. apart, and on the strap E at this point a second thickness of strapping, about 2 ins. long, is nailed; this piece, by butting against first one staple and then the other, checks the movement of the strap E in both directions. With 5 ins. between the staples and a check piece 2 ins. long, it is evident that the strap is allowed a travel of 3 ins. in each direction. The tab G should be adjusted to be $\frac{1}{2}$ in. clear of the box end H when pulled hard over towards it with the shuttle in that box, and the check piece of the strap bearing hard on the corresponding staple. The amount of travel allowed to the strap will in great measure depend upon the length of the spindle and the shuttle-box, but generally speaking it should be as much as possible. A travel of 3 ins. in a 45-in. reed space loom is not too much. If the travel be short and the shuttle be checked suddenly, it is practically equivalent to having no check strap at all, and results in the shuttle rebounding, in broken cops, and in ravelled pirns. Checking should not begin, however, until the shuttle has actuated the warp protector.

The check straps for most box looms are essentially of a different kind. One end of the strap is, as in the above case, placed behind the picker J, while the other end is fixed to the breast beam. The strap being of a fixed length, it follows that the position of the end behind J will vary with the position of the lay. Thus, when the lay is back and the shuttle approaching the box, the tab will be drawn from H, while from this point the strap can move gradually towards H as the lay moves to its full forward position. In some box looms no check strap whatever is used.

The weft fork grate is indicated at A in the illustration, and one of the many methods of connecting the picking arm K with the picker J is also shown in the figure. Two short pieces of leather are taken and slotted at each end. One is passed round the groove on the end of the picking arm, and the other through the necessary opening in the picker. A long piece of strap is then slotted lengthwise near its broader or heavier end; the other end is passed through the ends of the leather on the arm, then through the ends of the piece in the picker, and finally is passed through the slot in the heavy end of itself, and tied in the manner indicated. This is a simple and satisfactory method of attachment. It affords a ready means of adjusting the length of the strap, and obviates the use of the somewhat dangerous bolt-and-nut attachment often found in jute-weaving looms.

Temples.—These are instruments the function of which is to distend the cloth from selvage to selvage or across the width of the piece while weaving. This statement presupposes a tendency on the part of the cloth to shrink in width during the weaving process; and although this is true with regard to the great majority of fabrics, yet there are a few, such as some heavy carpetings and mattings, in which the cloth width and the reed width are practically the same.

The causes tending to make a cloth shrink in width while weaving are many, and it may not be out of place to enumerate a few of them. Firstly, there is the nature of the fibre of which the yarns are composed, and the question as to whether it is elastic or inelastic. Jute and flax are

fibres possessing little or no elastic property, and hence yarns made from either material will not have the same tendency to shrink when relieved from the distending power of the reed, as will yarns made from an elastic fibre such as cotton or wool. Secondly, there is the nature of the weave. If a so-called square, balanced plain cloth—that is, one in which the threads and picks per inch are equal, and in which warp and weft are alike in size—be woven correctly, warp and weft will be equally deflected out of the straight line at the point of interweaving, and the contraction of each yarn will be approximately the same. If, however, the yarn beam be paced rather heavily, the increased strain upon the warp resists the bending power of the weft more effectually than before, and causes the latter to be deflected or bent more out of the straight line than formerly, with the result that the cloth shrinks more in the width. Conversely, if the yarn beam be paced too lightly, the warp may come off sufficiently slack to reduce its bending power below that of the weft, with the result that the latter remains almost in a straight line, and the cloth is kept more nearly the full width. It is, of course, evident that any decrease or increase of width due to the above-mentioned causes will be accompanied by a corresponding increase or decrease in length respectively; and for very similar reasons to the above, the contraction is greater with positive than with negative uptake motions. These facts are very generally known in the factory, but their underlying causes are not so widely understood. In plain weaving there are what might be termed two extremes in structure, between which the balanced cloth forms the mean. In one extreme the warp may lie perfectly straight and the weft do all the bending, in which case the shrinkage in length will be at a minimum and the contraction in width at a maximum; while in the other extreme the weft may lie perfectly straight and the warp do all the bending, in which case the contraction in width is practically *nil* and the contraction in length at a maximum. In a plain weave the intersecting of the warp with the weft is at its highest point, and contraction both in width and length from this point of view is also at a maximum. Any change of weave or of the interlacings of the warp with the weft must therefore result in a reduction of the percentage of contraction, provided other things, such as the sett and the size of the yarns, remain constant. These, however, vary in great degree, and we must consider the effect of such variation.

Any increase in the sett of the warp beyond the square reduces in a sense the opportunity of the weft to be deflected—in fact, it approaches that extreme condition where the volume of warp is such that the weft is entirely prevented from bending and the shrinkage in width is reduced, while any increase in the picks beyond the square approaches the other extreme condition, where the volume of weft entirely prevents the warp from bending, and in consequence the bending of the weft, and therefore the contraction of the cloth, is increased. In changing the size of the yarns, as, for instance, reducing the size of the weft, the weaker thread—that is, the weft—is less able to resist the bending power of the warp, with the result that increased bending of the weft, and therefore increased contraction in the width, takes place. The use of weft heavier than the warp will of course have the opposite effect. Increasing or decreasing the size of the warp is equivalent to decreasing or increasing the size of the weft respectively, with the corresponding result.

The operation of distending the cloth during weaving

might seem at first glance to have for its principal object the influencing of the ultimate width of the fabric. But this is true only in a very small degree. The chief reason for distending the fabric from selvage to selvage is to minimise as much as possible the lateral strain of the warp upon the dents of the reed at and near the selvages, and to reduce the tendency of the reed to saw and chafe the warp at these points. This tendency of the reed will, it is obvious, increase with the fineness of the fabric, since the dents of the reed itself have naturally to be finer or sharper; and, further, as the picks per inch are increased, the warp is subjected for a longer period of time to the friction caused by the moving reed, and also in an increased degree to the influence of the reed in beating up. Occasionally reeds are built with slightly heavier wires near the ends in order that they may withstand more successfully the lateral stress of the warp at and near the selvages.

An incidental advantage in the use of temples is that a better shed usually results at the selvages, as the warp at these points has not the same tendency to hang slack, as is the case when no temples are used. According to the fineness of the fabric and to its tendency to shrink in width while weaving does the use of temples become necessary.

The elastic nature of the cotton fibre makes the use of temples imperative in the weaving of almost all cotton and union fabrics. In certain fabrics of this kind it is not unusual to find the temple in the form of an iron roller A, Fig. 266, which extends across the entire width of the fabric. This roller is supported by and rotates in a cast-iron trough B which is fixed on the top of long vertical spring bars C in front of the breast beam in such a manner as to be movable to and from the reed, and thus provide an escapement for the shuttle should the latter fail to enter the box in time. With the exception of a few inches in the centre, the roller A is case-hardened and fluted along its entire length. On each side of the central or plain portion a screw thread (right-hand at one end, and left-hand at the other) is cut across the flutes in order to form teeth which will grip the fabric. As the fabric leaves the reed, it passes over the edge of the trough B, encircles fully half the circumference of the roller A, and then passes over the other edge of the trough to the breast beam. This roller temple is most suitable for plain fabrics of light to medium weight.

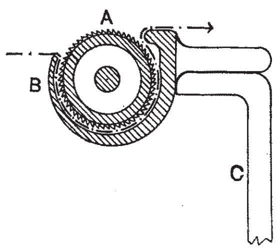


FIG. 266.

The fact that a considerable portion of the cloth is hidden from the weaver immediately after being woven renders this type of temple unsuitable for figured fabrics, and its distending power partakes more of the nature of an uptake roller than of a temple proper. In certain types of looms the two functions are combined in one roller, which occupies the position of the breast beam in an ordinary loom, and acts in a way as uptake roller and roller temple combined. Its effect is, however, often supplemented by side temples.

In jute weaving, due primarily to the inelastic nature of the fibre and to the comparative coarseness of the fabric generally woven, temples are unnecessary, and their use is practically unknown. A similar state of matters obtains in the coarser end of linen weaving, such as canvas, sheetings, and heavy plain cloths generally; and even in the weaving of the finer grades of linen damasks considerable difference of opinion exists as to whether temples are desirable, far less a necessity, until a moderate width of fabric (say

$1\frac{1}{2}$ yds.) is reached. As a matter of fact, fine damasks of this width are regularly woven without the aid of temples. In all heavily picked linens, however, no matter of what width, their use would be undoubtedly beneficial.

In the wider fabrics, where the production is a comparatively slow process, the hand temple indicated in Fig. 267 is still extensively used. It consists of two wooden arms D, which are fitted with a series of sharp spikes E at their outer and broader ends. The inner end of each arm D overlaps a third piece F as shown, and D and F are each drilled at intervals to receive a lacing cord G, which is adjusted to regulate the minimum distance between the two spiked ends. Snibs H screwed to bar F permit of the

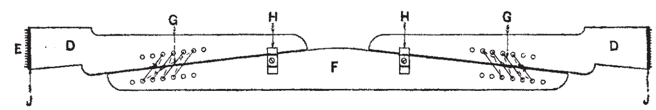


FIG. 267.

temple being released from its position in the cloth, and by projecting across the arms D keep the temple distended when in position. Spikes E are inserted into the cloth about $\frac{1}{4}$ in. from the edge of the selvage, the cloth being protected from the action of the wood by a piece of leather lace J pressed to the roots of the spikes.

By far the most popular and widely used temples are the roller temple and the self-acting one known as the segmental ring temple; the plan of one type of the latter is shown in Fig. 268. It consists of a spindle K on which are fitted a series of inclined brass rings L, about $\frac{7}{8}$ in. diameter by $\frac{3}{16}$ in. thick, having one or two rows of short, sharp spikes projecting from their periphery. This spindle is bolted in the temple-holder M, which is then passed through the bracket N, the latter in turn being bolted, near the selvage of the cloth, on a round or a square rod O attached to the front of the breast beam. In cases where the temple is not provided with a proper shuttle escapement, the spring of the rod O enables the temple to recede should the shuttle

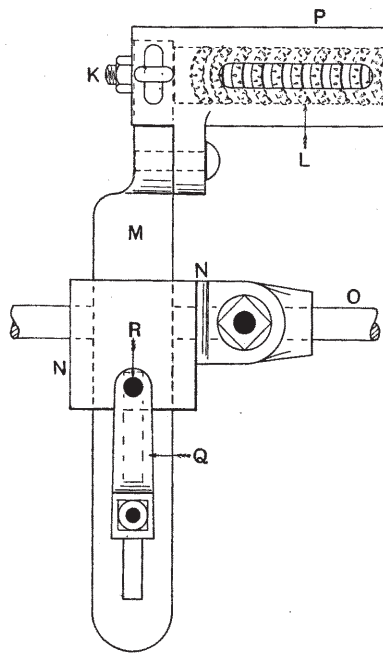


FIG. 268.

and the temple come in contact. A brass cover P, screwed or snibbed to the holder M, fulfils the double purpose of protecting the weaver and of deflecting the cloth sufficiently to grip the rings L. As these rings rotate with the movement of the cloth, the first point of contact of the latter with the rings compels the cloth to move outwards, this

being due to the inclination at which the rings are set. The inclination varies in different temples, but a medium angle similar to that illustrated is about 20° from the vertical. The number of rings on one spindle may vary between 1 and 30, but a common number is 10 or 12. Since the pitch between the rings is about $\frac{5}{16}$ in., it will be seen that the temple can project some little distance, say about 3 ins., under the cloth. Now the threads forming the selvage are invariably closer together than those which form the body of the cloth, hence in open sets the ground threads are more susceptible to deflection under the outward pressure of the rings. In many cases this becomes very troublesome, since it leaves an apparent reed-mark which is difficult, and in some instances impossible, to remove. In order to avoid this defect, the temple is sometimes made with the rings varying in angle from approximately vertical at the extremity of the spindle to over 20° from the vertical at the butt or selvage end. The greater majority of those in use have, however, only one angle. The temple is capable of vertical or lateral adjustment in virtue of its fixing on the rod O, while the shuttle escapement is of the following nature. The holder M is slotted to receive the fixing bolt of a flat spring Q, in the forward end of which is riveted a nipple R. This nipple, which projects from the under side of Q, enters a corresponding countersink in the upper side of the bracket N—through which the holder passes—and retains the holder forward in the desired position. Should the shuttle strike the temple, the spring Q yields and allows the holder M to slip backwards.

Details of the structure of the temple are shown in Fig. 269. Here the spindle K is in side elevation. Fixed at the spindle end is a tapered collar S, which has its face inclined at the predetermined angle and its centre or boss

T continued at right angles to its face to form a centre of rotation for the first ring L. Fitted next upon the spindle is an elliptical washer U, the inclination of which corresponds with that of the collar S, and the centre of which is also continued at right angles to its face to form a centre for the next ring. Washers and rings are then slipped on in succession, until the desired number is attained. A second collar V follows the last ring upon the spindle K, which is then bolted in the holder M. The centre piece T of each washer is slightly longer than the thickness of the rings L in order that the latter shall have freedom to rotate. The clearance, however, is small, and in order to obtain the best results the temple must be kept scrupulously clean. Dust and loose threads readily choke them and prevent the rings rotating.

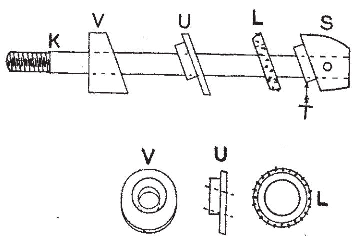


Fig. 269.

The small roller temples also grip from 2 ins. to 4 ins. of the fabric. They are much simpler and less scientifically made than the above, since they are simply small wooden or metal rollers into which fine pins are inserted, but for light to medium goods they are fairly efficient. One, two, or three of such rollers may be used for each temple.

Shuttle Guards.—The name applied to these contrivances is slightly a misnomer, as in no sense are they intended to guard or protect the shuttle, but rather the weaver and other persons against the shuttle. They fulfil no part in pure weaving operations, but instead serve to indicate by their presence upon a loom that weaving machinery is yet in a state of imperfection. Their use is an attempt to

anticipate an undesirable result rather than to eradicate its cause.

Under certain conditions it becomes a very difficult matter to prevent the shuttle from flying. If this were not the case there would be no use for shuttle guards, neither would the factory inspectors insist upon such guards being placed on the looms. There appears to be more shuttle-flying with light shuttles than with heavy ones, but this is probably due to the fact that the momentum of the heavy shuttle, even with its comparatively slow velocity, is greater than that of the light shuttle with its high velocity; in consequence, the heavy shuttle is better able to force its way through the shed rather than be turned aside by an obstruction, unless that obstruction be an imperfectly fitted reed, which will cause any shuttle to fly out.

One source of shuttles flying to which all alike are subject, is broken warp threads or other like matter causing a mixing of the upper and lower portions of the shed, with the result that the shuttle possibly rises over instead of passing under the mixed portions. In order to obviate this and to keep the shuttle close to the reed and the race, many artifices are tried. Sometimes the raceboard of the lay is made with a gentle and very slight decline from the shuttle-boxes to the centre, and in like manner the reed is made slightly concave. The outcome of this in many over-pick looms is that the picking spindle is raised slightly at the head and brought nearer the front at the same point, so that the picker may alter the position of the rear end of the shuttle in a similar way, with the view of causing the fore end to seek the race and the reed. A good method is to have the point of the shuttle as low as possible so that there will be a tendency for it to pass under instead of over any entangled threads. In underpick looms, although the picker may be guided in a practically horizontal course, yet it is constantly changing its angle, and at the last moment may slightly deflect the rear end of the shuttle, with the result that the fore end rises instead of lying to the race. To minimise this as far as possible, arrangements are made in some looms to traverse the head of a stick in a horizontal line instead of in the arc of a circle, and in other looms by means of a shoe at the lower end of the stick to raise the latter slightly, and with it the end of the shuttle at the finish of its stroke. The above-mentioned method of having the point below the centre of the shuttle also minimises the tendency of the picker to deflect the rear end of the shuttle.

In most cases shuttles are provided with a tipped end as shown in Fig. 270, and the picker, if not countersunk to correspond to this shape, quickly assumes it, and thus controls the rear end of the shuttle to such an extent that the movement of the latter is materially influenced by the movement of the former. This we consider the weak point of the arrangement; indeed, the picker has too much grip of the shuttle, and the slightest displacement of the former either laterally or vertically is conveyed to the shuttle, with occasionally serious results. Very few centre-tipped shuttles are in use in the large textile districts of the north and east of Scotland. The type of shuttle tip used in these districts is indicated in plan and elevation in Fig. 271. In this case A, the tip proper, has its centre line about a quarter of the total breadth from the back, and about three-eighths of the total depth from the bottom of the shuttle. At B, the part on which the picker acts, the tip is flat (and consequently the picker is not so readily damaged), while its face is about one-half the breadth by one-quarter the depth of the shuttle. In this, as it should be in all shuttles,

the centre of the tip is below the centre line of the shuttle, with the view of causing the shuttle to pass under any broken or imperfectly lifted threads. In addition, the tip will pass more easily and safely under the crossing threads of those centre selvage motions which are operated without under connections. This type has the additional advantage of the tip being near the reed, and therefore much more likely to take the proper path in a mixed shed. A further advantage is that the picker cannot grip or control the rear

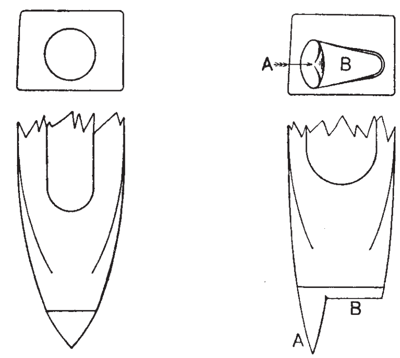


Fig. 270. Fig. 271.

end of the shuttle in the same manner as it does those with "centre" tips. A third and important point is that the line of force of the pick is applied in front of the centre line of the shuttle, which is thus compelled to seek the support of the shuttle-box back and the reed. In the other type of shuttle the tip is placed in some instances with its centre above and in front of the centre line of the shuttle, with the view of causing its head to seek the race and the reed, but this position makes it more ready to rise over mixed portions of the shed. So much is this the case that we have known many instances where the shuttles have had their under sides dressed down in order to reduce their tendency to rise, or if possible to prevent them from rising.

In other cases the centre of the tip is nearer the back and the bottom, so that it may avoid mixed portions of the shed; but in this position the line of force is behind and below the centre line of the shuttle, thus giving its head a tendency to turn in an upward and outward direction. Again, as in Fig. 270, the centre is found midway from front to back, but a little under the centre line. This is probably a better arrangement than either of the two foregoing, but in our opinion it is still a long way behind the flat or "side" tip of Fig. 271. With continual use the shuttle becomes worn and rounded from both ends towards the centre, and when in such a condition it is very liable to fly; worn pickers also often result in the shuttle leaving the race and shed.

Of shuttle guards there is an extraordinary variety, the result of combining, or of attempting to combine, efficiency and cheapness, but the one which will give least trouble to the weaver in the end, be the least expensive to begin with, and keep in order for the longest period, is, we believe, an iron rod of $\frac{3}{8}$ in. to $\frac{5}{8}$ in. diameter rigidly bolted to the upper shell or reed cap, and inclined at such an angle as not to interfere with the yarn in the shed. The fittings of many guards are such that in a week or two the guard is falling away from its position on the reed cap. In other cases, where it is not rigid, but folds back out of the weaver's way when mending broken threads, and is supposed to return automatically to its guarding position when the loom is restarted, it gets readily out of order, and it is often found tied back permanently by the weaver, or else wobbling inefficiently in front of the reed. We think, however, that if the flat or "side-tipped" shuttle indicated were more

universally adopted, the necessity for shuttle guards would be much reduced.

CHAPTER XIX

TURKISH OR TERRY TOWEL MOTIONS

In the weaving of a certain class of pile fabric requiring two warps—one of which in conjunction with the weft forms the ground of the fabric, while the other forms the pile—it is necessary to employ a motion which will either give the lay and the reed a variable movement as regards the full forward or beating-up position of the latter, or so control the reed as to cause it to swing upon its upper rib as a centre and thus vary its beating-up position. Such arrangements of mechanism are termed terry motions, and are used to place two or more successive weft shots in position a short distance behind the fell of the cloth proper, where they are interwoven with the pile and ground warps, but after the third shot, to lock the reed in its normal position, and so to press forward all three shots at once to the fell of the cloth. In so doing the weft threads pull forward the warp threads from the pile beam which is lightly tensioned, while they slip over the warp threads from the ground beam which is heavily paced. The result is that the pile warp threads, which before being beaten up stretched across the gap between the few picks and the fell of the cloth, become doubled up in loop form, and constitute a line of pile across the cloth from selvage to selvage.[1] One or more picks may then be put in with the

[1] See chapter xx. Turkish Towelling, or Terry Fabrics, pages 414 to 428, *Textile Design: Pure and Applied*.

locked reed to bind the pile warp firmly in position, after which the same operations are repeated.

Terry fabrics are known as 3, 4, 5, or 6 pick terrys according to the number of picks employed in forming one row of pile loops. Jute yarns even as weft are very seldom employed in the manufacture of terry fabrics, but linen yarns are used for both ground and pile warps, and also for weft. Most fabrics of this type are, however, made either entirely of cotton yarns, or as unions of cotton and linen, the latter being used for the pile.

In motions where the reed is rocked out of the normal position when beating up, it is necessary to provide means to close it again as the lay recedes in order that the shuttle will be properly supported as it crosses the lay.

Of the two systems of forming gaps, (*a*) by varying the movement of the lay and reed, or (*b*) by swinging the reed out of position only, the latter is probably the simpler and the more widely applied, and one of the best known of this type is that made by Messrs. Hacking and Co., Ltd., Bury.

In this motion, two views of which are shown in Figs. 272 and 273, the lay A and the upper shell B are secured to the swords in the usual manner. The underside of B is, however, specially formed to permit of the free movement of the reed C backwards, although the latter cannot leave the groove in B without being moved in an end-long direction. The lower rib of the reed C is supported as shown in a grooved carrier bolted to the upper ends of two arms D, which are in turn bolted on a large diameter hollow shaft E. This shaft E is carried in two brackets bolted to the lay swords, and therefore partakes of the usual movement of the swords and lay A. One ear of the sword arm is extended behind the connecting pin to provide a fulcrum at F for the lever G, the straight or pendant arm of which

is connected to arm D by a strong spiral spring H as shown, while the curved arm extends at right angles to the pendant arm and carries an adjustable stop-piece J, the function of which is to determine the extent to which the reed C may be opened, and therefore the length of pile which may be formed. Under normal conditions the action and strength of spring H is such that the lever G assumes the position

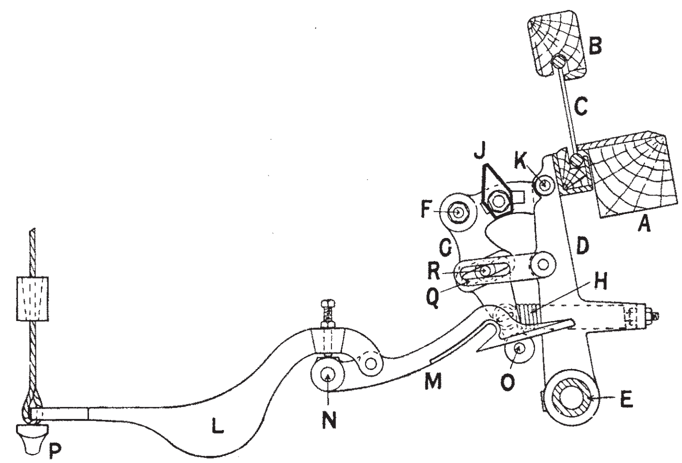


Fig. 272.

shown in Fig. 272, where the extremity of the curved arm of G is acting against stud K on arm D, and thus locking the reed C in its normal position. Provided no change takes place in the position of lever G, the reed would continue to beat up as in an ordinary loom, but further parts are provided to open the reed as required. These consist of a compound lever L M fulcrumed loosely on stud N; the latter is bolted to the framework, and stud pin O is bolted in the lower extremity of lever G. Arm L of the lever L M is so weighted that it tends to rest on its supporting bracket P, and so keep the hooked arm M raised clear of the stud pin O. But when an open reed or "loose pick" is wanted, the arm L is raised by connections from the dobby, see Fig. 273, and the hooked arm falls and arrests pin O in its forward movement; this causes lever G to swing on its fulcrum F, and permit stud K and arm D to

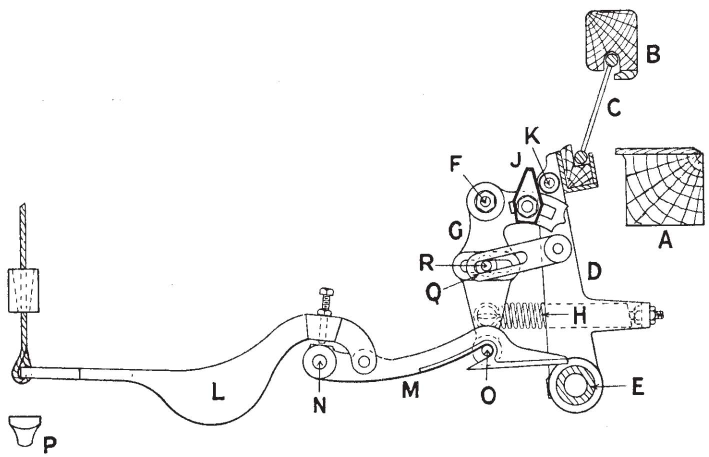


FIG. 273.

recede under the pull of spring H, and as far as the stop-piece J will permit. Further forward movement of the swords and the arm D will simply extend spring H. As the lay and swords again recede, the spring H closes the reed through the action of lever G, and the arm of the sword comes into contact with the stud pin O and carries it back clear of the hook on arm M. Link Q and stud R are provided to ensure that the reed will be opened, and that it will remain open when stud K impinges on the stop-piece J.

Figs. 274, 275, 276, and 277 show front elevation, plan, and two end sectional elevations of another type of loom for weaving terry fabrics. This motion, in which both the reed and the supplementary lay receive the varying movement, is made by Messrs. William Dickinson and Sons, Blackburn. A is the wyper shaft of the loom, and B is the shaft to which the shedding tappets are fixed. The latter shaft is driven from A by the three wheels C, D, and E,

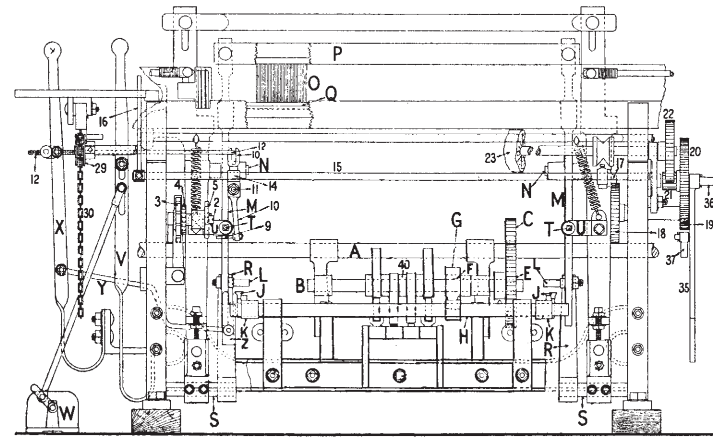


FIG. 274.

the central wheel being simply a carrier, while wheels C and E are in the ratio of 2 to 3—hence the tappet is for a 3-pick terry. A small cam F is set-screwed to shaft B, and gives motion to the reed in the following manner: a lever G, set-screwed to the shaft H, rests upon the top of cam F, and is actuated by it as shaft B revolves. A similar movement is given to the two levers J, which are fixed by the adjustable brackets K to the shaft H. It will be seen that the highest and lowest positions of these levers

G and J and the cam F are shown respectively in Figs. 277 and 276. Studs L on the lower ends of the supplementary swords M engage with levers J every third pick. These swords are pivoted on studs N fixed to the ordinary swords of the loom. To the upper ends of swords M the reed O is attached and held in position by the top shell or cap P and the lower shell Q. The levers are so adjusted that when they come into contact with the studs L the lower parts of supplementary swords M are pushed back, and the

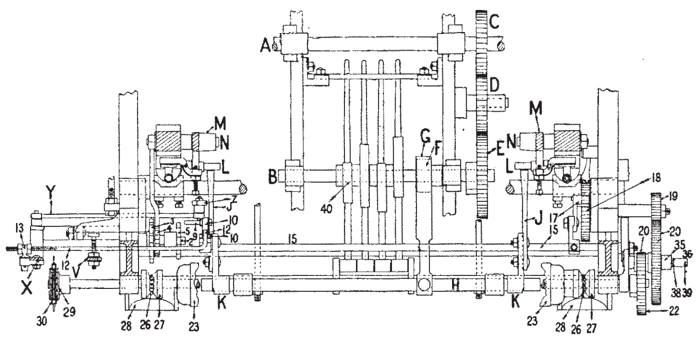


FIG. 275.

upper parts containing the reed are forced forwards a distance equal to the length of gap required for the formation of the loops of the towel. Two flat springs R, Fig. 276, fixed to brackets on the rocking shaft S, and pressing against the supplementary swords M, keep the reed in its normal position, and also return it to that position after it has been forced forwards by the above-mentioned action of levers J. The studs on the supplementary swords M can be adjusted in the slots for variations in the length of the pile. The lever J can also be lengthened or shortened to act on the studs L earlier or later, and thus increase or decrease the

size of the loops. The backward movement of the upper part M is limited by arresting the forward movement of the lower part by adjustable set-screws T in brackets U, fixed to the ordinary sword.

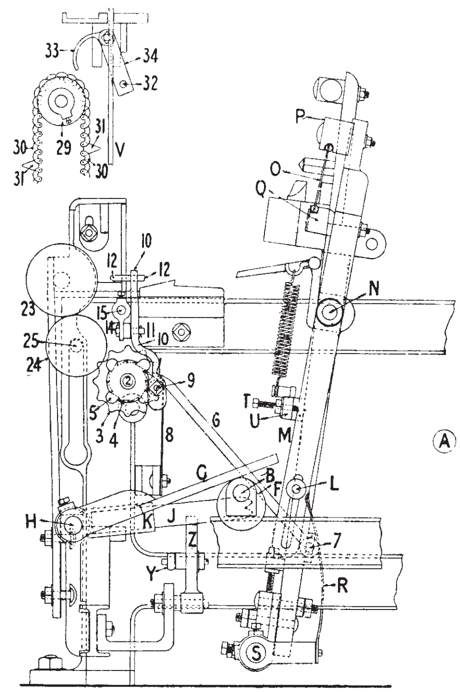


FIG. 276.

V is the ordinary set-on handle of the loom, and controls, as shown, the electrical switches in box W—the loom being driven by a small motor. A second handle X is provided for the purpose of controlling certain mechanism when the plain part, border or otherwise, is to be woven. When it is necessary to discontinue the formation of the pile, and to weave simple unlooped cloth, it is essential that the reed O should come full forward every pick; consequently arms J must come into contact with the studs L every pick during this period. The handle X is in the on-position, as shown in Figs. 274 and 275, when pile is being made, but if the handle be moved to the off-position, *i.e.* to the right, the connecting rod Y, which is fixed at one end to X and at the other end to a point near the upper end of a vertical locking lever Z, is also moved to the right. This places the ledge of the locking lever Z underneath the lever J, and thus keeps it up and in the line of the stud L. It is of course understood that both arms J move in unison. Immediately the handle X is moved to the on-position when pile is required, the locking lever Z is simultaneously withdrawn from under the lever J

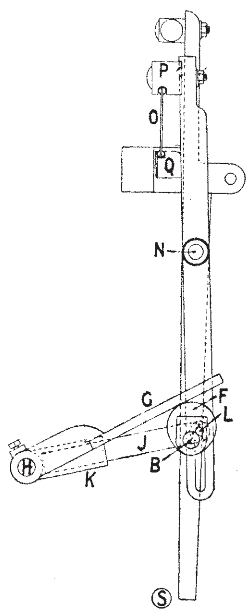


Fig. 277.

Projecting from the inside of the framework is a stud 2, upon which rotates the 12-lobed star wheel 3, ratchet wheel 4, and the 4-lobed plate 5. All three are compounded, and are driven one-twelfth of a revolution every time the lay comes forward by a long pawl 6 fulcrumed on a stud projecting from the ordinary sword. The 12-lobed star wheel 3 acts simply in conjunction with the flat spring 8 as a steadying motion. Since these parts rotate one-twelfth of a revolution every pick, and since plate 5 contains 4 lobes,

it follows that one or other of these lobes will pass any fixed point every third pick. When handle X is in the on-position and the loom making pile, the parts 3, 4, and 5 simply rotate one-twelfth of a revolution every pick, but are out of action with pin 9. If, however, the handle X be placed in the off-position when plain or unlooped cloth is being made, the pin 9 is brought into line with the 4-lobed plate 5, and is, consequently, pushed out a short distance every third pick. The pin 9 is fixed in the lower end of a lever 10 fulcrumed on stud 11, and the upper end of lever 10 is forked to receive one end of rod 12; the other end of rod 12 is attached to handle X by small bracket 13. The stud 11 is fixed to a small bracket 14 set-screwed to rod 15, and the two ends of this rod carry respectively finger 16 and retaining catch 17. When pin 9 is forced out by one of the lobes of plate 5, it is clear that rod 15 will be slightly rotated through lever 14, and hence the retaining catch 17 will be raised clear of the ratchet wheel 18 of the uptake motion. This naturally allows the uptake motion wheels to return for that pick, which is equivalent to keeping the cloth stationary, and increasing the number of picks per inch in that part of the cloth 50 per cent.

Wheels 18, 19, 20, 21, and 22 form the ordinary 5-wheel uptake motion, and impart movement to the spiked roller 23. The cloth roller 24, shown only in Fig. 276, is kept in close contact with the spiked roller 23 by means of a chain 26 hooked to a small collar on the cloth roller shaft 25, passed round grooved chain guide 27, which runs loosely on the arbor of spiked roller 23, and finally attached to a heavy weight 28. On the left-hand end of spiked roller 23 is fixed a sprocket wheel 29, see also detached view in Fig. 276, suspended over which is a governing chain 30 made up of small and large links.

The large links 31 are for the purpose of pushing set-on handle into the off-position by means of pin 32 and finger 33 of bracket 34. From the detached view it is evident that, as the chain rotates slowly counter-clockwise, the link 31 will ultimately press finger 33 to the left, and at the same time pin 32 will come into contact with handle V and thus stop the loom.

Fifteen links represent one complete revolution of spiked roller 23 or 15 ins. It is evident, therefore, that each link, large or small, represents 1 in. of cloth. In the chain shown in detached view in Fig. 276 the large link acts every 20 ins. When the handle Y is knocked off by means of the chain, the weaver moves handle X to the opposite position always, except when it is necessary to form a fringe, and then restarts the loom.

When fringes are being made, the uptake motion may be moved rapidly by means of handle 35, fulcrumed at 36, and pawl 37. To remove the cloth from the cloth roller, pin 38 is placed in hole 39, and the double intermediate 20 and 21 withdrawn from contact with wheel 22; the cloth roller can then be rotated easily. The arrangement as shown with 4 blades in tappet 40, and cam F on shaft B, is suitable only for a 3-pick terry; other terrys may, however, be made by substituting at C and E wheels of the proper relation, and suitable tappets in place of those shown at 40. For more elaborate patterns, the arms J may be operated by means of a hook in the dobby connected to a lever fulcrumed at H and used instead of lever G.

Messrs. Hacking and Co., Ltd., also provide their looms with special motions for the weaving of Turkish towels. All these motions may be controlled, when necessary, from the dobby. The various functions performed by these

extra motions are: the removal and the replacing of extra tension on the pile warp beam during the working of the end borders; the controlling of the shuttle-boxes for colour, and the uptake motion for an increase in the number of picks per inch; the rapid withdrawal of the warp so as to leave sufficient for the fringes during the time that the loom runs a few shots. All these operations are performed without stopping the loom, and when an automatic cross-border dobby is used, the changes of weave may also be made without stoppage.

Another terry motion made by Messrs. Lupton and Place, Ltd., Burnley, is illustrated in Fig. 278. A >-shaped heater A and sliding parts B and C are all connected by means of a hook D to a leather band E. This band passes, as shown, over roller F and under roller G, and is then continued to a hook in the dobby. Bracket H is bolted to the sword J, and supports oscillating lever K fulcrumed at L. The upper end of lever K is kept in close contact with the back of the bottom shell M, while its lower or forward end carries an anti-friction bowl N. The terry box O is bolted to the framework of the loom, and the lowest position of the sliding piece B is determined by the cushion P, which is in turn regulated by the set-screw Q and held in position by lock-nut R.

It is evident that when the lay moves forward, the bowl N can be made to come into contact with either the upper or the lower face of A, according as the latter is left down or raised by means of a hook in the dobby. It is evident that the lever K will be pressed hard against M for the proper beat up when the bowl N comes in contact with the under part of A. If, however, the bowl N rides on the upper part of A, it will cause the upper part of lever K and the bottom shell M to move backwards for the loose pick. Any type of terry can therefore be made by controlling the movement of A for the necessary number of times in a repeat.

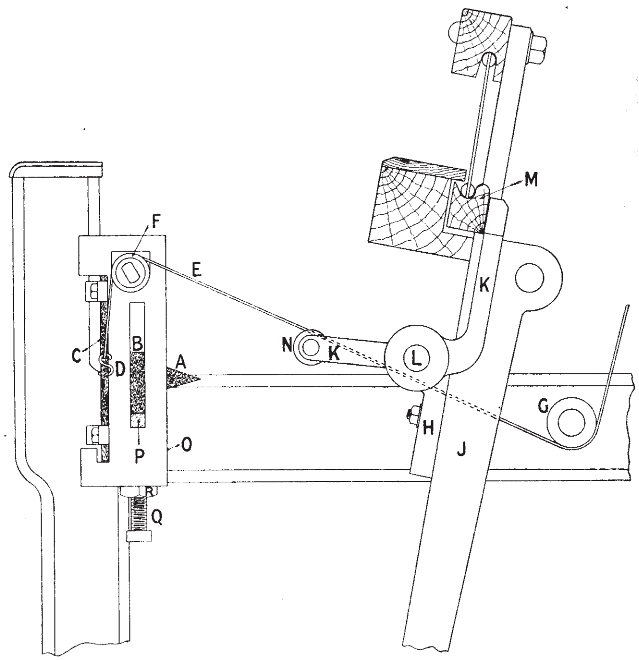


FIG. 278.

CHAPTER XX

AUTOMATIC WEFT SUPPLY

MECHANISM for the automatic supply of weft is of two general kinds—that which changes the shuttle and its contents, and that which changes the contents of the

shuttle only on the expiry or partial expiry of the weft. Mechanically, the former method of changing seems to be the easier, since many inventions of comparatively recent date have been placed on the market for this purpose, as against a very few which change the pirn or cop in the shuttle. From an economical point of view it appears more desirable to change the pirn or cop rather than the shuttle and pirn together, since in the former case only one shuttle per loom is required, whereas in the latter four to ten shuttles per loom, depending upon the size of the shuttle, may be required. Further, it is more difficult and troublesome to fit a large number of shuttles accurately to a shuttle box than to fit one, and, besides, shuttles are more liable to be damaged during a change than are pirns, no matter how slowly the shuttles are ejected.

Shuttle-changing mechanism may act in a number of ways; it may change a shuttle without losing a pick, with the loss of one or two picks, or by stopping the weaving motion of the loom for a greater number of picks, during which time the shuttle is changed and the loom restarted automatically. Amongst the several ways of ejecting the shuttle are the following:—

1. At the box front, where a new one is also inserted;
2. At the back of the box;
3. The bottom of the box is lifted at the inner end, so that the shuttle, instead of entering the box, passes through the opening between the box and the end of the raceboard and into a receptacle;
4. The shuttle is ejected sideways;
5. The circular box movement is made use of;
6. The drop box principle is adopted.

Of pirn or cop changing mechanisms the best known is the Northrop: at the time of writing, 1914, there are over

15,000 of these looms at work in the British Isles weaving various kinds of fabrics—principally cotton—besides large numbers on the Continent and in North and South America. The main idea of this changer is very simple, but, as in the case of all pirn changers, it centres round, and the change is entirely dependent upon the operations on the pirn in the shuttle, and the automatic threading of the weft during the first two picks after the change of pirn or cop is effected. All changes take place without the slightest cessation of movement or stoppage of the loom.

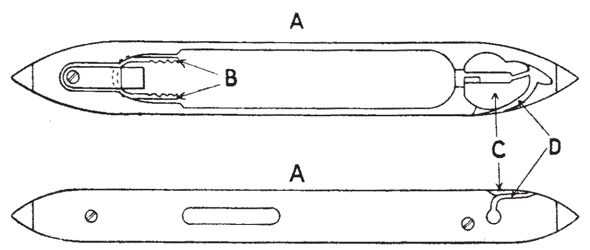


Fig. 279.

To facilitate the change, the shuttle A, Fig. 279, about 16 ins. long and taking a pirn up to 7 ins. in length, is provided with two powerful steel spring jaws B, the inner curve of each jaw being furnished with four grooves which grip and hold the butt end of the pirn by means of three thick wire rings securely fixed upon it. In the other end of the shuttle a brass casting C is fitted, which is provided with a slot so formed and moulded that the weft thread from the new pirn is drawn into it as the shuttle crosses the lay for the first pick after a change has taken place. On returning for the second pick, the weft is drawn down the curved groove D between the brass and the wood into

the eye of the shuttle. A horn or barb on the brass prevents the accidental return of the weft up the groove.

Full pirns, to the extent of twenty-five as a maximum, are fixed in a circular and rotatable hopper E, which is always situated on the right hand end of the breast beam, at which end of the lay all changes must take place. Hopper E consists of three discs, E, E′ and E″, all moving together, but capable of being independently set, as regards E′, to accommodate different lengths of pirns, and in the case of E″ to adjust the inclination of the weft threads F to the proper angle for threading. Spring castings in E grip the butt ends of the pirns, permit their ready entry into the hopper, and their free expulsion when changing. The next pirn to be transferred to the shuttle, see Fig. 283, which is a part sectional and part end elevation of the transferring parts, is always at the lowest point in the periphery of disc E with the pirn head immediately underneath the end of the transfer hammer G. A cross sectional view of the shuttle A, the shuttle box and lay H are given, from which it will be seen that the shuttle, in common with all pirn shuttles and all shuttles for skewered cops, is open both at the top and bottom, and that the shuttle box and lay also have each a similar opening through which the empty pirn may be expelled by the forcible entry of a full one from the top side. The transfer hammer G is fulcrumed at J, and a second arm K is continued downwards to support on fulcrum L a notched lever M which, through the influence of coiled spring N, Fig. 280, always tends to rise (see dotted position, Fig. 283) into the path of the bunter O secured to the face of the lay. Should this take place, M and O become locked and, as the lay moves forward, the end of hammer G presses the new pirn into the spring jaws B of the shuttle, and the new pirn as it enters forces the old one out. Arm P carries at its extremity a spring finger Q which supports and steadies the extremity of the pirn about to be inserted.

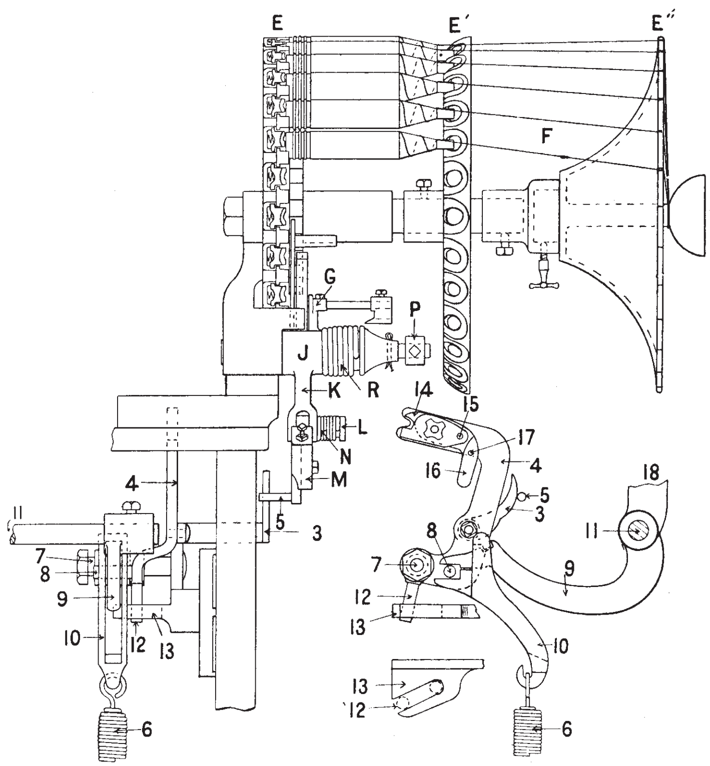


FIG. 280.

Transfer hammer G is returned to its position of inaction by a coiled spring R, Fig. 280, and, as the hammer returns, the hopper E is partially rotated clock-wise by the following means to bring the next pirn under the hammer head.

Between the arm of G and the inmost disc E are fulcrumed a retaining pawl S and a moving pawl T, see enlarged view at the base of Fig. 283; the moving pawl is fulcrumed loosely on pin U projecting from the framework, and a pin V projects from the inside of the arm of G into a slot in pawl T. As G descends to transfer a pirn, the pin V depresses pawl T beneath another tooth of the ratchet wheel W cast on the face of E, and at the same time compresses the spring X acting on the underside and slightly to the left of T. When G is released by the backward movement of the lay and rises under the pull of spring R, the spring X pushes up pawl T and rotates the hopper until the movement is checked by the next pirn head impinging against the stop Y. Pawl S prevents rotation in the opposite direction, but by means of projection Z cast on the side of S, and a further pin 2 which enters a triangular opening in T, both pawls may be withdrawn and the hopper rotated by hand.

It is now necessary to trace in what manner the notched lever M is permitted to rise in front of the bunter O, and for this purpose further reference is made to Fig. 280. Under normal conditions, M is retained in the position of inaction by the backward pressure of a curved finger 3, which is securely bolted in the side of the shuttle detector lever 4, and acts on lever M by pressure on projecting stud 5, under the influence of a strong spiral spring 6. The shuttle detector 4, which is fulcrumed on stud 7 and is shown detached in the view on the right, is one of the most important parts of the mechanism, since by its means a change of pirn is permitted, or is prevented should a shuttle fail to enter the changing box properly. It contains the mechanism by means of which the weft of the expiring pirn is severed from the pirn, and by which the severed end is carried back into a holder—not shown in the figures—where it is retained till it is further severed by the temple about half an inch from the selvage of the cloth. Immediately to the rear of the fulcrum of the detector lever 4 is a second stud 8, which projects into a jaw formed by the extremities of two pieces 9 and 10; part 9 is an arm secured to shaft 11, which extends along the front of the breast beam, while part 10 is a three-armed lever fulcrumed by one of its arms near the extremity of arm 9, while the second arm is kept hard in contact with the underside of stud 8 in lever 4 by the pull of spring 6 on arm number three. This last arm extends about 1½ ins. to the right of the fulcrum, so that when arm 9 is raised by the partial rotation of shaft 11, the pull of spring 6 causes the second arm of lever 10 to press stud 8 upwards and the detector lever 4 inwards until the projecting head of the latter crosses the race of the lay completely, just at the entrance to the shuttle box at the change end of the lay. Should the shuttle be in its correct position in the box, the curved finger 3 moves forward and permits stud 5 and lever M to rise to complete a change, but, should the shuttle project from the box and so obstruct the forward movement of the head of lever 4, stud 8 fails to rise, and the spring 6 yields to a greater extent than usual and permits arm 9 to rise and the jaw enclosing stud 8 to open. At the same time parts 3 and 5 keep the positions indicated, no change takes place, and the loom probably knocks off the next pick through defective picking.

In the Northrop loom a renewal of weft supply may take place either when the weft is completely exhausted, or some little time before it is exhausted. In the former case the action is from the weft fork, and, since no expiring weft requires to be cut, the detector lever 4 has a straight

forwards and backwards movement; but when a change is effected by feeler action, and the weft requires to be cut, then the detector 4 has a lateral motion to and from the selvage, in addition to its movement at right angles to the race, in order that, when moving backwards with the end of the severed thread, the latter will not be withdrawn from the jaws of the detector until it is securely gripped by the holder already referred to. This lateral movement is obtained by lengthening stud 7 to permit of the movement, and by providing detector lever 4 with a further stud 12 which enters the cam groove in the supporting bracket 13, and thus causes detector 4 to move in the desired manner. The head of 4 is equipped with a fixed blade, and also with a moving blade 14 for the purpose of cutting the weft; the moving blade, which has a pendant arm 16, is centred stiffly on pin 15. As the lay moves forward, the pendant arm 16 is pressed back sufficiently to cause the cutting blade 14 to descend and cut the weft which has entered the notch in the head of the detector. The blade 14 remains in this closed position, and retains the weft in its grip, until the detector is again moved forward, when the blade is opened by pin 17 being caused to press on the underside of a plate fixed to the weft holder. This pin 17 also opens the holder as it returns, and presses on the top side of the same plate.

As already stated, the shaft 11 extends along the breast beam to the weft fork end of the lay, which is always at the weaver's left hand, in order that it may bring the change mechanism into action through the movement of the weft fork on the total expiry of weft, or by the weft feeler when the weft is nearly exhausted. The feeler parts are illustrated in plan and side elevation in Fig. 281, and in elevation in Fig. 282. At this end, shaft 11 is furnished with a vertical arm 18, secured to the head of which is a loosely pivoted finger 19, which extends across the end of

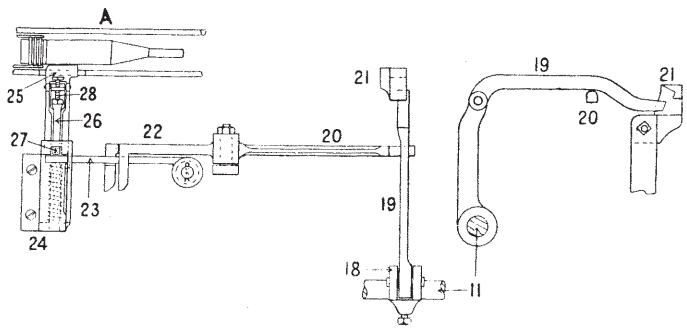


FIG. 281.

the arm 20 of the feeler lever and enters a slot in the specially formed head 21 of the weft fork hammer. Arm 22 of the feeler lever is forked at the end to provide a cam

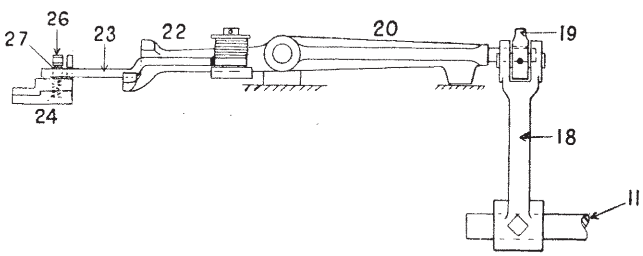


FIG. 282.

groove for the action of the bent depressor rod 23. The free end of rod 23 rests upon the top side of the feeler bracket 24, and, so long as there is sufficient weft in the shuttle, it is kept by spring action hard against the front of the bracket. Under these conditions, the feeler lever

20, 22 remains in the position shown, and finger 19 passes

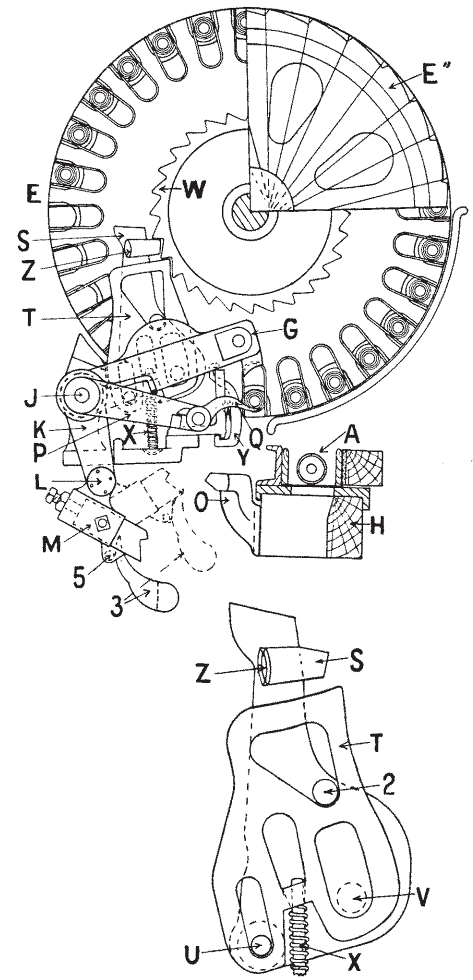


FIG. 283.

freely through the slot in head 21. The head of the weft feeler 25 enters an opening in the shuttle box front, and a slot in the front of the shuttle itself every pick, but is pushed backwards by the weft on the pirn so long as there is a sufficient supply. Feeler 25 carries near its head a little trip lever 26, the free end of which is supported by a small spring stud 27, so that normally it passes freely over the depressor rod 23, while a short vertical extension of 26 is provided with an adjustable bolt and nut 28. The feeler is naturally pushed back the same distance until the bulk of the weft on the cop or the pirn has been withdrawn, but the further exhaustion of the weft allows the feeler head 25 gradually to enter further into the shuttle A, and the bolt-head 28 to approach more closely to the wood of the shuttle. By proper adjustment, the wood of the shuttle is caused ultimately to strike the head of 28 before the feeler 25 reaches the wood of the pirn, and also before the weft is completely exhausted. When this occurs, the free end of 26 is depressed, and, instead of passing over depressor 23, drives the latter before it, causing feeler lever 22, 20 to tilt and to raise the finger 19 until its extremity is caught in the recess of head 21 as the latter comes forward under the influence of its special cam on the wyper shaft. Shaft 11 is thus partially rotated; shuttle detector 4 moves forwards, and the curved finger 3 permits lever M to rise into the path of the bunter O on the lay. If the action is through the weft fork, the latter may either act directly on shaft 11, in a similar manner to above, or indirectly through a tail piece on arm 18. Where the weft fork method is adopted, it is of course evident that occasionally there may be two picks in one shed in plain cloth, or a broken weave in others. As this would be detrimental to the appearance of some fabrics, it is essential, where perfect cloth is required, to adopt the feeler motion. In order to avoid

thin places when the change is effected from the weft fork, the loom is provided with a let-back motion which allows the take-up wheel to come back 1, 2 or 3 teeth, according as the motion is set. And further, it will be clear that the weft fork motion must not act to set off the loom when a change is required; but, should the change be effected improperly by the shuttle misthreading, and the weft fork act twice in succession, the loom will be stopped.

One of the chief defects of the feeler motion is the varying amount of weft which it may leave on the ejected pirn. Due to slight variations in the strength of the pick, or to other causes, such as an unusual amount of friction in the shed, the relative positions of the rings on the pirn, and the corresponding grooves in the grips of the shuttle, may vary when the shuttle is in the box; consequently, as the pirn is being forced into the shuttle by the hammer, the three rings on the butt end of the pirn may be caught in the three inner or in the three outer of the four grooves in the spring jaws of the shuttle. To be certain in its action, the feeler motion must be adjusted to act before the weft expires when the pirn is held by the three outer grooves, but, should it be held by the three inner grooves when a change takes place, it is clear that the difference in distance or in thickness must be made up of layers of yarn, the number of such layers depending naturally upon the diameter of the weft.

The automatic cop or pirn changer is quite satisfactory for yarns which are wound on pirns, or for such yarns as cotton which are spun in cop form and capable of being forced on some type of spindle or skewer and the head or grips of the latter being of course formed somewhat similarly to that illustrated in Fig. 279. For ordinary cops such as are extensively used in the jute and linen industries, particularly in the former, the above skewers are unsuitable, and it is questionable whether any arrangement of skewer or pirn head would be considered under present conditions because of the radical change which would be necessary in the winding process. It would therefore seem probable that some mechanism which can insert an ordinary cop, or which can eject a spent shuttle and insert a new one, will be adopted in the above trades if the yarns are otherwise suitable for automatic looms.

Although there are several types of automatic shuttle changing mechanism, that adopted by Messrs. George Hattersley & Sons, Ltd., Keighley, appears to have made most progress, and neglecting their apparatus for use in connection with two shuttles, termed a weft mixer, Figs. 284 to 294 illustrate perhaps the latest development of this type, in which practically all the mechanism is situated immediately under the shuttle box, and may be placed at either end for left hand or right hand looms.

There are two distinct ways of bringing the loom to a stop, (*a*) by means of an ordinary side weft fork or a centre weft fork on the expiry of the weft, and (*b*) by a weft feeler somewhat similar to that illustrated in connection with the Northrop loom. The weft feeler motion would naturally be essential for all but perfectly plain fabrics, and in such cases the ordinary cop could not be used with advantage. For many plain cloths, however, the cop may be allowed to run off, and the loom then brought to a stop at this point, and simultaneously the automatic changing mechanism be placed in action to perform the following functions :—

1. To raise the box front and also the upper part of the box back or rather the slip which keeps the shuttle down as it is leaving the box ; and to place in position the prongs for catching the ejected shuttle.

2. To push the spent shuttle out of the box.
3. To release a full shuttle from the magazine, carry it forward into the shuttle box, and keep the finger and swell out of action.
4. To withdraw the feed lever, lower the box front and the back slip, and allow the ejected shuttle to fall into a conveniently placed receptacle by lowering the prongs.
5. To restart the loom if all parts are in order.
6. To bring the loom to a stop when the magazine is empty, and not restart it unless all is right.

All these functions are performed when the crank is at or about the back centre after the driving mechanism has been withdrawn ; and when the loom is in working order it is always stopped at or near this point by means of a brake. Sufficient movement on the part of the magazine, as well as an escapement, is provided so that if any irregular working of the brake should take place, all parts can still move without damage but no actual change of shuttle will take place. It is seldom, however, that anything of this kind happens.

The loom may be driven by means of the ordinary fast and loose pulleys or by any other convenient method. In the drawings illustrated motion is imparted by means of a fast pulley and friction plates—cork insets being introduced into the driving plate. Under such circumstances the pulley A, Figs. 284 and 287, is kept running continuously during working hours, and so is the chain wheel B, the chain C, and the chain wheel D which, through a reduction in the gearing, drives the clutch E enclosed in case E′. When the set-on handle is moved, pulley A, chain wheel B and cork friction plate F are slid along the shaft by means of a fork G ; this causes the cork friction plate F to grip the plain friction plate H, and the loom then starts and runs like any ordinary loom. The presence or absence of weft enables the weft fork, in conjunction with other suitable mechanism, to keep the friction plates in contact or apart. Consequently,

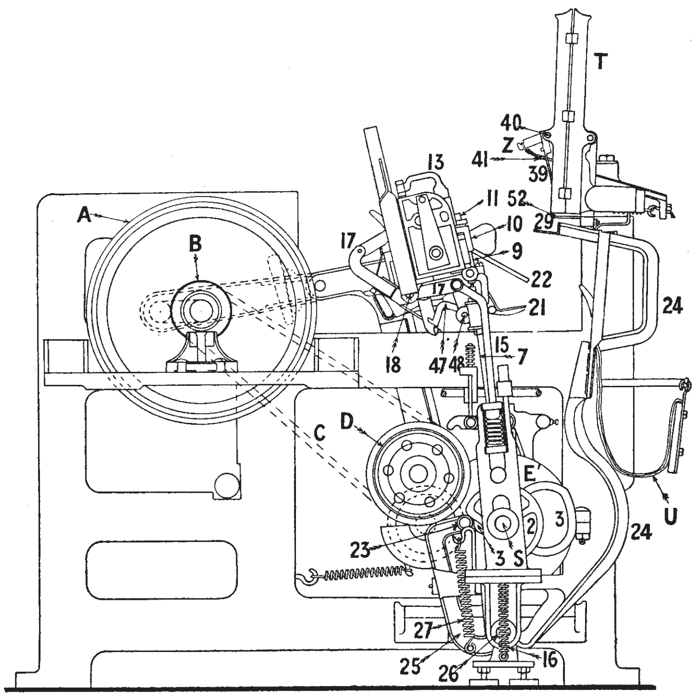


FIG. 284.

when the weft breaks or runs out, the fork G and all compounded parts are withdrawn from the plate H, the brake acts, and the loom is stopped with the crank at the back centre. Simultaneously the end J of clutch lever or trigger K, Fig. 290, is raised, the bottom end L is pulled outwards,

and the pin M in lever O is also forced towards the periphery of the clutch E. Lever O is fulcrumed at P, and

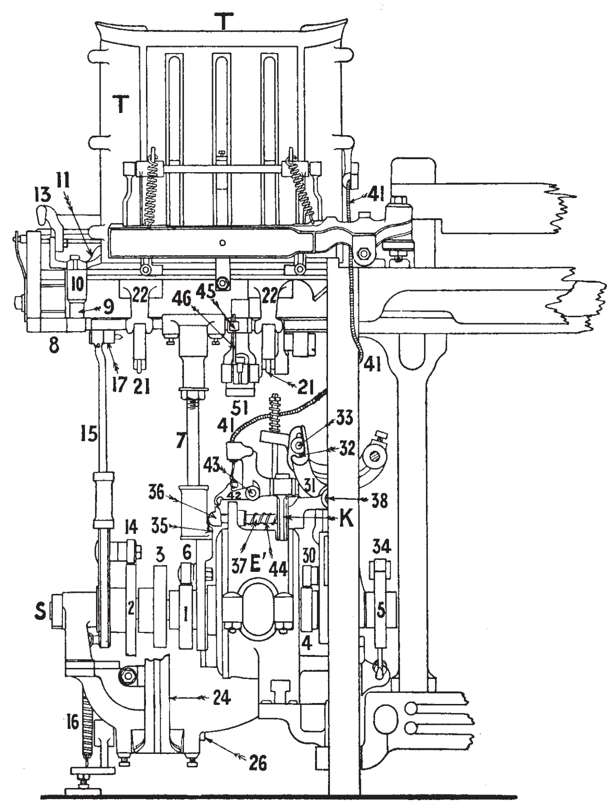


FIG. 285.

the outward movement of pin M is due to the partial rotation of lever O through the pull of spring N. When the lever O moves as indicated, the clutch pin Q enters one of the recesses R, indeed the first which is presented in virtue of the rotation counter clockwise in Fig. 290 of the clutch E. This is viewed from inside the loom. Immediately

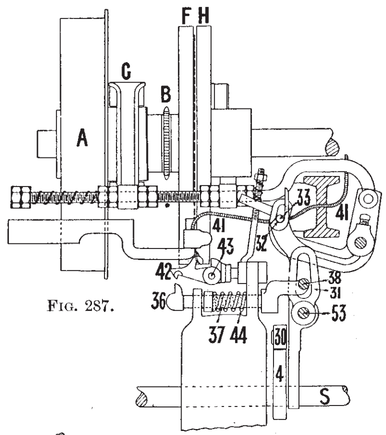


Fig. 287.

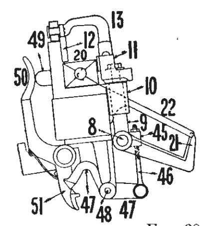


Fig. 288.

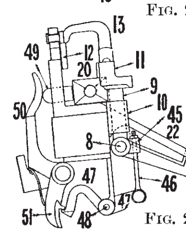


Fig. 289.

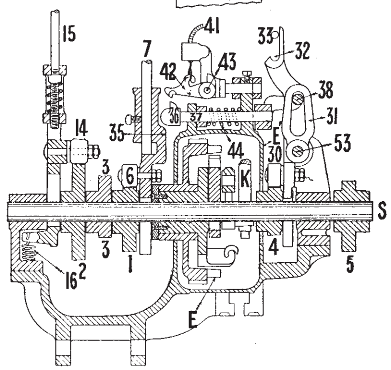


Fig. 286.

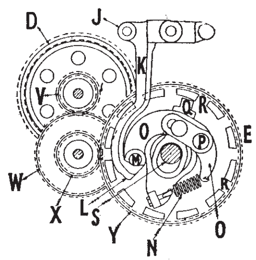


Fig. 290.

pin Q enters one of the recesses R, the main shaft S of the automatic motion commences to rotate. Fixed securely on this shaft, and working in perfect unison with each other, are five tappets, 1, 2, 3, 4, and 5, for operating the different

levers in connection with the various functions. The first tappet to act is No. 1, see Figs. 285, 286 and 291, and this tappet, coming into contact with the anti-friction bowl 6, raises rod 7 and the horizontal rod 8. Near the extremities

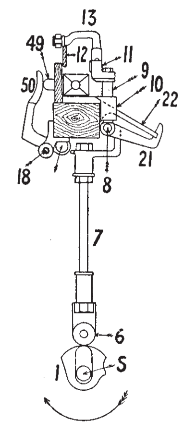


Fig. 291.

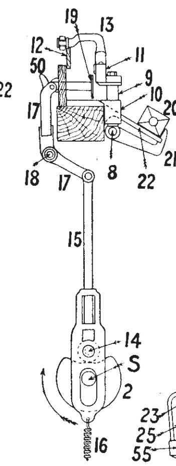


Fig. 292.

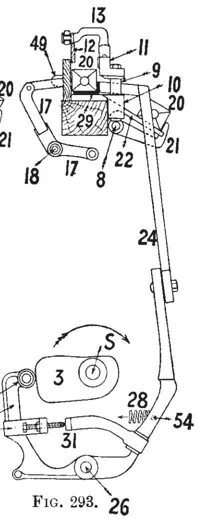


Fig. 293.

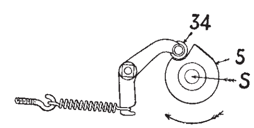


Fig. 294.

of rod 8 are two slide rods 9 which pass through and slide in pillar brackets 10, and are connected to the box front 11. It will thus be seen that when tappet 1 raises rod 7, the box front 11 will also be raised, and at the same time the slip 12 of the box back is also raised by the connection 13.

Meanwhile the clutch E continues to rotate, and immediately the above operations are concluded, the anti-friction bowl 14 will commence to dip into the recess of tappet 2, and the rod 15 will thus be pulled down by spring 16, Figs. 284, 285 and 292. Rod 15 is connected to a double-armed lever 17 fulcrumed at 18. The upper end of lever 17 is provided with a flat plate 19 which, when inoperative, is flush with the box back, but immediately the lever 15 is pulled down by spring 16, the plate 19 is forced sufficiently far into the box to push out the shuttle 20 as indicated in Fig. 292. The descent of the shuttle is made in two stages, so that little or no damage will result. In Fig. 292 it will be seen that the shuttle has been caught by the two projecting prongs 21 and the chute rods 22, and it is kept there until the box front is again lowered. The movement of the prongs as well as their shape differs slightly from that in Fig. 284, although all answer the same purpose.

The tappet 3 commences to act at the same time that the box front commences to rise, and therefore just before the shuttle is ejected. This tappet, through anti-friction bowl 23, operates the feed arm 24 for pushing in the new shuttle, and although the action of the tappet is positive an escapement is provided by means of which the arm 25 may move if arm 24 is locked. The lower end of lever 24 is in the form of a fork and is fulcrumed at 26, while the lower end of arm 25 is also fulcrumed at 26 and between the forked end of arm 24. Spring 27, shown in Fig. 284 but omitted in Fig. 293, keeps bowl 23 in contact with tappet 3, while spring 28 pulls arms 24 to carry the shuttle into the box and also acts as a flexible point or escapement spring. Part only of spring 28 is shown in Fig. 293. One end is fixed to a stud 54 on the arm 24, and the other end is secured to an adjustable hook 55 on the back of arm 25.

The first action of tappet 3 is that of allowing bowl 23 to approach the centre of the shaft S at the thinnest part of the tappet, and this results in the upper part of lever 24 being drawn backwards, and taking the shuttle supports 52 with it, sufficiently far to allow the bottom shuttle in the magazine T to drop into position on the shelf 29 of lever 24, Figs. 284 and 293. The shelf and shuttle are then moved forwards until both enter the shuttle box as shown in Fig. 293, but coincident with this the forks 52 move under the magazine and support the remaining shuttles.

The slip 12 on the box back has already been raised, and thus a free entry for the shuttle is secured. As soon as the shuttle is placed in the box a recess in the tappet 1 allows the box front to drop slightly, either by gravitation or assisted by a light spring, in order to prevent the withdrawal of the shuttle when the shelf 29 is returning. When the shelf is clear of the box and shuttle, the thin part of the tappet allows the box front to return to its lowest position, and in doing so the prongs 21 are also lowered until their tips are below the upper surface of the chutes 22. The spent shuttle is thus relieved and drops into the box or other receptacle U.

After the completion of the above operations, tappet 4, Figs. 285, 286 and 287, acts on anti-friction bowl 30 and raises lever 31 the extreme upper end of which is made in the form of a hook 32; if this hook comes into contact with pin 33 it will lift the latter, and further connections will restart the loom. The main shaft S will now have made one complete revolution, and the anti-friction bowl 34 of tappet 5 then rests in a recess of the tappet as illustrated in Fig. 294 and keeps all parts in their proper position until a further change of shuttle is necessary.

When all the above operations are finished the pin M, Fig. 290, will naturally have returned to the position there indicated, being guided to this position by the curve on the trigger K. In doing so it withdraws the clutch pin Q from the recess R. The automatic apparatus is reduced to a convenient speed for changing by means of wheels V, W, X and Y, Fig. 290, and according to the value of these wheels six or more picks are lost while changing. No reduction in the loom speed, however, need take place.

It will be observed from Fig. 286 that when rod 7 is raised by tappet 1 to lift the box front, the bulged part 35 will come into contact with the head 36 of pin 37, and will cause both to move to the right; this motion in conjunction with pin 38 will carry lever 31, fulcrumed at 53, also to the right, and thus place hook 32 in such a position that when it rises it will miss pin 33. Hence, if lever 7 be prevented from falling, in consequence of a shuttle being trapped under the box front or from any other cause, the loom cannot be started, for the starting depends upon contact between hook 32 and pin 33.

It is also desirable that the loom should be prevented from starting automatically when the magazine T is empty, and this is done in a simple manner. So long as there is a shuttle in the magazine T, the flat spring 39, Fig. 284, is kept out, but, immediately the last shuttle is fed into the shuttle box, the spring comes against the front inner part of the magazine, and thus partly rotates rod 40 counter clockwise. A short lever Z on this rod is connected by a flexible enclosed wire 41 to a hook on the upper part of catch 42 fulcrumed at 43, and when the lever Z is released the wire 41 allows the catch 42 to drop, and places the hooked end in front of the corresponding hook on the head 36 of pin 37, and thus prevents the spring 44 from forcing the pin to

the left, although rod 7 may be down. It thus keeps lever 31 to the right, and prevents the hook 32 from starting the loom; although the loom is prevented from being started by the automatic mechanism in this way, it can be started by means of the set-on handle, and the weaver can replenish the hopper with the loom in motion.

It will be evident that when a new shuttle is being introduced into the box, it is essential that the swell should not be acted upon by the stop rod finger, otherwise the swell would prevent the shuttle from being entered properly, and the box front could not be lowered. Provision is made for withdrawing the stop rod finger 50, Figs. 288 and 289, when a change is being made. A collar 45 is fixed on and near the middle of the horizontal rod 8, and from this collar a short connecting rod 46 is attached to the sneck-up lever 47 fulcrumed at 48, so that when the box front 11 and rod 8 are lifted, the short rod 46 is also raised, and the hooked end of sneck-up lever 47 is lowered. When the shuttle to be ejected is in the box, the swell 49 and stop rod finger 50 will be out, and the companion part 51 of sneck-up motion will be in the position shown in Fig. 288: consequently, when the box front is raised, the hooked end of the sneck-up lever 47 will pass behind the catch of lever 51, and will thus keep the stop rod finger out of action. Should the shuttle fail to reach the box properly, the swell would naturally be in the box as shown in Fig. 289, and the finger 50, being full forward, would take the catch of lever 51 to the left of sneck-up lever 47, so that although the box front is raised, and the new shuttle placed in the box, the return of the box front to its lowest position is prevented because the hooked part of lever 47 is snecked up by the corresponding hook of lever 51. It will therefore be seen that the bulge 35 of rod 7, Figs. 285 and 286, will keep pin 37 to the right and prevent communication between hook 32 and pin 33. It will be understood that after each shuttle is placed in the magazine, the end of the weft is slipped into a simple grip, and after a few shots have been inserted this thread is severed near the selvage by a simple apparatus fixed to the breast beam.

Warp stop motions.—The commercial value of an automatic weft supply mechanism is considerably raised when it is accompanied by an efficient warp stop motion; indeed, in the case of warps which break frequently, it is difficult to imagine any degree of success unless the two motions work in conjunction. Warp stop motions may be of general application, and operated independently of the shedding apparatus, or they may be specially adapted for working in conjunction with the leaves of the camb. Most warp stop motions are of the former type, and, in general, they consist of a series of thin steel pieces, termed drops, which are supported clear of some negatively driven moving part by the warp threads so long as the latter remain intact, but which, when a warp thread breaks, drop into the path of such moving part and arrest it. When arrested, this part actuates, or causes to actuate, other parts which set off the loom. The drops may be formed in many different ways, and the moving parts may be arranged differently, but most motions have the same fundamental principles. Other warp stop motions are used in which a comb of spring wires is used—one wire to each contiguous pair of warp threads. These wires project upwards between the lease rods, and each wire is drawn forward by the crossing of a pair of warp threads behind it, but should one of these threads break, the corresponding wire is released and springs back against a copper bar in the rear lease rod. The electrical contact between the

copper rod and the wire, together with further electro-mechanical mechanism, brings the loom to a stop.

Drop wires or steels are of two general kinds: 1st, those which may be dropped on the warp threads, and 2nd, those in which the warp must be drawn. At first sight, the former seems the preferable type, but they are objection-

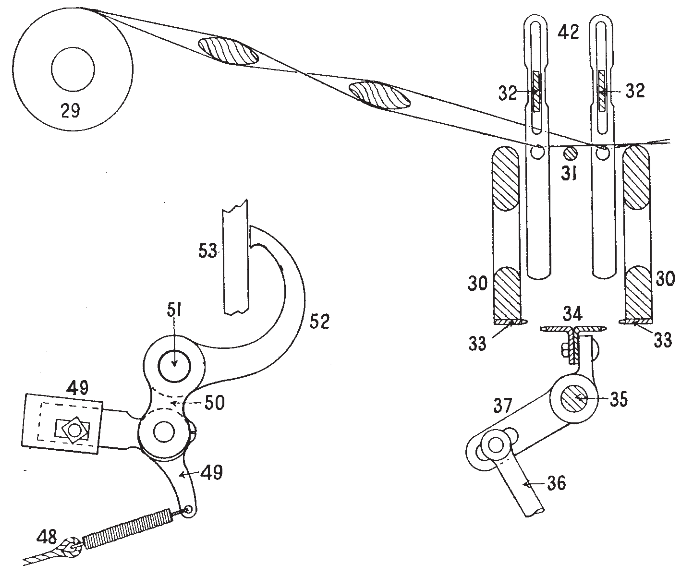


Fig. 295.

able in that they may be readily removed by an unscrupulous weaver should the warp be giving trouble.

The most recent type of warp stop motion issued by The British Northrop Loom Co., Ltd., is illustrated in sectional elevation in Fig. 295, in part plan elevation and in detailed elevation in Fig. 296. About seven inches in front of the back rest 29, two open-sided cast iron plates 30 are secured by suitable fixings to the loom frames, and between them a light rod 31 is supported. Plates and rod together form two divisions in which the drops 42 are suspended on the warp threads in two lines. These drops consist of very thin pieces of bronzed steel, are about 5 ins. long by $\frac{7}{16}$ in. broad, and are threaded on two bars 32 which keep the drops vertical, prevent their ready removal, and also support them when a thread breaks. Each drop is provided with a hole about $\frac{1}{4}$ inch in diameter for the warp thread, and is reduced in width near the top so that

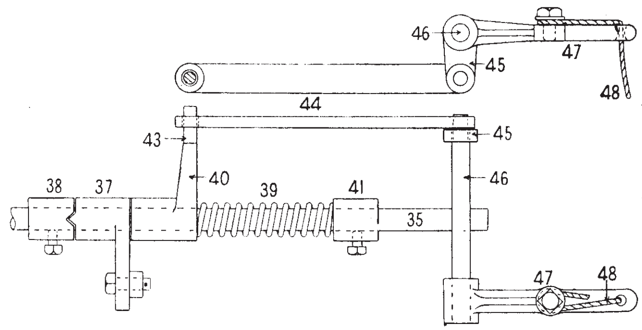


FIG. 296.

a warp breakage may be readily detected by drawing the fingers in the groove formed along the side of the drops at this point. Each side plate 30 has a finely serrated or saw-toothed bar 33 secured to it on the underside; and a similar saw-toothed but double edged plate 34 is fixed to a series of arms secured to rocking shaft 35. This shaft is driven from the wyper shaft by an eccentric not shown, a connecting rod 36 and lever 37 which, however, is loose on the shaft. From the lower view in Fig. 296, it will be seen that lever 37 is furnished with a >-shaped projection which enters a corresponding recess in collar 38, and the

latter is secured by set-screw to shaft 35, while both are kept in working contact by the pressure of strong spring 39 acting on loose piece 40 and collar 41. Provided no warp thread breaks, serrated plate 34 oscillates freely from side to side, but should a thread break and a drop 42 interpose between plate 34 and one or other of the fixed plates 33, plate 34, collar 38 and shaft 35 are arrested in their movement. But, since the wyper shaft and the eccentric continue to rotate, lever 37 oscillates, and is caused by its >-shaped projection to move to the right and to carry with it the loose piece 40 endwise on shaft 35. A projection 43 extends laterally from 40 and enters one end of a connecting bar 44, the other end of which is secured to short lever 45 on shaft 46. To the other end of shaft 46 a further lever 47 is secured, and from this a wire cable 48 is carried through a stiff tube, after the fashion of a well-known cycle brake, to the lever 49. As 40 moves endwise on shaft 35, it is clear that levers 45 and 47 will be tilted, and that the heavy arm of lever 49 will be raised. Since it is raised in front of the advancing lay, arm 50, on which it is centred and which in turn is fulcrumed on stud 51, will be driven backwards, and its curved arm 52 forwards, while the set-on handle 53 will be pushed out of its retaining catch, and thus stop the loom.

CHAPTER XXI

CENTRE AND SIDE SELVAGES

IN the manufacture of several kinds of jute and linen fabrics it is customary to weave two or more widths of narrow cloth in the loom at one time. This, however, is advisable in only those cases where the quality or firmness of the selvage of the cloth is a matter of secondary importance—as, for example, in jute cloths intended for paddings, for some classes of bags, and for cutting-up purposes generally; also in fringed linen doyleys and other similar domestic cloths. In the latter cases the cloths are usually fringed all round, the fringe made by the warp being obtained by drawing forward (sometimes automatically) the required length without the intersection of the weft, while the use of catch bands or narrow strips of warp threads at an equal distance from each selvage permits of a similar fringe of weft threads. In addition to this, however, it is necessary to leave sufficient space empty in the reed between each pair of cloths to form the weft fringe at these places; while in the former, or jute case, a cutting division between the cloths is all that is required. The omission of, say, two or three splits of the reed is in general quite sufficient for this purpose. In both cases, however, some provision should be made at each edge of each width, which will prevent the warp threads at these points working loose. Such provision is termed the centre selvage or patent selvage.

In general this selvage consists of three twist cotton threads A, B, and C, Fig. 297. A and B form plain cloth throughout, while a third or twisting cotton thread C binds the whole firmly together. This thread C crosses underneath A and B, but rises above the weft every pick, first at one side and then at the other. When up at the left of A, that thread itself is under the weft; similarly, when C is up at the right of B, the latter is under the weft. To permit of this twisting action, it is clear that all three threads must pass through the same split of the reed—

the last or first, as the case may be, in the width of the cloth. In all leaf work the threads A and B are drawn upon the usual two plain leaves, Fig. 297, whilst the thread C is first drawn through an ordinary mail or heddle on leaf No. 2, then passed underneath threads A and B in front of leaf No. 1, and finally drawn through a special or fly heddle attached to the latter leaf. Threads A and B are taken from the loom beam in the usual manner, but each thread C invariably comes from an independent bobbin attached in some convenient position to the loom and paced by light weights or other suitable means. This thread C is in some cases taken under the crankshaft and then direct to the heddles without being passed over the lease rods.

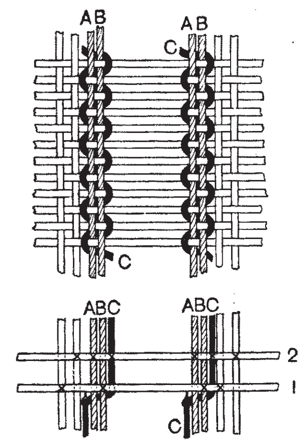


Fig. 297.

The usual method of mounting the fly heddle D is indicated in Figs. 298 and 299, which show the two positions of a shed formed when this particular arrangement is used for the centre selvage. Attached to the front of No. 1 leaf is a piece of heddle twine of sufficient length to reach nearly half-way down the shed when the latter is full open, with leaf No. 1 up. In this position (Fig. 298) the twisting thread C is crossed underneath threads A and B, and is lifted to the left of the latter by the fly heddle D. In Fig. 299 the thread C is lifted to the right of A and B by the action of leaf No. 2, the fly heddle permitting this to be done by doubling up under the threads A and B. It will be observed that in each case practically only half-a-shed is given to the thread C. This constitutes an objection to this method of mounting the fly heddle, more particularly if the false selvage happens to be weaving near the selvage proper of the cloth, as the reduced opening presented to the shuttle may necessitate a slightly heavier pick than if a full open shed were available. This objection is increased

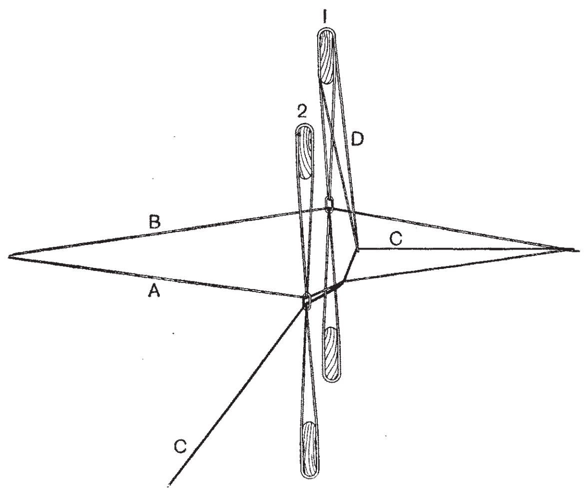


FIG. 298.

by the fact that the thread C in the one case, and the fly heddle in the other, has each a tendency to lift threads A and B off the raceboard when the shed is formed, and thus produce a more imperfect opening. A further objection is the fact that when leaf No. 1 begins to fall from the top position the fly heddle D immediately slackens, and sometimes mixes with the adjacent warp threads, causing faulty shedding. Notwithstanding these defects, this method is in constant use in numerous cases, and we believe is the one most generally adopted.

Another, and possibly better, way of attaching the fly heddle is illustrated in Figs. 300 and 301. By this method an approximately full shed is obtained each time; the lifting of the bottom portion takes place only slightly on alternate picks, and further, the fly heddle is never slack or in a position to mix with the adjacent warp yarn. The

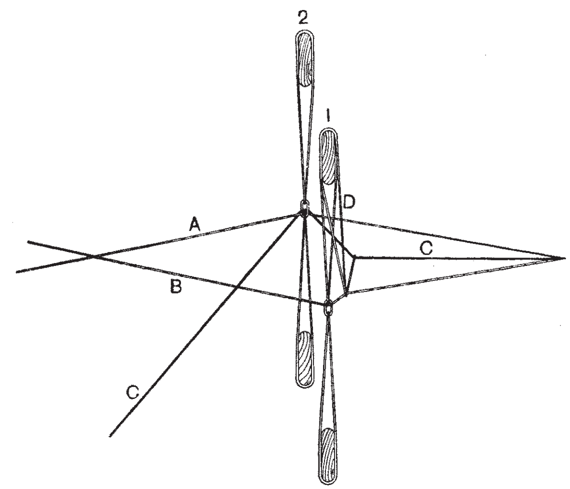


FIG. 299.

fly heddle D is passed through a double mail or heddle on the front leaf in the manner shown, and is then attached to an elastic band or other light spring E, which is fixed underneath to some rigid portion of the loom or to the floor. The spring E should be adjusted just in tension when the leaves are level. In Fig. 300 it will be observed that when the twisting thread C is raised by leaf No. 2 to the right of the threads A and B, the fly or doup heddle D simply slips up through the double eye of the special heddle on leaf No. 1, and does not affect the position of thread B in the slightest. In Fig. 301, which shows the crossed shed, the thread C is raised to the level of A and B by the special heddle on leaf No. 1 drawing up the doup heddle D and thread C with it. In this shed, the thread A is raised slightly from the raceboard. By passing the thread C

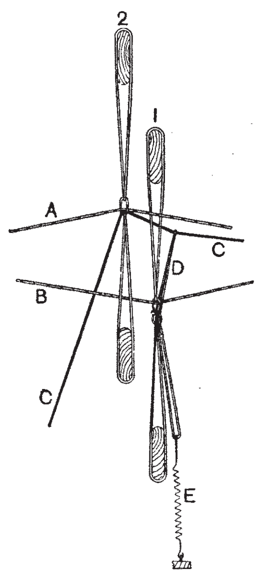


Fig. 300.

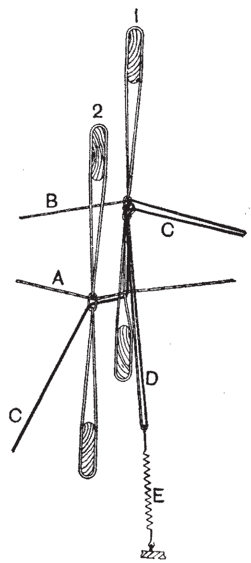


Fig. 301.

under the crankshaft as indicated, instead of over the lease rods, any tendency to increase the strain upon that thread when forming the crossed shed is greatly minimised. In weaving these selvages the proper pacing of the bobbin from which the thread C is drawn is a most important feature; indeed, the production of a perfect selvage, as well as the ensuring of a minimum of trouble to the weaver, depends almost entirely on this adjustment.

Some centre selvages are composed of only two threads instead of three, and for certain classes of light fabrics are considered quite satisfactory. Of these two threads forming the selvage, one is always stationary at the bottom line of the shed, and is therefore always under the weft. The other or twisting thread is always over the weft, alternately at the right and at the left of the stationary thread, crossing from side to side under the latter, and therefore binding warp and weft together. In this case the stationary thread is drawn through a special mail fixed in the low position, while the twisting thread can be worked from two plain leaves by passing it through a small ring which is attached to both leaves by heddle twine passing underneath the stationary thread. In the case of single-lift harness work, two hooks working plain are employed in place of the leaves.

Side Selvages.—In the majority of jute and linen fabrics the selvage may be said to make or mar the cloth, and where such is the case it is of great importance that a good selvage be woven. Several practical difficulties are from time to time encountered in the weaving of these—*e.g.*, inferior and insufficient cotton, yarn of the wrong size, faulty beams and pacing, badly-adjusted shedding, irregular picking, bad cops or pirns, and irregular tensioning of the weft; in every case, however, the weave employed is the prime factor in the production of a good selvage. Where possible, this should be plain, as a plain weave undoubtedly forms the strongest and best selvage obtainable, although in many instances in elementary leaf work it is not considered necessary to adopt special means to obtain any other selvage than that given by the weave itself. It may be noted, however, that with the 4-leaf serge or common twill $\frac{2}{2}$ a perfectly satisfactory selvage is obtained if the two first and two last threads of the warp be so drawn in the camb that they cross on the weft previous to picking from the left and right shuttle boxes respectively. In the case of the 4-leaf twill $\frac{3}{1}$ it is possible to work a perfectly plain selvage by drawing odd threads between the heddle bands of the first and third leaves under the heddle eye (not through it), and the even threads between the heddle bands of the second and fourth leaves, also under the eye. By doing this the odd threads will be depressed on the first and third picks by leaves one and three respectively, and the even threads will be depressed on the second and fourth picks by leaves two and four respectively. To complete the weave, however, it is necessary to connect these threads in some manner to an elastic band or other light spring overhead in order that they shall be raised when the downward pressure of the leaves is removed. Should the twill be working $\frac{1}{3}$, these selvage threads must be drawn through the heddle bands over the eye instead of under it, and the spring must be connected underneath instead of over the leaves. This method of forming a plain selvage might be said to be applicable generally to any number of leaves where the weave—twill, satin, or otherwise—is of a similar character, such as $\frac{2}{1}$, $\frac{3}{1}$, $\frac{4}{1}$, $\frac{5}{1}$, and so on, only in cases where the total number of leaves is an odd number the selvage formed is only partially correct.

In some leaf work it is not possible to arrange the selvage threads on the leaves in such a manner as to produce a plain or approximately plain selvage. It therefore becomes necessary in such cases to adopt some independent means of weaving it, and the most general method consists of placing two skeleton leaves, carrying the selvage threads only, behind, and in some few cases in front of, those employed for the pattern, and actuating them either

by a plain wyper on the low shaft, by two spare needles in the dobby, or, as is sometimes the case, by two special needles provided for that purpose, and actuated by the card or lag cylinder independently of the pattern cards or lags. Sometimes an arrangement is found which consists of a single-bladed wyper acting to raise or depress a treadle attached to one of the skeleton leaves, these latter being connected together by an ordinary top roller, and returned in the opposite direction by a spring connected to the second leaf.

Jute and linen fabrics are sometimes woven apparently plain, but with two shots of weft inserted in one shed. These can be most conveniently woven by a 4-leaf serge twill $\frac{2}{2}$ tappet. Two of the leaves working opposite to each other, say Nos. 1 and 2, carry the whole of the warp forming the cloth, also the selvage threads at one side; while the other two leaves, Nos. 3 and 4, carry the other selvage threads only. Some canvas cloths have the appearance of having been woven in this way, whereas only two plain leaves have been used in their production. In these instances the cop or pirn has been wound with two threads running on at the same time from two separate bobbins, or else with two cops in the same shuttle when the ends emerge from the centre of the shuttle. Generally, however, where two or more picks of weft have to be inserted in the same shed, and where the selvage is of secondary importance, it is the practice to employ a catch band or thread, which will simply prevent the weft returning with the shuttle through the open shed. This band is made to rise and fall on alternate picks, and may be actuated in different ways, most of the methods indicated for weaving a proper plain selvage being available. Some special methods of actuating this thread are adopted, but only one will be indicated. The cord from which the mail carrying this catch band is suspended is passed over suitable guide pulleys and attached to one end of a strap, the other end of which is so fixed that the strap is interposed in the path of the picking arm as the latter travels inwards. The arm thus acts on the strap, cord, and mail, and causes the catch thread to be raised above the shuttle as the latter leaves the box, while a lingoe or other negative device keeps the thread under the shuttle as the latter returns.

Various complicated and expensive devices have from time to time been patented for working centre and side selvages, but none has been anything like generally adopted in the jute and linen weaving industries. Where the shedding mechanism is a jacquard machine, the most simple and satisfactory method of forming selvages, and often other simple weaves near the selvages, is by having an extra six or eight hooks in the machine actuated by special needles direct from the card cylinder. Between the end of the card and the iron head on the cylinder end sufficient space is usually available for drilling an extra row of holes to control these needles. By suitably plugging up the holes not required, any weave repeating on a revolution of the cylinder (usually 4 picks) may be obtained. In damask weaving a plain selvage is thus formed, being twice repeated on the cylinder. Inside the selvage a portion of the cloth is often diced—that is, two or three threads together are lifted for two picks and left down for the next two—a kind of hopsack or basket weave. This is also worked from the same set of extra hooks; while in other cases one finds the $\frac{2}{2}$, $\frac{3}{1}$, or $\frac{1}{3}$ twill obtained from the same source.

In pick-and-pick weaving, where two shots require to be driven in succession from one side, an ordinary plain selvage

is not suitable. In this case the best effect obtains when the selvage threads rise and fall for two picks in succession. This can also be easily arranged on the extra row of hooks, which, besides being convenient, in this manner relieve the designer and the card cutter to some slight extent, as without this provision all selvages, etc., require to be painted on the design and cut upon the corresponding cards. Moreover, a set of cards which is punched for a certain selvage can produce only that particular selvage, whereas by adopting the method indicated above, any selvage capable of being produced on the lines mentioned can be woven with any set of cards.

CHAPTER XXII

CONCLUSION

In concluding this work on the mechanical side of jute and linen weaving, we have purposely omitted to particularise several special machines employed in the above industries—*e.g.*, Brussels carpet looms, Kidder or Scotch carpet jacquard, special looms for the weaving of cotton bagging, etc.; we have also withheld the description and illustrations of the special devices used in the production of many special yet simple fabrics. Our reason for these omissions is that such mechanism is not of sufficient general interest to merit its introduction into a treatise on weaving written specially to impart general knowledge.

Gauze weaving has also been passed over on account of its more general application to fabrics composed of cotton, worsted and silk. Centre shedding and open shedding jacquards have not been included because of the infrequent adoption of the former and the doubtful utility of the latter in the jute and linen industries. Design and calculations have already been treated in separate volumes under these heads.

Our reference in the first edition to the question of jacquard pitches needs little modification. How the standard British pitch of 0·269″ was evolved is difficult to answer, but there is no doubt that finer pitched machines are, to a limited extent, being more widely adopted, although the reasons against their ultimate displacing of the ordinary machine are still the same. These are, first, the extensive distribution of expensive plant suitable for the present pitch and size of card; second, the reduction of latitude of movement in connection with the new pitches is, in many cases, so great that very accurate adjustment of parts is necessary, and no allowance is possible for ordinary wear and tear; third, the wire is so much reduced in thickness that the life of the machine is materially shortened; fourth, the want of uniformity in the new pitches adopted, although these latter have been almost reduced to two, viz., a continental straight pitch of 4 mm., and the Verdol fine zig-zag pitch of 3 mm., as compared with the standard British pitch of $\frac{7}{26}$ of an inch.

Speeds.—Another point to which slight reference has already been made (see p. 124) is the speed of looms of different types and widths. Widely different opinions are held as to the benefits of high speeds, but it might be affirmed generally that as the speed is increased beyond certain limits it becomes proportionately, and in some cases actually, less productive; besides resulting in many cases in the production of inferior cloth. A speed of 160 to 165

picks per minute for a loom of 36 in. reed space is found to be very satisfactory for the great majority of jute and linen fabrics which are of a light or medium character. A similar speed is also found to give satisfactory results in damask looms where the shedding mechanism is a double lift jacquard or double lift dobby; but for heavy fabrics, and for narrow looms which actuate single lift jacquards or dobbies, a reduction of about 20 per cent in the above speeds is advisable. A less percentage reduction is required in wide looms, because since such looms run slower there is more time for the shedding changes to take place.

It is not usual to adhere to any fixed rule when determining the speeds of wide looms as compared with the speed of narrow ones of the same type and for weaving similar fabrics. A moderately safe proceeding, however, in such circumstances is to vary the speed in inverse proportion to the square root of the reed space. Thus, given that 160 picks per minute is found to be a satisfactory speed for a 36 in. reed space loom, and it is required to find a suitable speed for a similar but 81 in. reed space loom; then $\sqrt{81} : \sqrt{36} = 160 : x$, whence $x =$ approximately 107 picks per minute. An approximation to this, applicable only and obviously within limits, say up to 80″ reed space, is to subtract the reed space from a constant number, 196 for jute and linen, to obtain the speed.

To determine the actual speed of any loom by calculation is a simple matter. The necessary data are:—

1. The speed of driving shaft (say 150 revolutions per minute).
2. The diameter of the drum on driving shaft (say 16 ins.).
3. The diameter of pulleys on crankshaft of loom (say 15 ins.).

$$\frac{\text{Revolutions per minute} \times \text{diameter of drum}}{\text{Diameter of pulley}} = \text{the revolutions}$$

of the crankshaft, or the picks per minute; *i.e.*

$$\frac{150 \times 16}{15} = 160 \text{ picks per minute.}$$

From this number it would probably be necessary to deduct from 3 to 4 per cent to allow for the slipping of the belt; to obtain the effective or productive picks per minute a further 25 per cent at least must be deducted; *e.g.*,

$$\frac{160 \text{ picks} \times \{100 - (4 + 26)\}}{100} = 112 \text{ effective picks per min.}$$

Nothing has been said about the actual driving of the looms because, with the exception of driving each line shaft or a group of shafts by a motor, the method of driving has remained the same for years. Most looms have been and are still placed in and out of action by fast and loose pulleys, although there is a considerable number in use which are operated by friction cones and plates. In all cases, and particularly where the power required at various points of the cycle, or one revolution of the crankshaft, varies considerably, it is desirable that a constant speed should be maintained, and apart from the question of expense which we do not propose to discuss, we are of opinion that the greatest regularity of speed and probably the highest actual speed is obtained by means of individual driving. Thousands of looms are now driven by separate motors, and the number is increasing every year.

There are three methods of arranging the drive from a motor, (1) by belt, (2) by gear wheels and clutch, and (3) by friction and belt combined. In the third case the current is on all the time, and the motor and belt pulley run continuously during working hours; the friction plate is

brought into contact with its companion in the usual way to start the loom. Methods 1 and 2 as applied to jute looms are illustrated in Figs. 302 to 305, and represent installations by Messrs. Siemens Brothers Dynamo Works Limited. In Fig. 302 the motor A is situated at the back of the crankshaft B, but it may be placed in front if desired. The three-phase current motor A of say $\frac{1}{2}$ to $\frac{3}{4}$ B.H.P. runs at 900 to 950 revolutions per minute, and the necessary reduction in speed is obtained by a proper ratio between

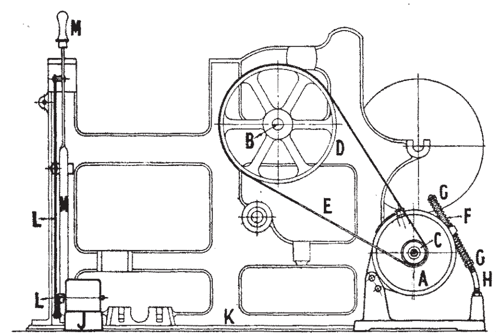


Fig. 302.

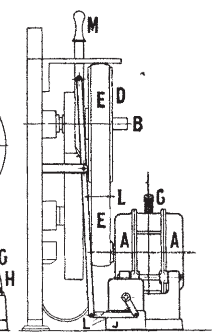


Fig. 303.

pulleys C and D round which is passed a good belt E—preferably a laminated one. Spring F keeps the motor down and the belt tight, but it will yield a little if desired. Limits of adjustment are provided in nuts G and rod H for any stretch in the belt. The wires from the mains pass to the switch box J through pipe K to the motor A, and the switch is placed in and out of action by a suitable arrangement of levers L to the set-on handle M. The heavy lines in the illustrations indicate the parts which belong to the drive proper.

The gear driven loom is shown in Figs. 304 and 305.

The motor A, driven in the same manner and at the same speed as the one just described, communicates its motion to the main shaft B through pinion N to large wheel O which is coupled to the crankshaft B by a friction brake. The brake slips when the loom knocks off, but is powerful

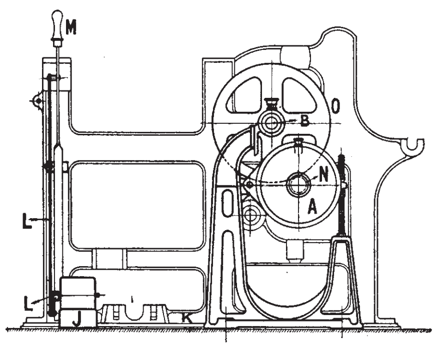


Fig. 304.

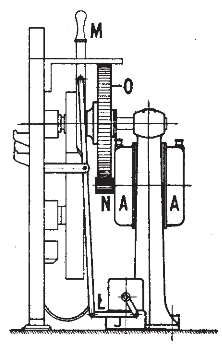


Fig. 305.

enough to drive the loom when all is working properly, and the grip of the brake may be strengthened or weakened at will according to requirements. Apart from the pinion, wheel and brake, the arrangement is very similar to that illustrated in Figs. 302 and 303, and the essential parts are again shown up in heavy lines.

INDEX

THE END

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