WEAVING

AMERICAN SCHOOL *of* CORRESPONDENCE
CHICAGO ILLINOIS
U. S. A.

PART II

WEAVING

PART II

INSTRUCTION PAPER

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PART II.

THE FILLING STOP MOTION.

The *filling stop motion* is one of the most sensitive minor parts of a loom and its adjustment requires skill and thought if the best results are to be obtained. There are two distinct forms of filling stop motions both of which serve the same purpose, *i. e.*, cause the loom to stop if the filling breaks or runs out. Of these the alternate stop motion, which is used most commonly on cotton looms, will be described first. It is attached to the breast beam, on the end nearest the driving pulley, at such a point as to cause the fork to pass directly in front of the shuttle-box entrance as the lay swings forward, and is actuated only when the lay is swinging back from the front center just as the shuttle is about to be picked from that side. This action takes place of course only on alternate picks hence the derivation of the name.

The motion in detail, as shown in Fig. 102, consists of the following pieces. An elbow lever composed of two sections, the hammer or upper section, C, and the lower section, B, which are bolted together and hung on the stud at C'. A cam, D, which is fixed on the pick cam shaft to actuate the lever. A grate, F, which is inserted in the lay near the entrance of the shuttle-box. A fork, E, provided with a hook at one end and usually three prongs at the other. The fork is mounted on the fork-slide, G, which slides in the slide-plate attached to the breast beam, often being recessed as shown to admit the end of the shipper-lever.

The action of the motion is as follows: As the cam revolves it raises the lower end of the elbow lever, thus throwing back the hammer, and as the lay swings forward at the same time, the fork enters the grate as shown at K, allowing the hook of the fork to rest behind the hammer which catches as it moves back, drawing the slide with it, and through the shipper lever releasing the shipper handle, thus stopping the loom. When there is filling across the face of the grate the fork is prevented from passing through the grate, being tipped up instead as shown at L, thus lifting the hook out of the way of the hammer and preventing any action from taking place. Consequently as long as the filling is across the grate the loom continues to run. There are two distinct forms in which the prongs of the fork may be bent as shown at M and N. Sometimes an intermediate form is adopted and in extreme cases the prongs extend further than at N: but for ordinary work this would be defective fixing. The form shown at M is by far the best for

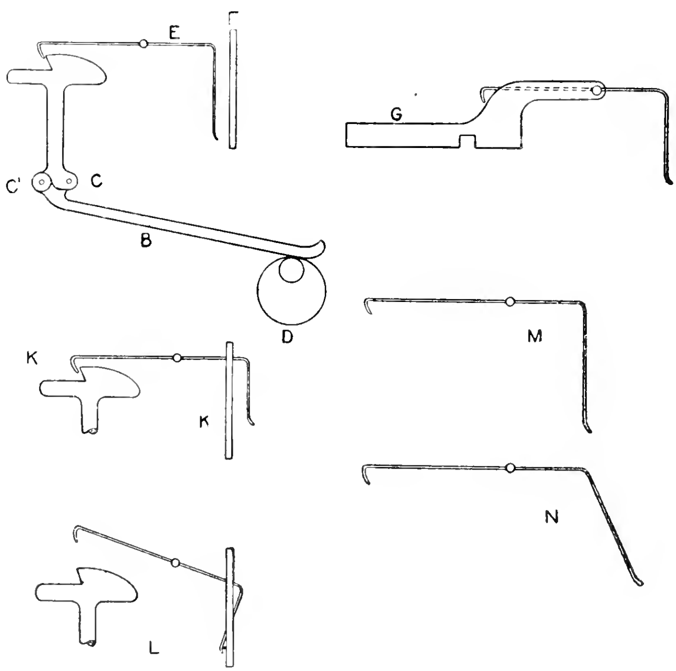

Fig. 102. Filling Stop Motion.

any kind of work. In setting the stop motion several facts must be considered as governing its most efficient action. As strain tends to weaken the filling the fork should be set so as not to cause excessive strain. The less movement required for the fork, the better. Correct timing is absolutely essential.

The prongs of the fork should be long enough to reach below the level of the race-plate, which is grooved at the required point. If they are not sufficiently long there is a tendency for the filling to slip under them, thus allowing the hook to catch and the loom to be stopped. Also as the lay swings back the filling which was pressed partially through the grate, becomes slack and often curls around the prongs if they are too short. This sometimes causes the loom to stop, but more often the loop so made, weaving down, holds the fork tipped up and prevents it from stopping when it should, until it is broken away. Occasionally this loop is woven into the cloth making a thick place which, especially on fine goods, is a defect. With the fork shaped as at M, the amount of strain to which the filling is subjected, and the amount of movement required, are both reduced to a minimum. When the prongs are vertical or nearly so it is not necessary to have them pass through the grate to the same extent as required with a fork shaped as at N, to produce the same amount of movement.

A glance only is necessary to see that there is less tendency for the filling to slide up on a fork shaped like M than on a fork shaped like N, and it is when the filling presses against the prongs nearest the ends that it is subjected to the least strain. It is especially on a multiple box loom that the effect of straining the yarn becomes most apparent, because on such a loom the eyelet would be in the back end of the shuttle-box as the fork enters the grate, and in the majority of cases the filling would be held tightly between the shuttle and the binder so that no let-off is possible from the bobbin. This being so it may readily be seen that the greater the distance the fork passes through the grate, the more the filling will be strained, often to the point of breaking out. Excessive movement of the fork is always to be avoided, because under such conditions it often rebounds just in time to catch and stop the loom. When setting the motion the prongs should project through the grate not more than one-quarter of an inch, and as some forks are made with short prongs and a long hook, care must be used to make sure that the grate does not come in contact with the slide. If the grate should strike the slide when the lay swings forward, the slide will be pushed back and the loom stopped without any extra jar to which the loom may be subjected.

To time the stop motion it is common practice to push the slide as far forward as it will go and set the fork and cam to this position. But occasionally the slide slips back from its position when the pressure is removed, reducing the distance which the fork projects through the grate with the result that occasionally the loom will stop, and the fixer having set the motion will naturally think something else the cause of the trouble. With the fork fixed in its correct position, swing forward the lay, and as it is just leaving the front center set the cam to move the elbow lever with the catch of the lever just passing the fork. If at this time the hook of the fork barely clears the hammer, the timing will almost invariably be correct when the loom is running.

There are different shapes of cams used, but an eccentric cam gives the best results. By its use the lever acquires even motion where other shapes cause sudden and uneven motion.

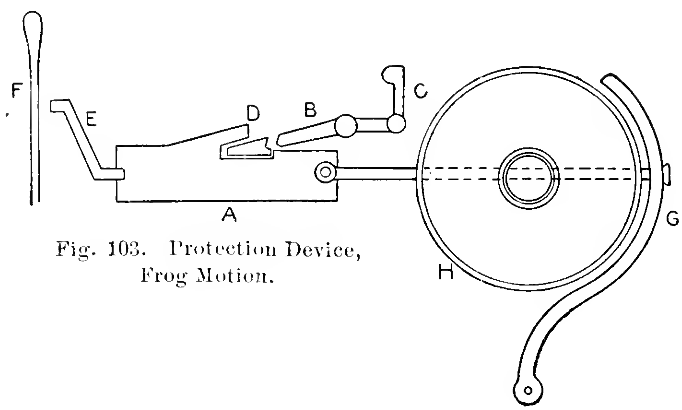

Fig. 103. Protection Device, Frog Motion.

THE PROTECTION DEVICE.

The protection device is to protect the warp from being broken out should the loom stop or bang off with the shuttle in the shed. There are two distinct forms of protection devices: first the frog motion, which is almost invariably used in connection with a back binder; second the device which has the dagger in the center of the lay and is used in connection with a front binder.

Referring to Fig. 103, which represents the frog motion, the explanation is as follows. A is the frog fitted on the side of the loom; B, the dagger attached to a rod suspended under the lay sole; C, the protection finger which is fixed on the outer end of the dagger rod with its upper end in contact with the binder; D, the steel receiver placed loosely in the frog to receive the blow from the dagger point; E, knock-off finger which pushes off the shipper handle, F, when the dagger strikes the receiver in the frog; G, a brake which is drawn in contact with the tight pulley, H, when the frog is forced forward. This checks the speed of the loom, and also throws on the pulley some of the jar caused by the loom banging off. Incorrect setting of the brake often causes the loom to become broken and the receiver to wear out before it should. The latter is replaceable when worn. Pieces, A, B, C, and D are fitted to both sides of the loom, but the complete device is only used on the driving side. At the opposite end, the device which is there termed a blind frog, is necessary to prevent the lay swinging forward at that side as would happen if only one receiver were used.

With this form of protection device more power is required to drive the shuttle than when front binders are used, because stronger springs are invariably used on the dagger-rod, and there is also more weight pressing against the binders due to the use of two daggers.

The daggers vary in length, but for this style device on a narrow loom the average length would be about $3\frac{3}{4}''$. Different systems of setting are employed to the same end. One system is to draw the lay forward with the shuttle in the shed until the reed is pressing the shuttle lightly against the warp, at which time the dagger should come in contact with the receiver, and the brake bind on the pulley. Another method is to place the shuttle on the race-plate against the reed, and draw the lay forward until the front side of the shuttle is about $\frac{5}{8}''$ from where the fell of the cloth will be. This may be readily determined from the inside edge of the temple. Setting by this method will cover nearly every case regardless of the make of loom. Where an extra large shuttle is used, or very heavy fabrics are being woven, either protect sooner, or have the dagger a trifle longer.

On the ordinary Northrop Loom, an extra large shuttle is used, this being necessary to give the requisite strength when forcing the bobbin through, and a $\frac{5}{8}''$ space between the shuttle and the fell of the cloth has been found to be amply sufficient. Smashes occur continually if the amount of space allowed is insufficient, even though the motion acts, and the cloth produced has defects in the form of thick places caused by the filling being beaten in too closely at the point where the shuttle comes to rest. The diagram at Fig. 104 shows the various positions. At A the position in weaving; B, when the loom has banged off and the shuttle is pressed forward until the protection acts; C, when the space allowed is insufficient and the yarn is tightened excessively. A third method of setting the device is to have the dagger in contact with the receiver when the crank shaft is slightly forward of the bottom center.

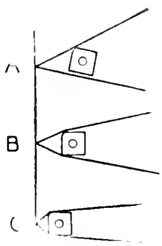

Fig. 104.

The other form of protection device is represented at Fig. 105. This form of device is in more general use than the one previously described both for single and multiple box looms, and is undoubtedly the better of the two. It is more easily fixed, does not require so much spring on protection rod, has fewer pieces, requires less power to drive the shuttle, and is used in connection with the front binder which is decidedly the most preferable form of binder. As illustrated, the various pieces are: A, the shuttle boxes; B, the protection finger; C, the dagger; D, the receiver; E, the protection spring; and F, the protection rod. The rod is held in close contact with the lower front of the lay sole, and the fingers, B, B, press against the binder or binder frame. Some makes of looms have only a binder forming the front of the box, while others have a wood front with an adjustable binder attached to the binder frame and fitted into an oblong slot cut in the wood front. Daggers vary in length for this form of device also, being from 4″ to $4\frac{3}{4}$″ long on a narrow loom, and correspondingly longer for broader looms because of the longer sweep of the lay. They are also made longer for narrow looms intended for very heavy weaving.

This form of motion is set similarly to the frog motion. To set the fingers, draw the lay forward until the dagger is well into the hollow of the receiver and fix one finger. Then insert a piece of cardboard about $\frac{1}{32}$″ thick between the finger and the binder, and fix the other finger in contact with the other binder.

When the second finger is being driven on, the rod has a tendency to spring a little and it is to allow for this that the paper is inserted. Have the dagger point strike squarely in the receiver for if it strikes either nearer the top or bottom the point of the dagger and the edges of the receiver soon wear out, and the first intimation of this is a smash in the warp, especially if the dagger has been striking against the bottom of the receiver. When the dagger is set to strike high up on the receiver it requires a greater amount of movement to keep it clear from the receiver when the loom is running. This means that the binder must be set closer into the box, causing increased pressure on the shuttle and a consequent increase of power necessary to drive the shuttle into the box. Under these conditions the loom will be constantly banging off because the slightest change in speed will prevent the shuttle from entering the box fully, and consequently the dagger fails to clear the receiver. There is also more wear which is due to the additional amount of movement required.

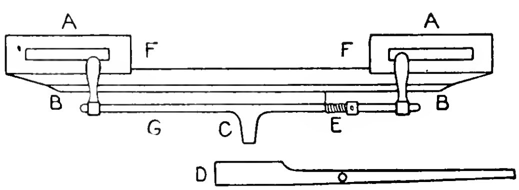

Fig. 105. Protection Device.

Tension on the spring should be as light as possible, only to the extent of keeping the finger in contact with the binder and applying sufficient pressure to the shuttle. The only real objection to this style of protection device is that all the jar caused by the loom banging off is applied at one point, and occasionally a breast beam is sprung or broken by reason of this. Neither of these faults will occur, however, if the breast beam is of well seasoned wood and free from dry rot. Incorrect setting of the brake is sometimes responsible for the trouble. The brake should be applied when the dagger strikes the receiver, for this tends to stops the momentum of the loom

KNOWLES GINGHAM BOX LOOMS.

The term *box loom* is applied to a loom which is fitted with two or more boxes at one or both ends of the lay. A loom equipped with several boxes at one end of the lay and only one at the other, is always fitted with an alternate picking motion and only

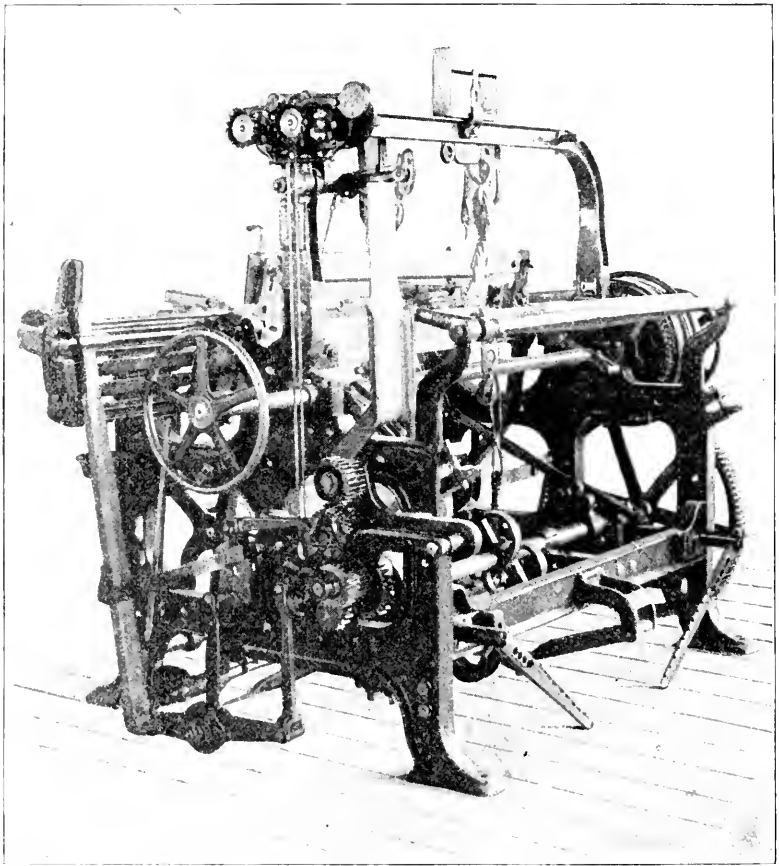

Fig. 106. Knowles Gingham Box Loom.

an even number of picks of any color may be woven into the cloth, because the shuttle having been picked across from the multiple box to the single box, must be returned to the multiple box before any change may be made. This type of loom, which is designated as a 2 by 1, 4 by 1, or 6 by 1 box loom, will be explained first.

The purpose of such looms is to produce cloth into which several different colors of filling are woven but only even numbers of picks of any one color may be used. The more boxes there are, the greater variety of patterns may be woven, but it is not advisable, however, to purchase looms having four boxes merely on the prospect of using four at some future time when only two are required for present needs. Unless the larger number of boxes are required for use in the immediate future, it is better to obtain only those necessary at the time. This may be explained by the fact that the shuttles are thrown differently from new boxes than from boxes which have been used. It is also difficult to obtain the right amount of leverage, and as all the shuttles from the multiple box are picked into the single box there is endless trouble from this source.

All the shuttles used for these looms must be as nearly equal in size and weight as possible, and should as well be in good proportion to the boxes. If they are too small the top edge of the back of the shuttle receives no support from the back of the box, and has a tendency to work in the slot or picker-race in the back of the boxes, while if too large, broken bobbins will often result and the shuttle require more power to drive it into the box, especially in the case of the temple being set a little high off the race-plate. There should be a space of not less than three-sixteenths of an inch in the box both above and in front of the shuttle. Two very good reasons may be given for allowing this space. First, the temple almost invariably raises the yarn from the race-plate and even when very slight it is sufficient to raise the shuttle so that it has a tendency to strike the top of the box, unless space is allowed, thus retarding the shuttle, chipping the wood, and breaking bobbins and yarn. Second, the shuttle travelling across the lay describes an arc, with the tendency for the shuttle to strike the front of the box, and unless space is allowed here equally bad results will follow.

In judging the value of a box motion two considerations ought to be taken into account as follows: Is the motion adapted to the speed of the loom to which it is to be fitted, and are the parts readily changed and easily adjusted when fitting is required? According to the practical answers to the above the returns are good or bad. A box motion may appear to be simple and yet not be suitable for the work it is expected to perform, while on the other hand a complex mechanism is not usually a very durable one. A solid compact motion is to be desired, especially for high speed looms, because a motion, the main working parts of which depend upon small studs for support, will not run long without repairing, even though good results could be obtained with slightly stronger parts on a slower running loom.

Fitting A New Set. Having selected the boxes, the next procedure is to fit them to the loom and a few moments examination of them may save hours of labor as well as supplies. A set of boxes may be fitted to a loom in such a way that the shuttles will run a month without any appreciable effect, or they may become spoiled in an hour, according to the precision of fitting. Of course boxes must be fitted to a high speed loom with the greatest possible care, or the back of the shuttles will soon become worn and splintered. Clean the boxes thoroughly, wiping away all grease from the inside of the boxes, particularly as its presence would cause false running of the shuttles. Smooth off all sharp edges such as are found on the inside edge of the back slot and the edges of the groove in the binder. Set all the binders so that each shuttle will be gripped at similar points: binding the shuttle at or slightly behind the center for reasons referred to in a previous chapter on Binders. Do not allow all of the flat end of the binder to come in contact with the box, or the filling will become cut, because as the shuttle leaves the box the filling curls and usually drops in between the binder and the front of the box, and when the binder comes in contact with the front of the box the filling is cut, while if the binder touched only at the extreme end there is no danger of this happening. After the binders are bent to fit the shuttle, the extreme end of the binder should not be in contact with the outside pin, but wherever possible a space of at least one-quarter of an inch should be allowed for change. With a new set of boxes the binders must be tighter than is necessary with an old set, due to a certain amount of grease which it is impossible to remove, and the shuttles as well are inclined to be oily.

Set the lifting rod thoroughly by means of the lock-nut underneath the boxes. Carelessness in regard to this is a source of trouble as the boxes become loose, and during the picking of the shuttle the front of the box descends, causing the shuttle to strike the race-plates with harmful effect. A loose lock-nut is also a common cause of the boxes binding in the slides.

The above directions apply to the fitting and fixing of boxes regardless of the motion employed to actuate them. Before describing the setting of the boxes, due consideration must be given the box motion. The box motion used on the two-harness gingham loom consists of two parts, the Upper and the Lower, the latter of which will be explained first because it is connected directly to the boxes.

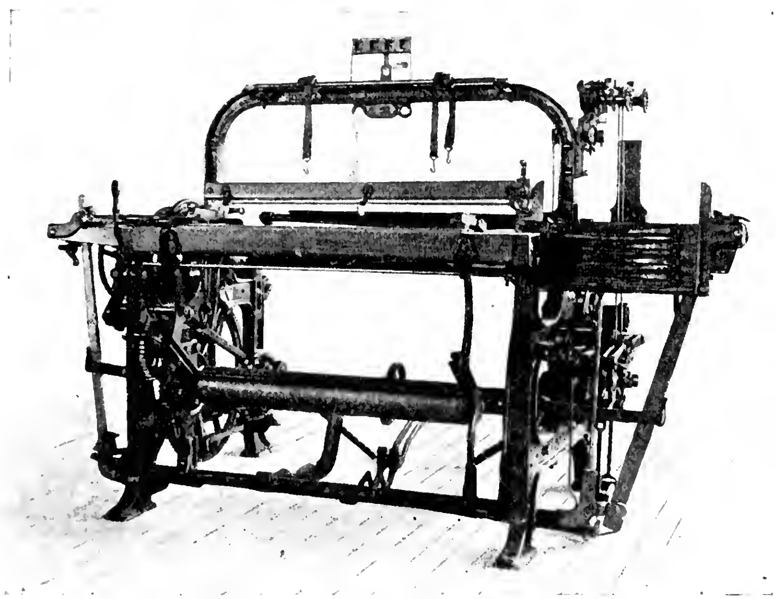

Fig. 107. Knowles Gingham Box Loom.

KNOWLES BOX LOOM LOWER MOTION.

This box motion derives its movement from elliptical gears, and consequently has a fast and slow motion. The gears are timed to impart their greatest speed during the change from one box to another, which regulates the color of filling to enter the cloth. While it is not only advisable but necessary to have the boxes changed in time, it is not always desirable to have too rapid action, for the movement should be as even as possible. A jerky action in changing boxes is constantly causing trouble. A diagram of the gearing of this motion is presented at Fig. 108. Elliptic gear

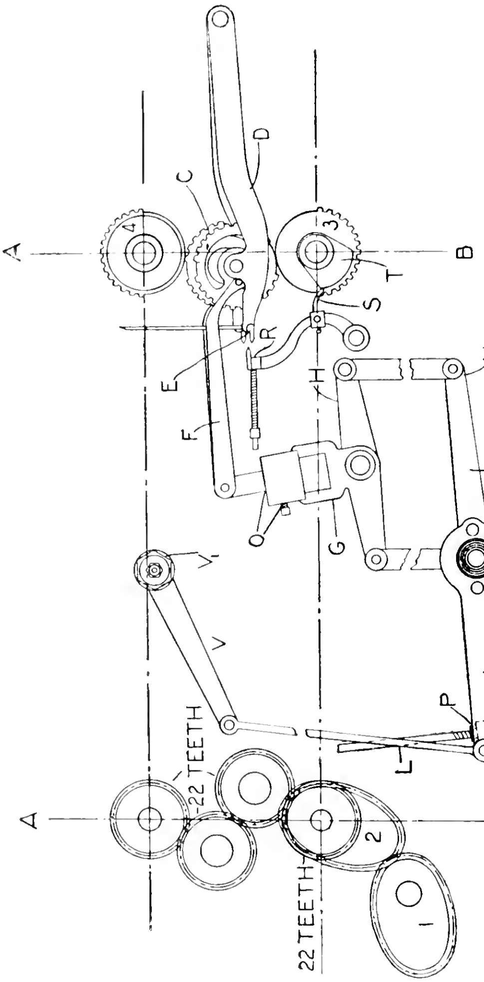

Fig. 108. Diagram of Gearing. Knowles Box Loom Lower Motion.

1, is fixed on the picking cam shaft and geared into 2, each having 27 teeth. Compounded with 2 is a 22-tooth gear and a segment gear 3, which has 15 teeth. The 22-tooth gear is the first of a train of four gears of the same number of teeth, which transmit motion to the second segment gear 4, also of 15 teeth. These segment gears which are placed one above and one beneath the vibrator gears C, have one tooth omitted from one side and three from the other, motion being imparted always through the smallest space, the first two teeth of the segment entering that space. The larger space is to allow the segments to revolve without acting upon the vibrator gear.

The vibrator gears, of which there are two, are mounted on studs fixed to the vibrator leve s D, and these in turn are supported at one end by a stud attached to the loom side, the other end being connected by means of the connecting rods E, to the small levers which press on the filling chain bars. A vibrator or connecting bar, F, is fixed by means of a stud to each vibrator gear, both vibrators also being attached to the box levers, which impart the rise and fall to the boxes. One of these levers is a compound lever, G, which will raise or lower two boxes, and the other is a single lever, H, which will raise or lower one box. The pieces, K, and, K', act as one solid lever during the ordinary working of the loom, and the two box levers, G and H are attached to K and K' at points M and N respectively. The box lifting rod is attached to the outer end of K', being adjusted by means of the adjusting nuts at P. Leverage is increased or diminished at O, increased by lowering the connection and diminished by raising the connection.

A cam, T, which is compounded with segment gear, 3, actuates the lock-knife, R. This knife engages with the ends of the vibrator levers, keeping them in position during the time the segment gears revolve. If they were not so held they would tend to spring out of contact with the shells, forcing the lock-knife out of connection with the vibrator levers during the changing of the box chain, and allowing the bars to be raised or lowered. To time the lock-knife, set the finger, S, on the center of the highest part of the cam, when the crank shaft is between the bottom and front centers, inclined to the front center, with the shuttle in the single box.

A protection device is provided to protect the mechanism from becoming broken at any point, if anything should happen to prevent the boxes from working. Sometimes a shuttle does not fully enter the box, leaving part of it extending on the race-plate, and if some device were not provided to free the boxes, either the shuttle or the boxes would be broken. The manner of joining together the levers, K, and, K′, provides this protection. Two short studs with tapered ends are set into the hub of lever, K′, and fit into corresponding holes in the hub of lever, K, the two levers being held in close contact by means of a spiral spring, which is held compressed between the head of the bolt and the lever. When the boxes are prevented from working, the studs in lever, K′, twist out of the holes in lever, K, thus breaking the connection, which will be re-established on the removal of the obstruction. A spring at V′ in the box of lever, V, assists in drawing the levers back into place.

To Set the Boxes. Place the boxes in the slides and attach the lifting rod to the swivel, P. Bend the lifting rod very slightly away from the loom at a point near its center, in order to elevate the back end of the boxes and thus guide the shuttle higher on the picker. Loosen the bottom of the lifting rod and adjust the slides so that the boxes may be raised freely, but not loosely, as the latter is detrimental to good work. Set the boxes by means of the adjusting nuts at P, so that the bottom of the top box at the entrance is level with the race-plate. Then raise the second box by means of the box motion, and level the bottom with the race-plate by changing the connection of the single lever at O; raising the connection to lower the box or lowering the connection to raise the box. Next raise and adjust the third box similarly to the second. The fourth box should be all right after the former adjustments, and if not, it is an indication that the boxes are not true. This is occasionally the case, caused by the boxes becoming bent before leaving the machine shop. It must be remembered in connection with this motion, that changing the adjusting nuts at P will alter all the boxes, and the adjustment of the second and third boxes must be effected by altering the connections of the single and compound levers at O, therefore the top box must be adjusted first and the others in order.

Always bend the lifting rod at the center, because if the bend is higher it will rub against the frame work of the boxes, and if lower it will come in contact with the supporting bracket, in either case causing endless trouble. As the shuttle is brought forward by the picker, it should be so driven that its front end is inclined toward the reed, this method of driving tending to cause the shuttle to run better across the lay. This may be brought about by having the back end of the boxes forward, out of a straight line with the reed, or by having the back end of the picker spindle forward, out of line with the back of the box. The parts are sometimes fitted in this manner in the machine shop, but if they are not, the fixer should see to it that they are.

Patent buffers and checks are made to be fitted at the end of the box frame behind the picker, but in place of these a roll of cloth or several layers of leather tacked together, may be used. Such checks serve a two-fold purpose, that of reducing the jar on the shuttle when it reaches the end of the box, and also to keep the picker-face level with the guide plates, the latter being an essential feature in the running of a box loom. Fig. 109 shows the guide plates which press out the shuttle when the boxes change if the picker is too far back from the face of the slide. If the picker is allowed to remain in that position, the tip of the shuttle eventually wears flat with sharp edges which cut the warp yarn. Occasionally the shuttle being back too far will catch, and preventing the boxes from sliding freely, cause a smash. For a buffer or check to the picker on the inner end of the picker-

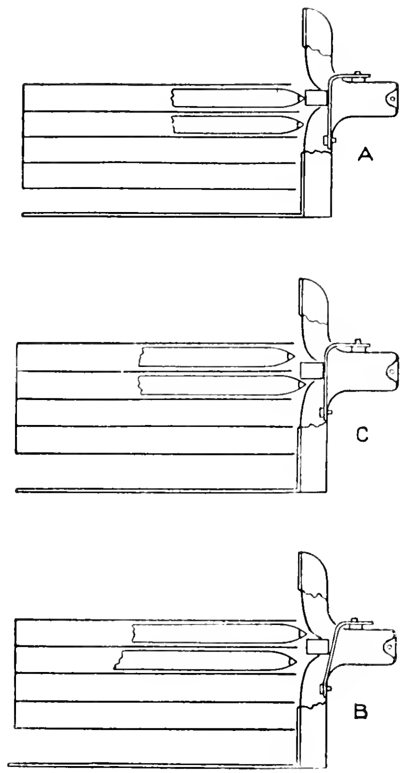

Fig. 109. Guide Plates

spindle, a strip of leather doubled three or four times will give good service, and if a leather or rawhide washer is placed in between each doubling, the check will last much longer.

Previous to placing the picker on the spindle, be sure that it is perfectly straight, for it is not worth while trying to fix a warped picker as it will never give satisfaction.

The normal position of the vibrator gears is with the small space on top, and it may readily be seen that in order to accommodate the risers on the chain, it is necessary to have the vibrator gears almost rest on the lower segment gear, hence the space is necessary on the bottom of the vibrator gears to allow the bottom segment to rotate freely. When the boxes are to be raised, a riser is placed on the box chain, to lift the small lever connected to the lifting rods, which in turn lifts the vibrator bar and vibrator gear, which is mounted on the bar. This brings the vibrator gear into position so that the first tooth of the segment gear enters the space in the vibrator gear, which is then rotated one-half turn, drawing with it the vibrator lever and consequently raising the box lever. The vibrator gear now being turned half round the large space, is on top, thus allowing the top segment gear to revolve freely. This position will be maintained until a blank bar in the chain comes under the small lever, thus through the connections allowing the gear to drop into contact with the bottom segment gear, which, rotating in the opposite direction to the top one, returns the vibrator gear and the boxes to their first positions.

Timing the Box Motion. Set the box motion so that when the boxes are changing up or down, the bottom of the box will be about one-eighth of an inch above or below the race-plate, when the dagger is in contact with the receiver. Or, have the first tooth of the segment in contact with the vibrator gear when the crank shaft is just behind the bottom center, coming forward.

Upper Box Motion. The upper box motion consists mainly of two barrels or cylinders, with the necessary driving mechanism, which carry the box or filling pattern chain and the multiplying chain. A detail sketch of this motion is given at Fig. 110, lettered for reference as follows:

A. Box chain ratchet, which is fixed to the filling chain barrel.

B. Small lifting lever which rests on the box chain. There are two of these, one for the single lever and one for the compound.

C. Connecting rod which connects lever, B, with the vibrator bar in the lower box motion, in the sketch of which it is lettered E. There are two connecting rods, one for each lever.

D. Multiplying ratchet which is fixed to the multiplier chain barrel.

E, E′. Elbow lever.

F, G. Driving pawls which are mounted on the upper end of E and work in opposite directions.

H. Small lever which rests on the multiplying chain.

J, J′. Slide or shield controlled by H.

K. Small lever same as H which rests on the box chain.

L, L′. Shield controlled by K.

M. Small clamp fitted around the box of elbow lever, E, E′.

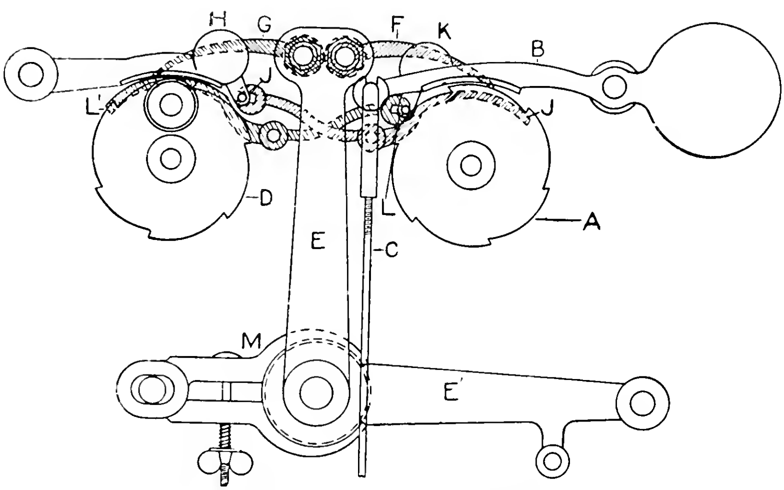

Fig. 110. Upper Box Motion.

The motion is driven through a connecting rod with a disconnecting device from a shell cam fixed on the pick-cam shaft. A stud is bolted to the loom side, forming a bearing for one end of a small lever which carries two studs at the other end, one on each side. One of these studs works in the shell-cam, and the connecting rod, A, (Fig. 111) is attached to the other. At the upper end of this connecting rod, A, is attached this disconnecting device in the form of a slotted lever, B, with a semi-circular recess in which a stud, D, is held during the operation of the motion, this stud being fixed at the end of the elbow lever. Ordinarily the disconnector fits over the stud, and as the connecting rod moves up and down the lower part of the elbow lever moves with it, thus causing the upper part to vibrate between the chain barrels actuating the pawls which are mounted on its upper end. A chain or cord, F, connects the filling fork slide to the back of the slotted lever, and consequently when the filling runs out or becomes broken, the lever is drawn back against the pressure of spring finger, E, which ordinarily holds it in position, in this way breaking the connection. Though the rod continues to act it is so held that the stud remains in the slot, not being allowed to engage in the recess and consequently the elbow lever is not actuated. This action of the disconnector prevents the occurrence of mispicks by stopping the turning of the box chain. The clamp, M, holds the elbow lever in a fixed position when the rod is disconnected.

Timing the Cam. When the crank shaft is on the front center with the shuttle in the single box, set the cam so that it will commence to draw down the rod, and the pawl will commence to turn the box chain.

Chain Building. Risers are small iron rollers which are placed on the chain bars to pass under and raise the small lifting levers which through the connecting rods actuate the box motion and thus raise the boxes. A riser is always a starter.

Sinkers are small iron tubes which are placed on the chain bars to keep the risers in position, also being used where risers are not required, *i. e.*, when the motion is not to be changed or is to be returned to its regular position.

When there are but two shuttle boxes to be controlled by the motion, one space only is required for a riser or sinker on the chain. Four boxes require two spaces, six boxes require three spaces and when a multiplier is used at least one space more must be allowed. In the consideration of chain building it is as well to start the subject with building the box chain alone, leaving the multiplier until later, and the four-box motion just described is a good example on which to work. The main facts to be borne in mind are that the single lever will raise or lower one box and the compound lever will raise or lower two boxes.

A riser placed on the chain to actuate the single lever will lift the boxes from first to second; a riser placed on the chain to actuate the compound lever will lift the boxes from first to third and a combination of the two will lift the boxes from first to fourth, irrespective of the previous bar. To return the boxes to

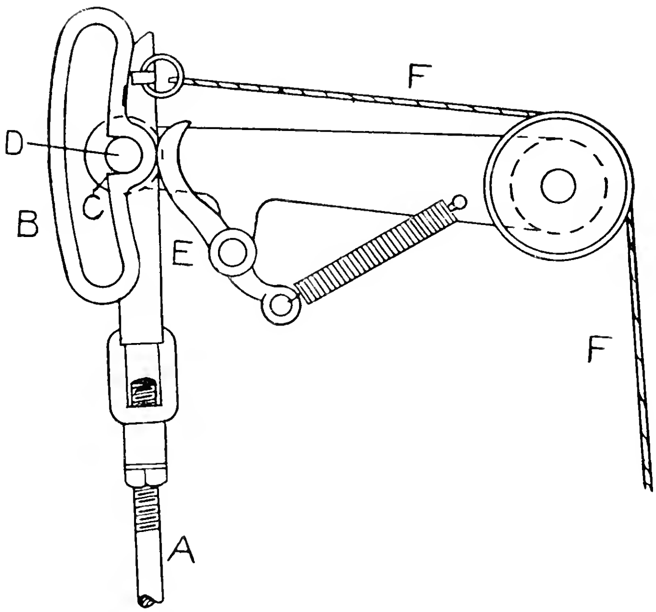

Fig. 111. Disconnecting Device.

place, build as follows: To return from fourth to second a riser under the single lever; fourth to first, a blank bar; third to second a riser under the single lever; second to first, a blank bar, fourth to third, a riser under the compound. The boxes are in the regular or normal position when the bottom of the top box is even with the race-plate, and a blank bar, *i.e.*, a bar containing sinkers only, is necessary to retain this position, but risers must be used to cause a change. When possible to avoid it, never build a chain so as to cause the boxes to jump from first to fourth or fourth to first, because in so doing the motion is subjected to a greater strain than it should be, and constant fixing will be required. If soft or loosely spun filling is being used in one shuttle, run that shuttle in the top box to prevent the fibres of the loose filling from clinging to the other filling and causing a bad selvedge.

Example: Suppose a chain is required to weave the following colors, 4 red, 4 white, 4 red, 4 white, 2 black, 2 green, 2 black, 4 white, 4 red, 4 white, making 34 picks in the pattern. Each bar in the chain has the value of two picks because the shuttle passes from the multiple box to the single box and back again, before a change can be made, and for 34 picks 17 bars are required. Place the red in the top box, the white in the second box, the black in the third box, the green in the fourth box. Then the chain would be built according to the following directions:

4	picks	of red	will	require	two blank bars or sinkers.
4	"	" white	"	"	a riser under the single lever, and a sinker under the compound lever, on two bars.
4	"	" red	"	"	two blank bars.
4	"	" white	"	"	a riser under the single lever, and a sinker under the compound lever, on two bars.
2	"	" black	"	"	one bar with a riser under the compound lever, and a sinker under the single lever.
2	"	" green	"	"	one bar with a riser under both single and compound levers.
2	"	" black	"	"	one bar with a riser under the compound lever, and a sinker under the single lever.
4	"	" white	"	"	a riser under the single lever and a sinker under the compound lever, on two bars.
4	"	" red	"	"	two blank bars.
4	"	" white	"	"	a riser under the single lever and a sinker under the compound lever, on two bars.
34					

The above is indicated on design paper as shown in Fig. 112; C, meaning compound lever; S, single lever; x, a riser; and —, a sinker. Any chain where a multiplier is not used, may be laid out in a similar manner by increasing or decreasing the number of bars as required, using one bar for each two picks.

The Multiplier. The multiplier is of great value as its use saves time in building box chains, and also reduces greatly the length of chain required. It is especially valuable when large check patterns are to be woven, for however large the pattern is, the multiplying chain can be so built as to reduce the box chain to a comparatively small number of bars. In mills where blankets are woven it is customary to use a double and occasionally a triple multiplier, one multiplying the other. The multiplier does not control the box motion, but does control the box chain, giving to every bar in the box chain, which carries a multiplying riser on it, the value of the multiplier itself, whatever that may be. A multiplier has for its value twice as many picks as there are bars in the chain without repeat, *i. e.*, a 4-pick multiplier would require only two bars one blank and one carrying a box chain riser, but these would have to be repeated to give sufficient length of chain to go around the chain barrel. The multipliers most commonly used are 4, 6, 8, 10, 20, 30, and a bar in the box chain carrying a multiplying riser has the respective value as indicated, because the box chain will remain stationary while that number of picks are placed in the cloth. The box chain is stationary while the multiplier is working, and the multiplier is stationary while the box chain is working, a riser always being the starter or changer from one chain to the other.

S.	C.
—	—
—	—
X	—
X	—
—	—
—	—
X	—
X	—
—	X
X	X
—	X
X	—
X	—
—	—
—	—
X	—
X	—

Fig. 112.

A multiplying riser on the box chain starts the multiplier and stops the box chain, which starts again when a riser comes up on the multiplier chain. The multiplier which will reduce the length of the box chain to the greatest extent, without requiring an excessively long multiplying chain, should always be selected. In a pattern having 20 picks of one color and 10 each of two other colors it would seem as though a 20-pick multiplier would give the greatest amount of reduction, but this is not the case, as a 10-pick multiplier instead would be better. A multiplying chain may be used continuously for two or more repeats, adding a bar with a multiplying riser to the box chain for each repeat, or for any number of picks greater than its value, by adding one bar to the box chain for every two picks extra, but it cannot be used for a number of picks smaller than its value, hence the reason for the statement that a 10-pick multiplier should be used for the given pattern. As a proof, for a pattern composed of 20 white, 10 black, 10 red, using a 20-pick multiplier, one bar, carrying a multiplying riser, would be required for the 20 picks of white, five ordinary bars would be required for the black, and five for the red, making 11 bars in all with 20 bars in the multiplier chain, a total of 31. Using a 10-pick multiplyer, two bars carrying multiplying risers, would be required for the white, and one each, carrying multiplying risers, for the black and red, making 4 bars for the box chain, which together with the 10 bars required for the multiplier would make a total of only 14 bars.

As a further example, suppose the pattern is required to be composed of 20 pink, 20 white, 20 pink, 10 white, 2 cord pink, 10 white, 20 pink, 20 white. Working out the chains for this pattern to find whether a 20-pick or a 10-pick multiplier would be better, the result would be as follows:

Picks.	10-Pick Multiplier.	20-Pick Multiplier.
20 pink	2	1
20 white	2	1
20 pink	2	1
10 white	1	5
2 cord pink	1	1
10 white	1	5
20 pink	2	1
20 white	2	1
	13 bars	16 bars

For this pattern also the 10-pick multiplier would require the shorter chain, 13 bars being required for the box chain with the 10-pick multiplier, and 16 bars being required with the 20-pick multiplier. If the length of the multiplier chain is also taken into account, the difference becomes still more favorable to the 10-pick multiplier, as 13 box chain plus 10 multiplier = 23 bars total required, using a 10-pick multiplier; and 16-box chain plus 20 multiplier = 36 bars total required using a 20-pick multiplier. The length of the multiplier chain, however, should not receive too much consideration as in building a multiplier chain it is only necessary to place a single riser on one bar as a changer.

As a pattern where a larger multipler will allow the use of a shorter box chain, the one worked out as follows is a good one.

Picks.	16-Pick Multiplier.	8-Pick Multiplier.
26 Dark Green	6	4
16 Medium Green	1	2
16 Light Green	1	2
16 Medium Green	1	2
4 Black	2	2
16 Medium Green	1	2
16 Light Green	1	2
16 Medium Green	1	2
	14 bars	18 bars

Here again, the total number of bars required is less when the smaller multipler is used, because only four bars in the box chain are saved by the addition of eight bars to the multiplier, the difference being four bars in favor of the smaller multiplier. For the 26 picks the 8-pick multiplier repeats three times, giving 24 picks to 3 bars in the box chain with one ordinary bar for the two picks over, making 4 bars for the 26 picks. For the 16 picks the multiplier repeats twice, having two bars in the box chain, and for the four picks black two ordinary bars are required with the multiplier stopped. Careful judgment must be used in arranging the colors in the boxes. In all ordinary cases the best method is to place that color of which most is used, in the top box, but when this necessitates jumping more than two boxes the colors should be placed differently according to the limitations imposed. This arrangement may easily be used for the pattern in hand, placing the Dark Green in the first box, Medium Green in the second, Light Green in the third, and Black in the fourth.

Picks.	Color.	Box.
26	Dark Green	1
16	Medium Green	2
16	Light Green	3
16	Medium Green	2
4	Black	4
16	Medium Green	2
16	Light Green	3
16	Medium Green	2

The box and multiplier chains are now worked out on design paper as illustrated in Fig. 113.

Start the chains with the riser in the multiplier chain on the top, so that the front end of the shield is clear from the teeth of the box chain ratchet. This allows the pawl to turn the box chain, and if the first bar carries a multiplying riser it will cause the front end of the shield to clear the multiplier ratchet, which is

BOX CHAIN.			MULTIPLYING CHAIN.
M.	S.	C.	
X	—	—	—
X	—	—	—
X	—	—	—
—	—	—	—
X	X	—	—
X	X	—	—
X	—	X	—
X	—	X	X
X	X	—	
X	X	—	
—	X	X	
—	X	X	
X	X	—	
X	X	—	
X	—	X	
X	—	X	
X	X	—	
X	X	—	

Fig. 113.

then turned bringing up a blank bar or sinker, thus allowing the back end of the shield to be down with the front end covering the teeth of the box chain ratchet, so preventing the box chain from being turned. The shield of the multiplier being clear, owing to the riser on the box chain, the multiplier works around until the riser comes up, which clears the shield from the box chain ratchet, and the box chain is again started up.

From the above it is readily seen that it is the multiplying riser on the box chain which starts the multiplier, and it is the riser on the multiplier which again starts the box chain. If both chains were so set that a sinker came at the top of each, neither one would be turned and only one color of filling would be woven into the cloth.

Worn vibrator gear studs and worn studs in the protection lever are the most frequent causes of trouble in this form of box motion. When the latter becomes worn or the spring is too weak, the lever slips and the boxes are not lifted high enough. If the gear stud is worn there is a tendency for the gear to become sprung or the first tooth to break. The first two or three teeth in the gear and segment become worn and allow them to spring out of mesh. Incorrect timing of the lock-knife will cause skips, and incorrect timing of the chain barrel will cause broken risers and bent chains. Care must be taken in timing the boxes and fitting the swells, as previously explained. Sometimes when a loom bangs off with the shuttle partly in the shed, a smash results, due to the boxes being set early so that the protection finger is in contact with the edge of the swell, preventing the protection from working. A protection finger, worn so that the flat part rests against the other binder, will occasionally cause a smash in a similar way. If there is insufficient movement given to the dagger, owing to faulty fixing of the binder by bending out the end instead of shaping it properly, smashes often occur, and in addition the inner part of the binder will cut the filling by pressing against the box frame.

To Prevent Filling from Drawing, first examine the filling, and if one shuttle contains soft spun filling it should be placed in the top box, as it is almost impossible to prevent the filling from drawing in if the soft filling is between the others, because it causes them to cling together. If the shuttles cannot readily be changed, or if the filling is all alike, bend a piece of wire into a bow and fix it in the lay sole near the box entrance, with about one and one-half inches extending above the race-plate. Should this not answer the purpose, fix a narrow band of leather to the boxes near the entrance, extending from bottom to top. Avoid as far as possible jumping the boxes from first to fourth or from fourth to first, especially the latter, as the tendency to rebound is greater on the descent than on the rise. Many fixers tighten up the protection spring on the box rod, believing that the spring is only for that purpose, which of course is not the case. Its purpose is to protect the motion from becoming broken if the shuttle sticks in the boxes or if they are held fast by some other cause, and the tighter the spring is, the less protection will be given. Jumping of the boxes is usually due to incorrect timing of the eccentric gears. They will sometimes run well when the slow speed comes on at the finish, thus easing off the boxes, while at other times it is necessary to set them with the fast speed, just finishing so as to get the boxes started before the fast speed is put on, otherwise the chain travels more quickly than the boxes. Heavy lifting of the harnesses often influences the boxes, the heavy lift causing extra vibration to the upper motion.

CROMPTON GINGHAM LOOM, 4 x 1 BOXES.

The Upper Box Motion. Similarly to the Knowles Gingham Loom, the box motion of the Crompton Gingham Loom is composed of an upper and a lower motion. The upper motion consists of box chain, chain barrel and multiplier, together with the necessary driving pawls and ratchets as illustrated in Fig. 114.

The Multiplier. A disc multiplier is used on this motion, *i. e.*, a multiplier run without a chain. The disc, B, which has two indentations, C, in its circumference, carries a ratchet, A, of a variable number of teeth. Pressing against the disc is a small finger, acting in combination with a slide, D, on the same stud which extends under a pin fixed in the driving pawl, H. When the finger is held on the circumference of the disc the driving pawl is held out of contact with the filling chain ratchet, but when the finger enters the indentation the slide drops away, allowing the pawl, H, to engage with the ratchet and turn the filling chain. There is also a lever, E, pivoted on the same stud which carries the disc, one end of which extends over the chain at F, and the other extends directly under the end of the pawl, G, which operates the multiplier ratchet. When a multiplying riser comes up on the box chain it raises the lower end of the lever, E, and consequently lowers the upper end, allowing the pawl, G, to engage with the ratchet, A, thus turning the disc until the finger again enters an indentation. Then the slide, D, drops, allowing the pawl, H, to engage with the filling chain ratchet which continues to turn until another multiplying riser comes up on the chain.

To change the value of the multiplier a ratchet of a different number of teeth is substituted. Each tooth has the value of two picks, but owing to the disc having two indentations the value of the multiplier is half the number of teeth in the ratchet. The value of a multiplier may readily be doubled by attaching a piece of tin to the disc so as to cover up one indentation, when its value will become double the whole number of teeth. The disc multiplier is an exceptionally good mechanism as it is simple, positive in action, and has no links to get out of order, thereby requiring very little fixing.

The upper box motion is operated through a double cam, A,

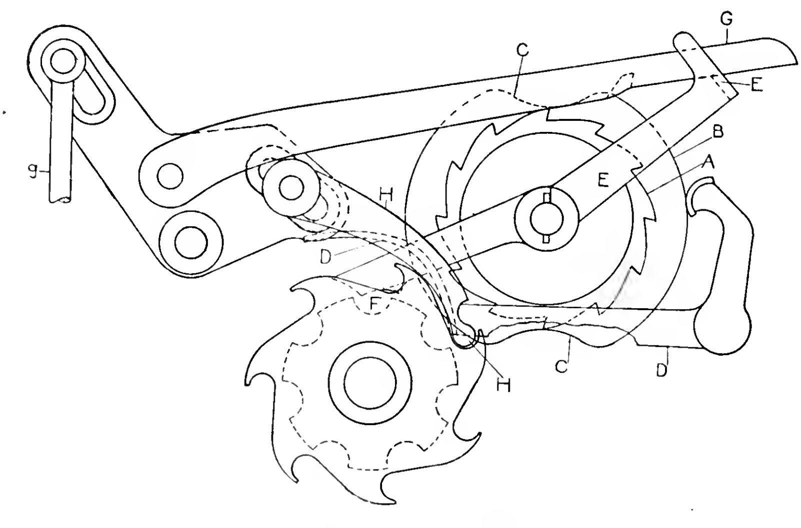

Fig. 114. Upper Box Motion.

(Fig. 116) fixed on the pick cam shaft, one part of which actuates, through the connections, the oscillating lever on which are mounted the driving pawls. A disconnector, which prevents the driving rod from working when the filling breaks, is actuated by the smaller part of the cam, which also assists in drawing back the motion after a disconnection has taken place. The dwell of the larger part of the cam is one-half a revolution of the pick cam shaft, equal to a full revolution of the crank shaft, and the smaller cam has one-half the dwell of the larger. There are two separate elbow levers, C and D, between which the cams revolve, both being pivoted on the same stud, E, which is attached to the cross rail of the loom. A catch slide, L, is attached to the upper end of the lower elbow lever, D, at F, and the driving rod, G, which drives the upper box motion, is attached at the other end. The

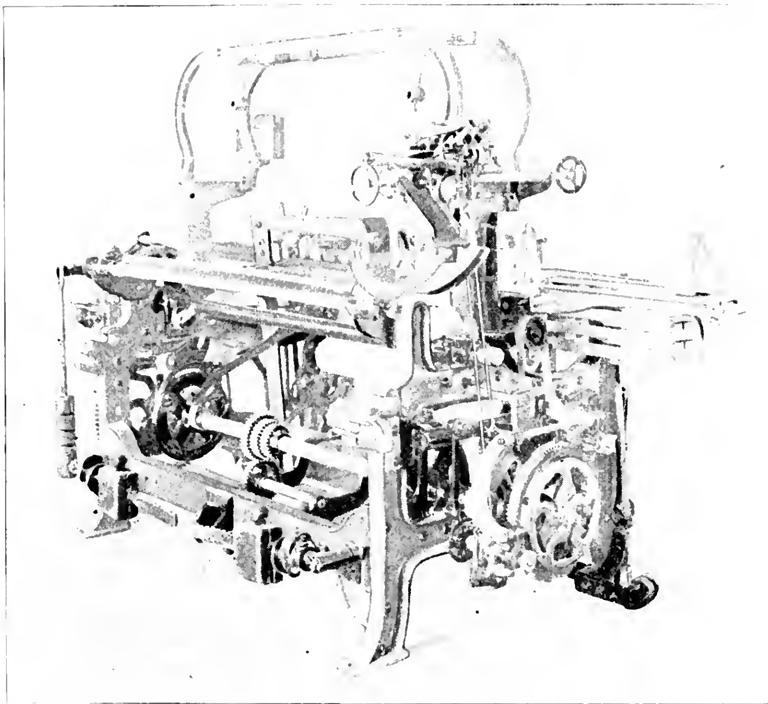

Fig 115. Crompton Gingham Loom.

upper elbow lever, C, is actuated by the large cam, and carries, fixed on a stud, H, at the elbow, a spring clamp which also grips a stud fixed in the upper part of the lower lever, D, at J. As the cams revolve, the large one coming in contact with the upper elbow lever, raises it, and by the combined action of the spring clamp and the spring, K, the lower elbow lever is also actuated. A slotted bar, M, is supported by a bracket fixed to the loom side, and the slide, L, works in the slot of this bar when the motion is in operation. When the filling breaks, the fork-slide draws back and lifts a finger which is also in contact with the slotted bar, M, thus raising the slotted bar so that as the slide is driven forward the catch comes in contact with the bottom of the slot, with the result that further forward movement is prevented, and the stud on the lever, D, at J, is forced out of connection with the spring clamp. This stud being out of connection, the connecting rod cannot be lifted sufficiently high to cause the pawl to turn the

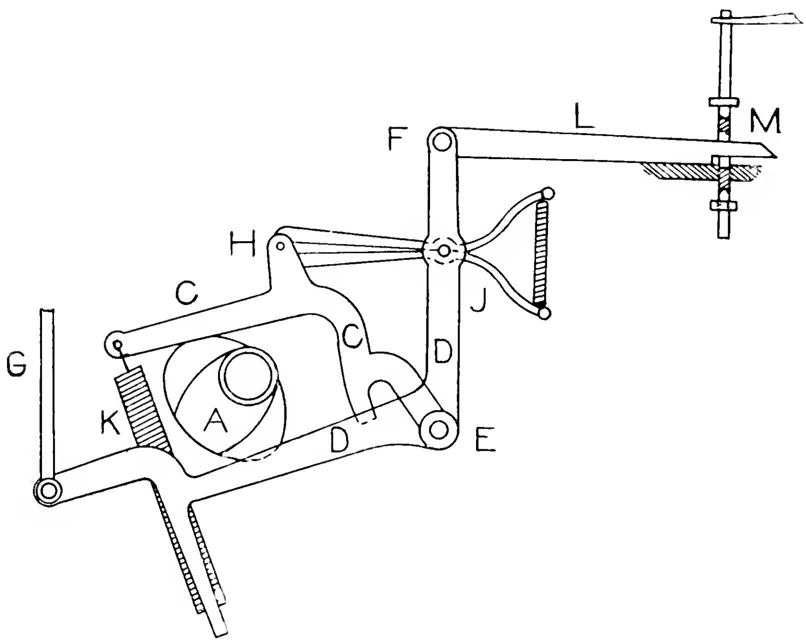

Fig. 116. Disconnecting Device.

ratchet gear on the filling chain barrel, and all operation of the box motion ceases. While the elbow levers are disconnected, the tension spring, K, is extended, and it will draw the upper elbow lever back into position when allowed to contract: this is called the grasshopper motion.

The Lower Box Motion. This motion, which is illustrated in Fig. 117, is known as the pin gear motion, deriving its name from the manner of driving the large segment or space gear, B.

The pin gear, also termed the dog, is attached to the end of the pick cam shaft, and as the shaft revolves, the pin, A, enters one of the recesses in the segment gear, B, advancing the gear one space for each revolution. There are ten spaces on the inside separated by recesses, and on the outside the gear is divided into ten segments of seven teeth each, with blank spaces between, so an

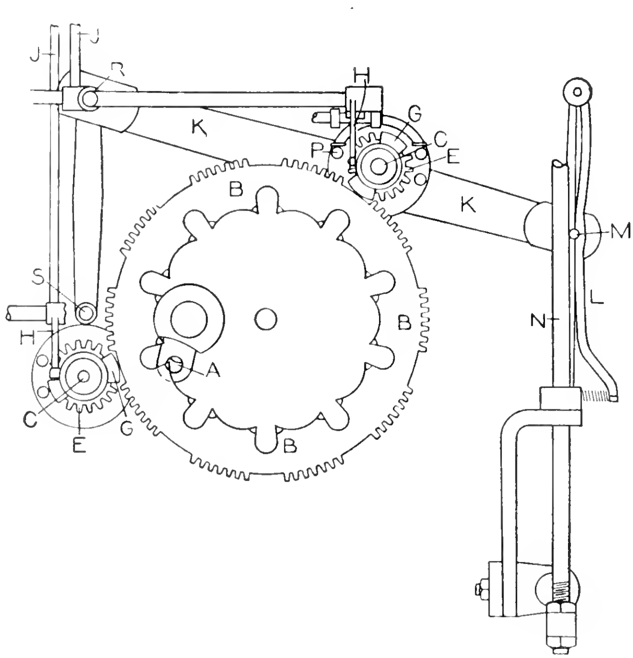

Fig. 117. Lower Box Motion.

advancement of one space has the value of seven teeth. The segment gear revolves on a stud fixed to the frame, about $3\frac{1}{2}$ inches forward of the pick cam shaft. At the top and side of the segment gear, small shafts, C C, are placed, carrying at one end cams, which operate the box lever. The cam on top lifts one box, and the side cam lifts two. A small segment gear, E, having two spaces, separating as many segments of six teeth each, is also fitted on each shaft, together with a double fork or slide, F, which has a projection, G, on each side. These projections are of such form as to fill the spaces in the small segment gear, and act the part of a broad tooth, meshing with the spaces in the large segment gear.

One side of the slide is twice as long as the other, and consequently when one projection is filling a space on the gear, the other is out of connection; the short end being the starter or raiser, and the long end the returner. Each slide is operated by a small elbow lever, H, which is connected by the connecting rod, J,

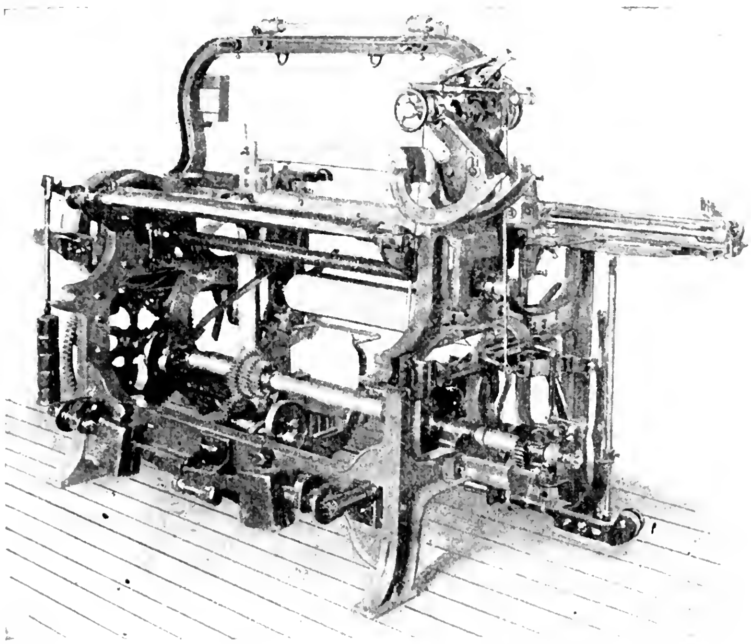

Fig. 118. Crompton Gingham Loom.

to one of the small levers in the upper motion under which the risers in the chain pass. The flat portion of the projection, when in the small segment gear, almost touches the teeth of the large segment gear, so that the projection catches when the small segment gear is turned, and the teeth of both large and small segment gears are brought into mesh. There is but one box lever required with this motion, and this is shown at K, with the spring clamp, L, gripping a stud fixed to its outer end. The lower end of the clamp is attached to the bottom of the box lifting rod, N, A small finger called the check finger, is provided to hold each cam in place, being held in contact with the small studs by means of a spiral spring.

The normal position of the motion is with the short ends of both slides nearest the larger gear, and when a riser lifts the connecting rod, the small elbow lever presses in the slide until the

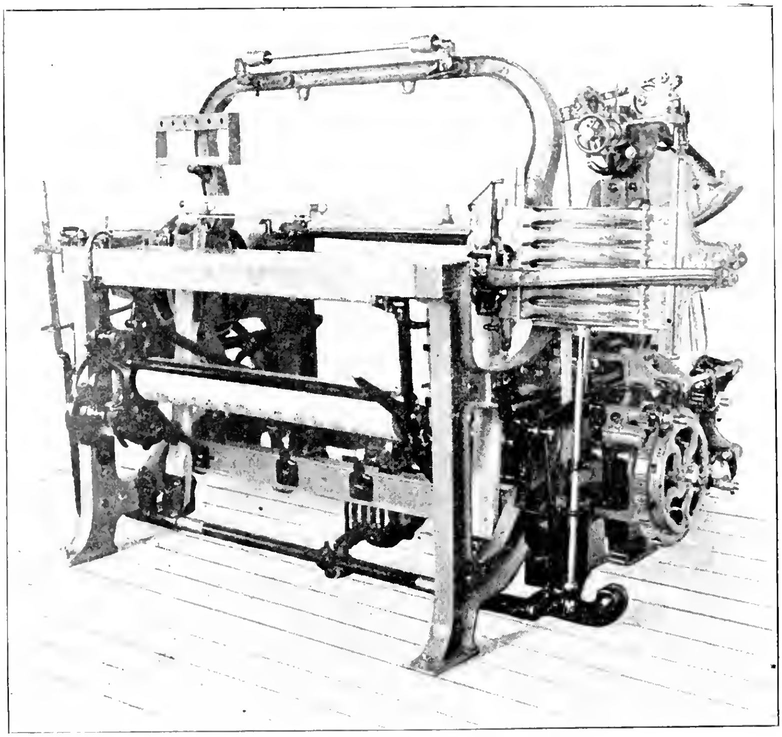

Fig. 119. Crompton Gingham Loom.

projection fills up the blank space on the gear. Then as the segment gear is advanced by the pin gear, the teeth engage with those of the small segment gear, turning it half around, and consequently the cam at the end of the shaft will be given a half turn, thus lifting the boxes. Actuating the top cam lifts one box, and the bottom cam lifts two, or both together lift three. The small gear being turned one-half revolution, the long side of the slide is now next the segment gear. To cause the box to change back again a sinker is brought up under the top lever, allowing the connecting rod to fall, thus drawing the projection on the long slide into place, and completing the revolution of small gear, when the boxes will return to their normal position. The spring clamp, L, serves the purpose of a protection device to prevent breakage of boxes or shuttles in case of a shuttle or picker binding in the boxes. When the boxes catch, the stud on the box lever is forced out of connection, and slides up the crank, thus preventing the lifting rod from being raised.

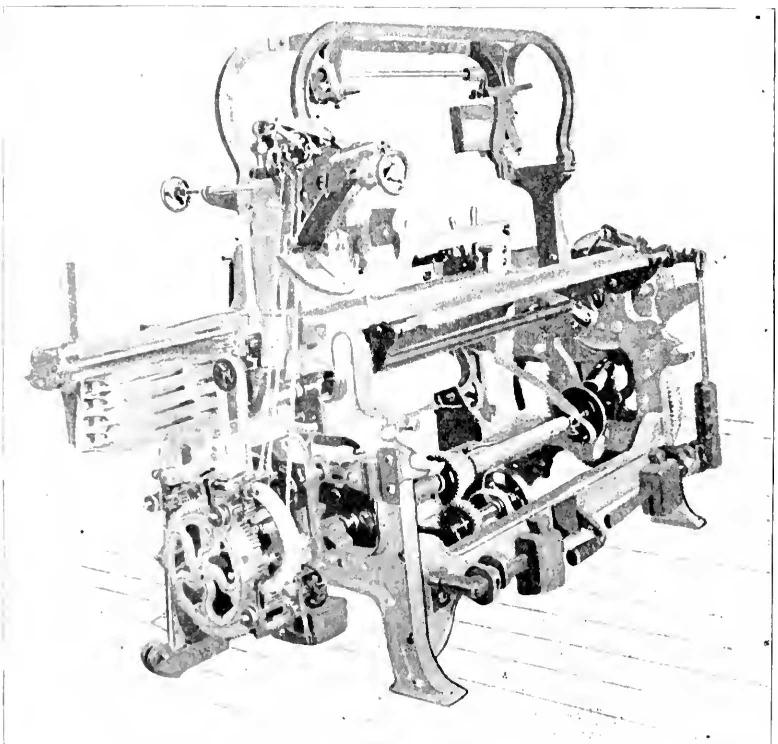

Fig. 120. Crompton Gingham Loom.

Timing and Fixing of the Motion. To time the motion set the pin gear with the pin on the bottom center when the crank is on the back center and the shuttles being picked from the box side; or with the pin on the top center when the crank is on the back center with the shuttle being picked from the single box.

When this box motion is fitted to some other make of loom, the stud which supports the large segment gear is often below the center of the pick cam shaft, in which case the timing must be changed to suit requirements. Set the pin on the top center with the crank shaft on the top center and the shuttle at the box end.

Set the head motion driving cams with the small cam on the bottom center, when the crank shaft is just behind the bottom center coming forward, and the shuttle is in the single box. As the single box lever used with this motion must necessarily supply both single and compound leverage two fulcrums are required, the upper cam serving as one, and the stud upon which the inner end of the box lever is pivoted, acting as the other. This being the case, it is impossible to change the position of the stud at either end of the lever, without affecting the leverage at the other end. For example, suppose the first box is set level with the race-plate, but on raising the second box, it is found to be too low. Moving out the stud, M, would obviate this, but it is probable that the lift would be excessive for the third box, and not only that, but the first box would be too low when returned to normal position. Under such conditions, the only satisfactory method of setting this motion is to work in between the two points of leverage. Starting first with the studs, M and R, near the centers of their respective slots, with M inclined to the outer end, move out S and its connection almost to the limit, and let it remain in this position, because the slightest change at this point makes a great difference in the lift of the boxes. Moving out stud, S, causes the boxes to be lower when normal, but to raise higher when turning the bottom cam. Moving in stud, R, has a similar effect, while setting in stud, M, closer causes the boxes to be higher in their normal position and lower when raised.

In connection with some box motions, the boxes are found to be higher or lower, according to the position of the lay. This occurs to the greatest extent where a box motion is fitted to a different make of loom, but will never occur if the lifting rod and connections are set to move in the same arc as the lay. When the boxes do change position, great care must be used in setting them: the best method being to have the boxes a trifle high when the crank is on the top center, as this allows for a slight drop as the lay swings back.

The greatest cause of trouble on this motion is the loosening of the small segment gear, and this will seldom occur if due care is used in fitting the gear on the shaft, and in fixing the motion afterwards. Trouble of this sort is met with most frequently on the old type of motion, which is fitted with a check cam to prevent the motion from turning too far. It is the jarring of the cam against the check finger which is the objectionable feature, as the sudden check must sooner or later wear the check cam and loosen both the box cam and the gear.

This motion is not hard to fix if thought is devoted to it, and once thoroughly fixed it will remain in good condition for months. If the small gear should become loose, care must be used in replacing the worn pin, for with a small shaft sprung, the condition is worse than with a loose gear, due to the binding in the bearings, which is difficult to remedy.

The small shaft, C, is a pivot or swivel bearing attached by a pin to the framework of the motion, a spring bolt keeping the bearing in place during the ordinary running of the motion. When anything becomes fast between the two gears, or the teeth of the small segment do not mesh with the teeth of the large segment, the spring bolt allows the bearing to be pressed out of position, thereby separating the two gears and preventing breakage. Occasionally the spring bolt becomes loose, allowing the small gear to work out of mesh with the large gear, and in this way causing a mispick or skipping of the boxes. Sometimes under these conditions the small gear skips one tooth, only meshing with the second tooth of the large gear.

Worn projections on the fork-slides also cause skipping, because instead of the projection engaging with the first tooth of the space gear, the slide springs out. Both slides are alike, but as they work in opposite directions they become worn on opposite sides, and therefore may be interchanged when worn, giving results as good as new ones.

A washer is placed at the end of the single cam to prevent the box lever from slipping, and this washer becoming loose will sometimes bind on the shaft and thus cause skipping. If it becomes very troublesome remove it, and nothing serious will occur if the motion is set in correct alignment.

Incorrect timing of the chain barrel, bent chain bars, or broken risers, all have the effect of preventing the fork slide from moving into place, and skipping is the result. Chain links riding on the chain barrel also cause skipping. Insufficient lubrication of the shaft, C, the chain lever studs, or the finger rod bearing, will prevent the slide from returning to place when the boxes are to be lowered. A small coil spring placed around the bearing of the finger rod in contact with the finger will help to draw in the slide. The hook to which the check finger spring is attached, works loose occasionally, and allows the small gear to turn a trifle too far. This may cause one of several effects, such as the boxes lifting too high or dropping too low, the picker to become fast in the boxes, or the teeth of the small gear will not mesh with those of the large gear. Binding of the boxes in the slides tends to injure the motion owing to the increased amount of pressure to which the gears are subjected. The stud, M, soon wears out if not sufficiently oiled, necessitating constant fixing of the boxes, as the stud becoming worn allows the boxes to drop lower than they should. It is seldom that the pin in the pin gear requires attention. If the large segment gear shows a tendency to travel too far after the pin gear has left it, the probable cause is a worn supporting stud.

This form of box motion is one of the best and most compactly built, and is adaptable to either slow or fast speed. The parts are substantial, and if the motion is kept well oiled and carefully fixed, it will probably require fewer repairs than any other box motion.

TEMPLES.

Temples are for the purpose of keeping the cloth stretched as near as possible to the reed width during the weaving process. As much care should be used in setting the temples as is used in setting the pick-motion, because unless the cloth is kept approximately to the width of the warp in the reed the edges will not weave as they should. A very slight twist on the temple or a little too much distance from the fell of the cloth is often the cause of great loss of time. Temples are made for almost every kind of cloth woven, and the kind of cloth to be woven should always be considered when purchasing temples.

Temples may be divided into two distinct types, *burr* or *roller temples* and *ring temples*, each of these types being again sub-

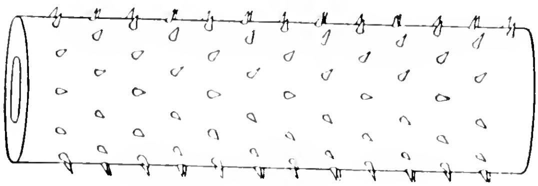

Fig. 121. Burr.

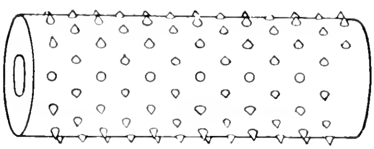

Fig. 122. Burr.

divided into several varieties. The burrs are made of brass, steel and wood, the latter being the most common, and they are fitted with teeth or pins, set spirally around the roller, varying in number and height of setting. Singly the burrs are from $1\frac{1}{2}$ inches to $2\frac{1}{2}$ inches long, but often two or three of the smaller ones are used together, and they vary in diameter from $\frac{1}{2}$ inch to $\frac{11}{16}$ inch, some of them being cylindrical and others tapered. Figs. 121, 122 and 123 show three different burrs to be used for cloth, ranging from fine to moderately heavy cotton or silk cloth. Fig. 124 shows a left-hand temple fitted to the breast beam. It is a spring temple and one of the best possible for general work. A hinge temple is shown at Fig. 125. The burrs and pods or troughs in which they work are similar to those in Fig. 124, the difference being in the position in which they are fixed. Spring temples are probably the best because of the greater ease of adjustment. Figs. 126, 127, 128 and 129 show four different varieties of inclined ring temples. Fig. 126 is a combined right-hand temple. Fig. 127 shows roll with rings attached. This temple is suited for heavy weight

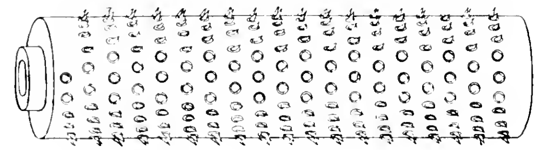

Fig. 123. Burr.

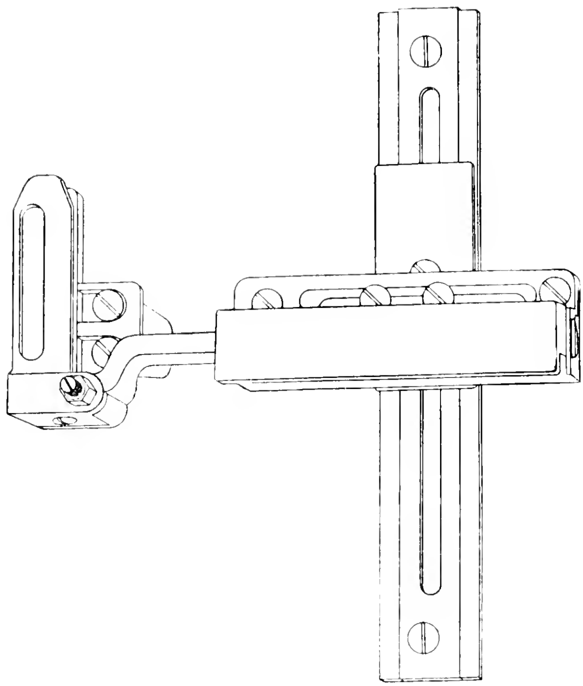

Fig. 124. Left-hand Temple.

cotton goods and light weight worsteds. Figs. 128 and 129 show temples suitable for heavy woolens and worsteds. Ring temples are made from two to fifteen rings, the number being determined by the weight of the fabric to be woven. The horizontal ring temple, which is illustrated at Fig. 130, is used exclusively for fabrics which must be gripped only on the selvedge.

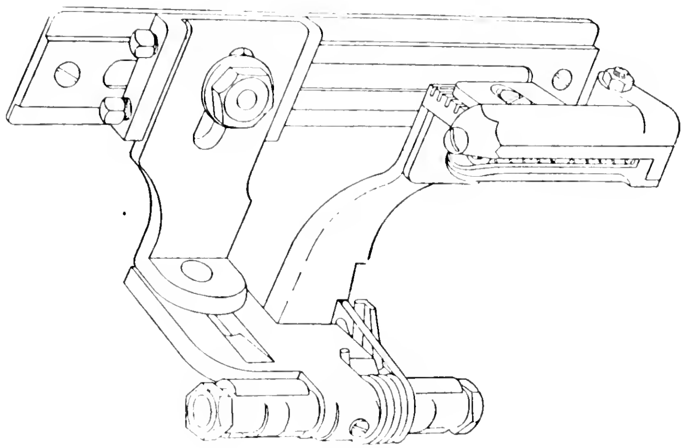

Fig. 125. Hinge Temple.

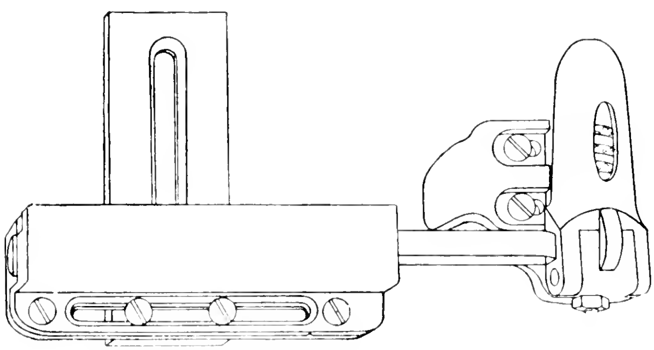

Fig. 126. Combined Right-hand Temple.

As previously stated, temples are to maintain the fell of the cloth at the same width as the warp in the reed, and in doing this temple marks often result, *i. e.*, holes are made in the cloth by the pins in the temple. Every precaution should be taken to avoid such, particularly on fine goods, and it is fine cloth which is most likely to become so injured. Sometimes the finest burrs will make temple marks, in which case tapered burrs should be used, and the pins covered with tissue paper or very thin cloth until only the points show through. Filling is sometimes wound around the burrs

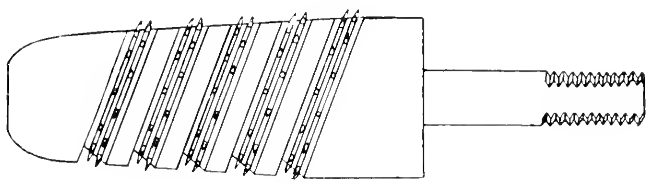

Fig. 127. Inclined Ring Temple.

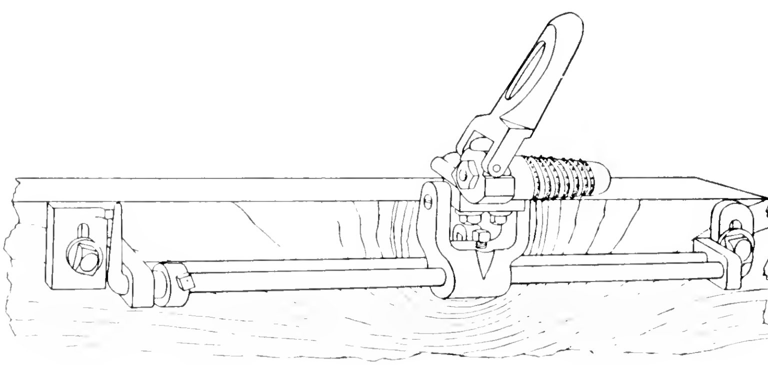

Fig. 128. Inclined Ring Temple.

for the same purpose, but paper or thin cloth is preferable. Using burrs which are too coarse is often the cause of temple marks on fine goods, and finer burrs must be used to remedy any such fault. Blunted or bent pins and incorrect setting are also frequent causes of temple marks. The face of the temple should be set parallel to the fell of the cloth at a distance of from $\frac{1}{16}$ inch to $\frac{1}{4}$ inch according to circumstances. A small amount of action to the temple always has a beneficial effect, especially when it is set close to the fell of the cloth, because it reduces the strain on the selvedge threads, when the lay beats up. By attaching to the lay sole a piece of leather in such a position that it will strike against the heel of the temple when the lay swings forward, a sufficient amount of motion is given for ordinary requirements.

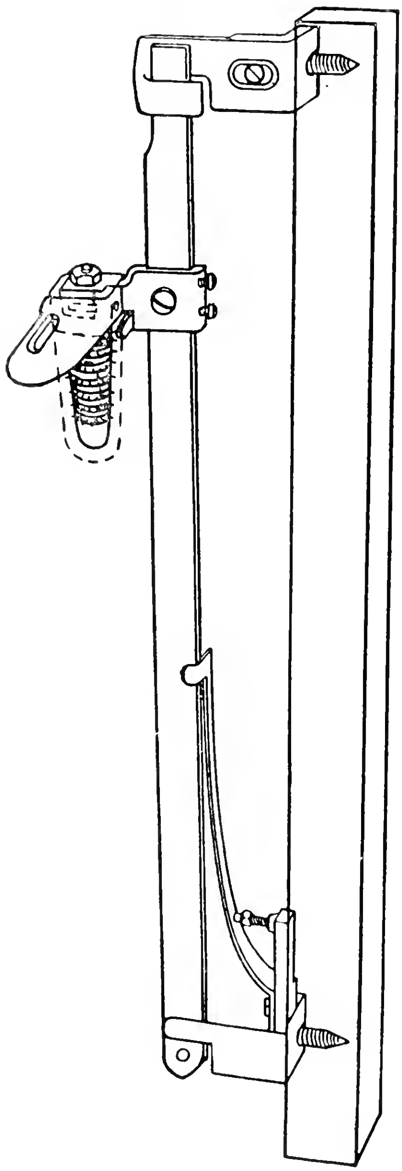

Fig. 129. Temple.

It is common practice on medium and light weight goods to use burrs for both temples in which the spikes are set in the same direction, the idea being that as long as the spiral turns toward the outer end of the burr they will work as they should. On some grades of cloth this holds true, but it may easily be seen that while the pins point toward the outer end and tend to pull the cloth that way, yet the spiral setting of the pins in both temples is the same, *i. e.*, the spiral setting runs toward the right, and a burr set in this way would act better in a right hand temple with the cloth running over it, because every turn of the spiral would give the pins a closer grip. With such a burr in the left-hand temple the cloth is held by the incline of the pins alone, and the method of setting tends to allow the selvedge to run in, rather than to keep it stretched out. When weaving heavy goods this objectionable tendency of one selvedge to draw in, caused by using temples of the same setting for both sides, becomes more strongly apparent, and that selvedge becoming slack does not weave as it should.

Right and left-hand burrs are now obtainable, and they should be used if the best results are desired. When fitting burrs the spiral setting of the pins must turn toward the right, *i. e.*, like a right-hand screw, for the right-hand temple, and toward the left for the left-hand temple, if the cloth is to be kept at width, for otherwise the cloth will be drawn in.

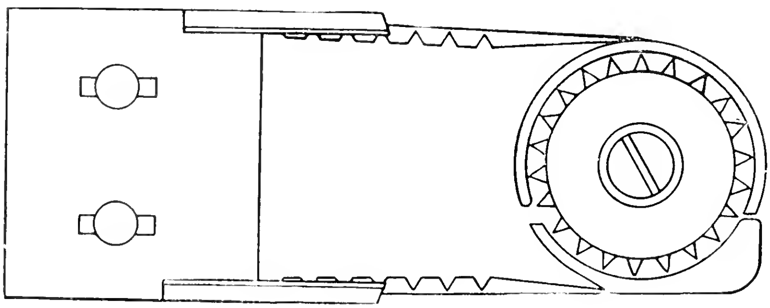

Fig. 130. Horizontal Ring Temple.

The roll in the ring temple may be raised or lowered to change the amount of grip by which it holds the cloth. The higher it is, the firmer grip it has on the cloth, and the lower it is, the weaker grip it has. This method of adjustment allows the temple to be accommodated to various weights of cloth. One of the best ring temples intended to permit of ready adjustment to various grades of goods, is illustrated in Fig. 131. The washer, A, is made with an eccentric ring bearing, upon which the pin ring is placed, and this washer is turned on the stud, C, so as to increase or diminish the length of the pin extending above the washer, thus regulating the contact of the pins with the cloth. The stud, C, is shown carrying the base against which the washers and rings are placed, there being also a solid piece burr tapered on the inner end of the stud.

The Hardaker temple is intended to be used on close shed looms, especially as the temple works with the cloth, thereby preventing injury to the cloth by the temple. On heavy goods there is always considerable movement to the cloth when the lay is beating up, and as it leaves the fell of the cloth. There is also a considearble rise and fall to the cloth, the movement being greatest with the heaviest shed. These temples allow for that movement,

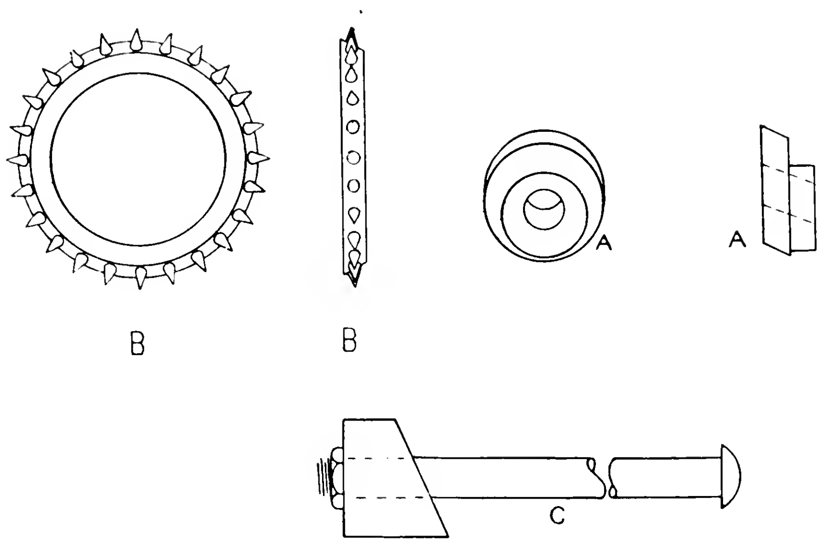

Fig. 131. Ring Temple.

and should be set close to the fell of the cloth, inclined slightly toward the race.

CENTER STOP MOTION.

This type of filling stop motion is usually fitted to woolen and worsted looms, and is of especial value when single picks of certain colors are being woven into the cloth, because the loom will be stopped on the broken pick if the motion is in good order.

The motion is generally fitted to the center of the lay, but on carpet looms two feeler motions are fitted one near each end of the lay sole. It must be kept in the best condition by accurate fixing if good results are to be obtained. A detail drawing of the motion used on the Knowles Broad Loom is shown at Fig. 132. The feeler wires, A, are attached to the base or hub which carries a small crank, B, this being connected through the adjusting rod, C, to the dagger lever, the dagger being attached to the end of this at right angles to it. G is a bracket fixed to the breast beam, having mounted upon it the inclined slide, F, the receiving lever, H, the protection slide, L, and the slide finger, M. The knock-off finger, J, is attached to the rod, K, which extending under the breast beam is in contact with the shipper handle. A flat steel spring, N, is also attached to K, for the purpose of holding M in place when the loom is stopped.

As represented in Fig. 132 the loom is stopped with the lay just forward of the back center, the feeler wires being raised to allow the shuttle to pass under and lay the filling under the wires when the loom is started. When the shipper handle is drawn forward to start the loom, the knock-off finger is raised up under the projection, H′, on the receiver, H, thus causing the upper end to extend above the bracket, G, the lower end being pivoted at H″. As the lay swings forward, the dagger, E, slides down the incline of F, allowing the feelers to drop, and if there is no filling under them they drop into a recess cut in the lay sole. This allows the dagger to drop far enough to strike against the upper end of the receiver, H, and as the lay continues to swing forward, the receiver being pressed down carries with it the knock-off finger, thus, through the connections, stopping the loom. If there is a strand of filling under the feelers, they are held up so that the dagger cannot strike against the receiver, and the loom continues to run. The protection slide, L, acts only on the first pick after each start-up.

Immediately as the loom stops, the flat spring, N, causes the finger, M, to force the slide sufficiently high to protect the receiver from the dagger. When the power is applied by drawing forward the shipper handle, the spring, N, is drawn away from the finger, releasing the pressure on the slide, but the latter remains in place until the dagger strikes the hook at L′ and forces the slide out of the way, leaving the receiver in position to act. This protection slide is necessary for the reason that often after the loom is stopped, the lay is drawn forward and then pushed back, when the feelers pass under the filling, and if no protection slide were provided the dagger would strike the receiver thus stopping the loom. When no protection slide is fitted, it is necessary to place the filling under the feeler wires in order to prevent the dagger from striking the receiver, thus occasioning a loss of time.

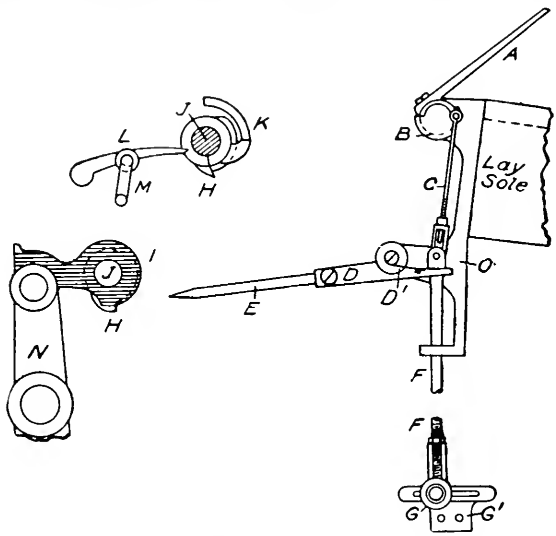

Fig. 132. Knowles Broad Loom Motion.

Timing the Motion. The inclined slide, F, is adjustable to control the action and position of the feeler wires. By lowering the front end and raising the back, the feelers are caused to rise more quickly. On looms fitted with two sets of feelers the slide must be set to raise the feelers as quickly as possible, otherwise the shuttle may strike and bend them. If this happens they are held up by the warp threads, and the loom will not be stopped even if the filling is broken. Adjust the slide, F, and adjusting rod, C, so that the feelers will be raised almost the height of the shed when the crank shaft is between the top and back centers and the dagger is almost at the top of the slide. Set the feelers in the base so that $\frac{3}{8}$ inch to $\frac{1}{2}$ inch will remain on the filling when the dagger passes the receiver; and yet they should pass clear of the rib of the reed when in the lay sole, to prevent any possibility of the feeler wires catching in case of the yarn dropping to the bottom of the reed. With the lay drawn forward so that the crank is on the bottom center, the dagger should be at the bottom of the slide at $\frac{1}{8}$ inch to $\frac{1}{4}$ inch from the receiver. This range is given to cover a variety of looms. For the Knowles Loom the distance is generally $\frac{1}{4}$ inch, but on the Crompton Loom the dagger should be in contact with the receiver when the crank shaft is on the bottom center, and occasionally with some looms the dagger is set in contact with the receiver when the crank shaft is just behind the bottom center.

On the Knowles Narrow Loom a different form of center stop motion is used. As illustrated in Fig. 132, the motion is composed of the following pieces: A, the feelers; B, feeler cam; C, connecting rod; D, dagger lever; E, dagger; F, adjusting rod; G, adjusting point; G′, bracket; H, receiver; I, lock finger; J, rod upon which lock finger and shield, K, are placed; L, shield finger; M, finger rod; N, locking lever. The adjusting rod, F, is pivoted on an adjustable stud, G, attached to the bracket, G′, which is fitted to the cross-brace of the loom and extending upward through the bracket on the lay sole, the end comes in contact with the dagger lever. It is so adjusted as to push up against the dagger lever, thus raising the feelers as the lay swings back. As the lay swings forward the rod is drawn down, allowing the lever to drop and with it the feelers, so that if there is no filling under the feelers, the dagger is allowed to strike the receiver, H, thus stopping the loom. The locking lever, N, is attached to the brake-rod upon which is also fixed a projection coming in contact with the shipper handle.

When the dagger point strikes the receiver, the lock-finger, I, is raised up, thus releasing the lock lever, and allowing the projection on the brake-rod to force off the shipper handle. If there is a pick of filling under the feelers when they descend, the dagger is held out of contact with the receiver, and the loom continues to run. The shield, K, is controlled by the finger, L, and rod, M, the outer end of the rod being in contact with the shipper handle.

When the loom is stopped the shield covers the receiver, preventing the dagger from striking it, thereby allowing the loom to be turned over by hand, but when the shipper handle is drawn into place, the finger forces up the shield and leaves the receiver free to be acted upon by the dagger. This form of stop motion is one of the most instantaneous in action because, immediately as the dagger strikes the receiver, the power is removed and the brake applied.

In setting this motion have the dagger point in contact with the receiver when the crank shaft is on the bottom center. The feelers are raised to the highest point when the adjusting rod is perpendicular, the crank shaft being between the back and bottom centers. To lessen the lift of the feelers move the adjusting rod pivot farther back in the slot of the bracket, G′, or adjust by changing the screw connection on the lower end of the rod. The former method is the better.

When weaving tender filling if the feelers rest so heavily on it as to break it often, or cause it to kink in the cloth, a small weight may be attached to the back end of the dagger lever at point D′. Or set the feelers so that they will not descend so low into the feeler slot, changing also the timing of the motion to be slightly early, *i. e.*, to have the feelers leave the filling a little sooner than ordinarily would be the case. Occasionally a piece of wire is so inserted in the feeler slot as to come between the feelers and in this way prevent the filling from becoming broken or kinky. General fixing points will be described later.

Odd Points Pertaining to Warps. Under this heading some of the minor problems which come up in running a loom will be considered. A loom ought to be cleaned, oiled, and fixed every time a warp is run out, and if a fixer could only realize how much work a small amount of attention at this time would save him, he would soon make it a regular practice. It is when a loom is empty that some little thing can be seen, which might cause endless trouble when the warp is in. How often a screw head slightly above the race-plate cuts the warp yarn or chips the shuttle a little: or the race-plate is broken behind the feeler-slot, cutting the yarn: and sometimes a flat whip-roll has grooves worn in it which chafe the yarn, when tilting it slightly will remedy the fault.

Accumulation of grease at the box entrance often causes dirty filling, and sometimes causes the shuttle to run crooked, thus making the warp weave badly. Unless the yarn is very poor, a warp seldom weaves badly in a cam loom except in case of the loom being out of order, for which the remedy is given elsewhere. Sufficient attention is not given to the stretch of the yarn from the whip-roll to the harnesses. A warp which otherwise would not run, can often be run out by increasing the distance between the whip-roll and the harnesses. Additional lease rods will often even up the yarn in a warp even though a striped cloth is being woven from the same warp. Double cloths will usually weave better if a lease rod is inserted between the two warps, especially if one cloth is a more open weave than the other, as the take-up differs under such conditions, and the rod should be inserted so that the slack warp is underneath.

The use of a lease rod is also a remedy for rough looking cloth caused by curly warp or filling yarn. Dimities often weave better by the use of an extra lease rod, a wire rod being preferable. A soft warp can be made to run better by laying across the warp a long cloth bag filled with French chalk, or by laying a piece of wax on the warp. The latter remedy is not to be recommended for all cases, however, as any wax retained on the yarn proves detrimental to further processes such as dyeing, etc. A stiffly sized warp may also run better by above treatment, but a damp cloth laid over it, or a pail of hot water placed under it so that the steam will rise and soften the size, will give much better results. Staggering the harnesses is the best possible treatment where a large number of harnesses or heavily sleyed warps are being used. A plaid back can be woven much more easily by adjusting the backing harnesses a trifle lower than the others.

It can readily be seen that if there are six or eight ends in one dent, with the harnesses all level, and four or five of the harnesses on which they are drawn are lifted at one time, those threads will be crowded in the dent, but if the harnesses are staggered the threads will be separated. If when weaving a plain stripe there is a tendency for the threads to cling together, a possible remedy is to use a friction let-off in conjunction with an oscillating whip-roll, fixing the whip-roll so that the yarn is tight on the center of movement of the harnesses. This prevents the cloth from becoming unduly slack at times, which is the most common cause of threads clinging together. When weaving fine or very thin cloths, there is often much trouble with the filling in the cloth being dragged at the edges, making ragged looking cloth. A piece of wire driven in the top edge of the breast beam will often overcome this fault, but better yet is a roller mounted near the top of the breast beam over which the cloth may pass.

If the fixer will use care in tying in warps, a great amount of yarn may be saved in a year. Tying in warps carelessly is a slovenly practice, and it takes longer to get them started, as well as causing an extra amount of work for the weaver because of some threads, which are not drawn tight enough, being broken out on starting up. First tie in bunches sufficiently large to go under the temple on each side, and then complete the warp by tying in bunches occupying about two inches width in the reed. It will be noticed that the yarn often snarls behind the harnesses, and while it takes some time to draw out the snarls, a bad start-up is the result if it is neglected. When such a case is met with, draw back the warp until the snarls leave the harnesses, and the warp may then be tied in very readily.

The above points are all small things, but they often save hours of labor, and increase the production as well, which is a very material consideration.

CARE OF LOOMS.

Before considering the general fixing of looms, it would be well to understand the following: A loom that is kept in good repair will cause very little trouble, and never serious faults. Looms give warning of coming danger, and the careful fixer will see to it that these warnings are heeded. A fixer who patches a job, very often has serious results from his neglect. A loom banging off, or a shuttle jumping or rattling in the box, is a sure sign that something is giving way; the manner in which a shuttle is weaving, indicates, to the careful thinking fixer, the seat of the trouble, and he knows full well if the warning is unheeded, that probably a shuttle will fly out and hurt some one. If there are any of the parts that control the boxes wearing, the shuttle will almost invariably show it, because it will be wearing either at the top or bottom. A reed over or underfaced, or bent dents, will show themselves on the shuttle; the back of the shuttle will be worn, or it will be wavy instead of having a smooth back.

The term shuttle flying out, for jumping shuttles and flying shuttles, has been used, because it is a generally accepted term, but there is a difference between the two. A jumping shuttle is one that may skip over the cloth and go in the other box, or it might slip over the end of the loom to the floor, or possibly drop two or three feet from the loom, or the shuttle may jump up from the lay. Such shuttles rarely, if ever, hurt any one, but they are possible indications of a serious defect which, if not attended to as soon as possible, will result in the shuttle flying a good many feet from the loom. By noting distinctly where the shuttle has fallen, and the distance it has gone, it is possible to locate the cause. The shuttle will not travel in the same direction if it meets any obstruction in its passage across the lay, as it will if it has shot clean from the box. A worn picker, picker-stick or loose spindle will throw a shuttle more clearly than any other cause, and these are the two causes that throw the shuttle with the full force of the picking motion; and by a picker springing the picker spindle often adds force to the shuttles. A shuttle that jumps through striking the feeler wires has met a sudden check, and it is impossible for such a shuttle to fly as far, or in near the same direction as when thrown as before stated.

When the boxes are below the race-plate, the shuttle must force itself out of the box, and has an upward tendency. Following out this line of reasoning, the effect can be clearly traced to the cause, and will save many hours of labor.

GENERAL LOOM FIXING.

In these chapters on general loom fixing it is the purpose to give the causes of and remedies for the various faults met with in the majority of looms, whether with cone or bat-wing pick motions, single or multiple boxes. There may be odd cases missed in one chapter, but they will in most cases be found in another; for example, a loose picker will often cause a shuttle to fly out and it will also cause a loom to bang off. A loose rocker-shaft will cause the loom to bang off and also cause it to be stopped through the filling stop motion. Some of the points have also been explained in the different chapters descriptive of the various parts and motions. Many of the little troubles common to some fixers may be avoided by following the ideas regarding different methods of fixing and the reasons given for such. Special attention should be given to the binders for they are probably the most frequent cause of trouble. Every fixer should have a straight edge, as it is useful for many purposes, particularly for levelling the boxes with the lay or reed.

The various points will be explained in detail in different chapters.

Banging Off. This term is applied to the action of the loom when it is stopped by the dagger striking the receiver, owing to the shuttle not being in place. Various causes are as follows:

Most of the items from 38 to 51 inclusive apply especially to the ball and shoe-pick motion.

Banging off is the most common occurrence in the defective running of a loom, and it is due mainly to changes in the atmosphere although many fixers lose sight of this.

1. Supposing the room to be cold, it naturally acts on the loom, particularly the boxes, so that the shuttle does not run as freely as when it has become warm. The best method to follow is to wipe the boxes and the shuttle with dry waste when in the majority of cases the loom will run all right. It is possible that it may bang off once again, but on starting up it will generally be found that the use of a wrench is unnecessary; and in case of such use changing back again is usually required, when the room becomes warm. Occasionally it is well to apply a drop of oil to the binder, the merest trifle being sufficient. If the loom is damp wipe the boxes and shuttle thoroughly dry, apply a little oil, as above, to the swell, and start up again. Should it bang off again rub the face of the shuttle with some fine sandpaper. It may be noticed that when the box and shuttle are damp the front of the shuttle becomes black from the dampness and friction with the swell. Above points apply only when nothing is broken or worn out, and if it is found necessary afterwards, to make some alterations no loss

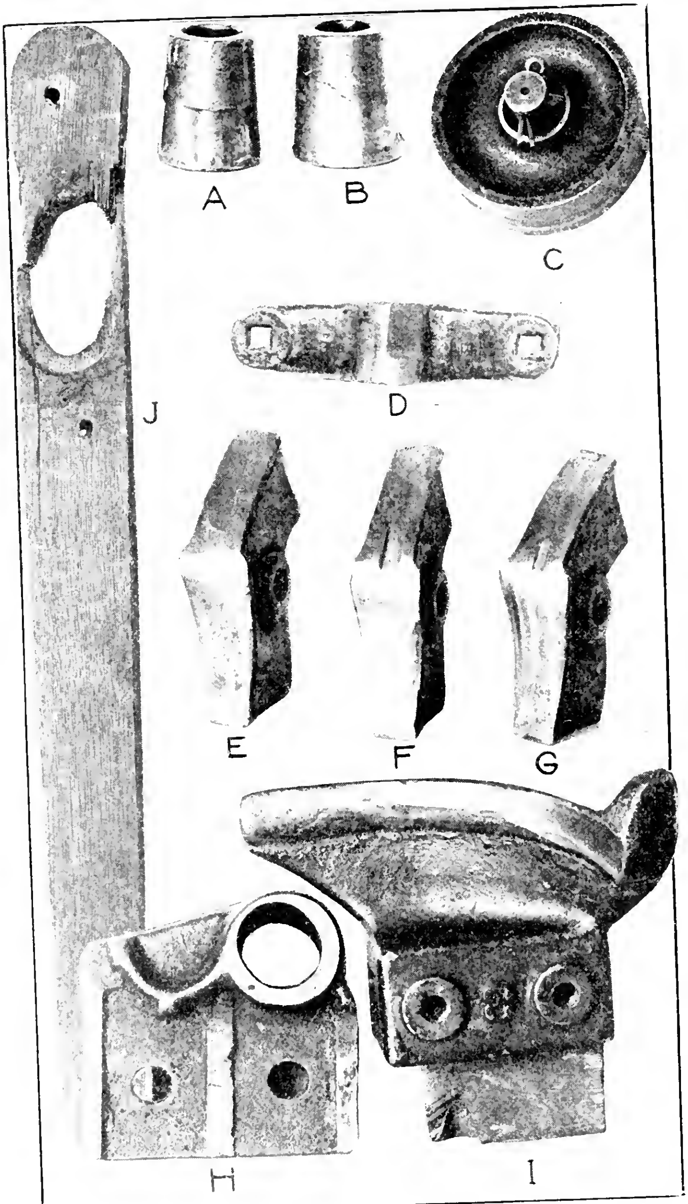

Fig. 133. Worn Parts of Loom Causing Shuttle to Bang Off.

will have been incurred. On the contrary, it is a most beneficial lesson to learn to fix a loom as much as possible without a wrench, because many defects may be remedied in this way and with a great saving in supplies.

2. A loom banging off is sometimes caused by the cone being worn flat on one side. This may be very slight, but very little is sufficient to have this effect. The loom may run well for half an hour, or longer, but as soon as the point of the cam comes in contact with the flat place on the cone a soft pick is the result, and the shuttle not being driven far enough into the box the loom bangs off on the next pick.

3. A partially broken lug-strap has the same effect, because the shuttle is not driven with sufficient force. In repairing the lug-strap, it is advisable to connect the new strap in the same position as the old.

4. The picking-stand becoming worn, particularly the iron projection on it, which fits into the slot of the shoe and guides it, causes the stick to jump because of the shoe catching on it, and the result is either the loom bangs off or the shuttle is thrown out.

5. A worn plug in the picker-stand twists the picker-stick, causing the shuttle to be thrown crookedly. This plug is easily replaced by a new one, and keeping the plug in good condition will save a considerable amount of work.

6. When the pick point of the cam is worn so that the cone slides off out of contact with it, a weak pick is caused and consequent banging off.

7. If the lug-strap has too long a range the shuttle is picked across a little late with the same result. Occasionally, though the shuttle may be picked on time, the sweep or power stick is too short, causing the strap to become soft with a consequent loss of power.

8. A cracked picker-stick is of course lacking in strength, and cannot drive the shuttle with sufficient speed to enter the opposite box, and the loom bangs off.

9. Loosening of the shoe-bolt, which attaches the picker-stick to the shoe, causes either a soft or a hard jarring pick and the loom bangs off on the return.

10. The shuttle striking too forcibly in the box sometimes softens the picker so that there is not the firm throw behind it, and as it does not fully enter the opposite box the loom bangs off. While many fixers discredit this, they often replace the picker.

11. When the collar, which holds the picker on the picker-stick becomes loose, the shuttle may either be thrown out or the loom bang off. The reason for this is that the picker sliding on the stick, reduces the power and keeps the back of the shuttle down, which, by causing it to press against the top of the shed on entering it, retards the passage through. In many instances the collar is loosened by the shuttle rising in the box as it nears the back end, and pushing the picker upwards. This may also occur when the picker-stick is too far into the box instead of being at the back end.

12. One of two conditions is generally responsible for rebounding shuttles: either the pick is too strong, or the binder too loose. As a rebounding shuttle often results in a smash, it is well to use care in ascertaining the cause. By placing the small piece of tube between the extension bolt and the swell, an opportunity is given to watch closely the operation of the loom, and a strong pick is readily perceived. Sometimes it is possible to feel the jar by placing the hand on the lay cap, or if it is seen that the shuttle goes through the shed at the opposite side, clear of the yarn, the strength of the pick may be reduced a little. Do this by lengthening out the lug-strap, or by raising up the stirrup-strap about half an inch, the latter method being preferable. Another method of ascertaining the strength of the pick is to place the hand flat on the top of the box, with the little finger just over the edge of the slot in which the picker-stick moves, known as the picker-race, thus covering the slot to the extent of almost four fingers. If the picker presses sufficiently hard against it to push the hand away, the stick has too strong a pick and too long a range, which may be remedied by letting out the lug-strap. Occasionally the pick-shaft drops slightly and allows the back end of the cone to rest on the cam, in which case a hard pick results. Raising it up again will ease the pick. When the pick is found to be all right, the box pressure must be increased, and this must be done with

allowances for future changes in speed and atmosphere. A very slight change is usually sufficient, and many times arranging the check-spring at the end of the box will obviate the difficulty. As fixing for present conditions generally necessitates altering back again for the next change, the best method is to fix for average conditions, and thus save time and work.

13. An early or late pick will cause the loom to bang off. The shuttle should commence to move when the crank is on the top center. When the picking motion is late, it may readily be noticed by watching the shuttle as it leaves the shed to enter the box. The shed closes upon it and the tendency is for the warp to become broken. Test the pick from both sides to see if both sides are a little late. If so, the probable cause is that the driving gears have slipped. Sometimes the key is a little narrower than the key-bed in the shaft, and it is only necessary to fit a new key, or the key may occasionally work loose, requiring only tightening.

14. The late pick is also caused by slipping of the pick cams, particularly in the case where it is late on one side only. For this the only lasting remedy is to either sink the screw into the shaft or use a hardened cup-pointed screw which will bite the shaft. A common occurrence in tightening up set screws, especially in pick-cams, is to twist off the heads. Instead of tightening to this extent, it is better to draw up until it tightens against the shaft, then withdraw a little, tightening up solid after this, when it will hold with as strong a grip as possible.

15. When the shed is too early it closes on the shuttle, and when too late there is not sufficient space for the shuttle to enter, in either case the shuttle being retarded so that it does not fully enter the box. This condition is easily remedied, particularly so when the cams are on an auxiliary shaft, when by simply disengaging the carrier gear the cams can be set to the right time and gear replaced. Set the cams to have the shed full open with the crank on the top center.

16. When the shed is too small the shuttle is retarded all the way across with similar results. With cams constructed on correct principles, and with treadles of proportionate length, this does not often occur; but when it does, it will generally be found that the harnesses can be moved up and down for $\frac{1}{2}$ inch or $\frac{3}{4}$

inch, owing to the fact that the harness straps have not been equally attached. Frequently in remedying this defect the shed is made uneven. Taking up one hole in the strap does not always suffice, as they may not be equally spaced, and particular attention should be given to having them equal. Harnesses last longer when a little play is allowed in attaching, but this should not be enough to alter materially the size of the shed.

17. A loose rocker shaft allows the lay to spring up and interfere with the throw of the shuttle, which is sometimes thrown out by this means, as well as causing the loom to bang off. It is only necessary to tighten the bearing to remedy this defect.

18. In connection with an adjustable swell, the lock-nut working loose allows the bolt to slip back, causing the swell to become loose. When the temper leaves the swell, it becomes loose and the loom bangs off. The bolt which retains the binder in its frame shows the effect very quickly on becoming loose by ripping pieces out of the shuttle.

19. Picker-sticks of poor quality will spring and bend, causing a soft pick, and a new stick is the only remedy. Using cheap picker-sticks is false economy, as good hickory sticks at slightly higher cost last many times longer. Picker-sticks have been known to run for five years, and on high-speeded looms which ran continuously.

20. On some looms, collars are fitted on the end of the pick-cam shaft to prevent the shaft from slipping, and if a collar loosens, the shaft will move when the pick is taking place, allowing the cam to leave the cone, with the result of either a soft or a hard jarring pick.

21. Key of driving gears too narrow. Covered under 13.

22. Broken heel-straps allow the sticks to jump, and as the stick does not return to place, more power is required behind the shuttle to drive it to the end of the box.

23. A loose or weak spring has the same effect.

24. When the reed is not level with the back of the box it is known as an over-faced reed, when in front of its correct position, and an under-faced reed when behind. The shuttle is caused to run crookedly in either case, and more power is

required to drive a shuttle crookedly because being turned out of its course it strikes the front of the box. A few minutes spent in setting the reed level with the back of the box will save many hours of fixing, as well as adding greatly to the time the shuttle will last. If the reed is over-faced or under-faced it is easily detected through small pieces being chipped out of the shuttle. Single wires in the reed becoming bent forward will also cause the shuttle to run crookedly, and in time the shuttle wears them so that they become sharp and cut the yarn, especially the filling, when the lay beats up. This is one of the causes of stitching. The back of the shuttle becomes worn wavy by these dents.

25. A tight lug-strap binds the picker-stick, thus causing the stick to jump when motion is imparted to it, and the shuttle is driven crookedly, with the usual result that it is stopped before fully entering the box.

26. When the warp is held under too much tension the shed is drawn together, leaving insufficient space for the shuttle to pass through, and the loom bangs off, or it sometimes causes a smash.

27. The bottom of the box at the entrance should be level with the race-plate. If it is too high, the shuttle strikes against it and is thrown against the top: while if too low, the shuttle strikes against the top of the box and there is too little space for it to enter. Either fault will cause the loom to bang off by preventing the shuttle from entering the box, and will also splinter the shuttles, making them so rough that they will constantly break out the warp. When the boxes are not level with the race-plate it is best to look for the cause, rather than immediately alter the position of the lifting rod or chain connections. Sometimes only one box is out of position, and any alteration of the lifting rod or chain would affect all the boxes, making the trouble worse. If the collar on the lifting rod slips a trifle it allows the bottom of the chain-bolt to drop, and the bracket and the boxes are lifted too high. A chain pulley-stud becoming worn allows the boxes to be too low. One or two links of the lifting chain being worn will cause one or two boxes to be too low without affecting the others. To remedy this a thin piece of wire may be attached to the under part of the link, thus lifting

the boxes slightly higher when that link passes over the pulley. Other causes of single boxes being out of position are: the lever which lifts that special box having slipped, and the chain twisting and riding on the edge of the pulley or dropping from the large to the small pulley.

28. Yarn clinging in the shed hinders the shuttle from passing through freely. It may be the result of poor sizing, incorrect timing of the shed, or too small a shed, the remedies for which are manifest.

29. In connection with fancy looms sometimes a harness drops when the shuttle is passing through the shed, in this way holding the shuttle and causing the loom to bang off. More will be said of this later.

30. A worn face on the friction driving pulley causes the loom to bang off, owing to a slackening of the power, with a resultant soft pick. As the belt sometimes slips it is best to determine just where the fault lies. This may be tested as follows: Remove the shuttle, draw the lay forward until the dagger is almost in the receiver, and then draw on the shipper-handle watching the pulley at the same time. If it stops, the friction is all right, and the fault is with the belt, which may be remedied by cleaning with a piece of card clothing and applying a little belt dressing. Dry slaked lime is one of the best remedies for a greasy friction, but a worn pulley must be replaced. Occasionally the driving pulley becomes just sufficiently loose on the shaft to give an uneven motion on starting up, especially when a heavy pattern is being woven, or one having changes from a light to a heavy lift. This looseness may be hardly perceptible, and yet be sufficient to cause much trouble.

31. If the picker is worn it imparts an uneven motion to the shuttle, and also a soft pick, especially if worn too large around the picker-spindle. Should the hole be too deep in the picker, the shuttle is bound and the boxes will not change freely. A crooked or warped picker will not slide freely in the slot and the shuttle is not driven with enough force.

32. Incorrect timing of the boxes has the effects described under 27. The boxes should be timed according to previous instructions.

33. Looseness of the boxes in the slides not only causes a soft pick, but also is the cause of the shuttle becoming broken and flying out. When the motion is imparted to the picker-stick, instead of the shuttle alone receiving it, the boxes, being loose, are carried forward and the front end is thrown below the race-plate, causing the shuttle to strike the end of the plate.

34. If the boxes bind in the slides they will not move freely and the shuttle being crooked in the box cannot be thrown straight.

35. Worn binder pin and pin-hole.

36. Loose crank-arms.

37. Occasionally one crank-arm will wear out faster than the other without being noticed, or new ones will be slightly unequal and the throw of the lay will consequently be uneven. This causes the loom to bang off. Binding crank-arms have the same effect.

38. Shoes slipping will cause the loom to bang off because of a soft pick, but if they are fixed according to instructions given they will rarely work loose. Unless the shoes are worn, tightening is sufficient to remedy the trouble.

39. Worn shoes have the same effect as loose ones, but the only satisfactory remedy is to fit new ones. A worn shoe oftentimes wears the shaft also, so that the shoe will not fit squarely upon it, and the shaft will also require repairing.

40. Lack of oil causes the pick-ball to bind. This will spoil the ball and stud and the only satisfactory remedy is to replace it.

41. It is impossible to obtain a good picking action if the pick shaft binds, and this is one of the causes of a loom requiring more power when picking from one side than the other. To test the shaft remove the sweep-stick and turn by hand, when any binding will become apparent and the bearings can be set to remedy.

42. When the pick-ball and stud become worn, the best remedy is to replace them with new ones. Fit the stud in the slot of the extension as snugly as possible, with the collar flat against the casting. Lack of attention to this small detail means constant fixing and tightening of the stud, which otherwise would not be required.

43. A worn sweep-stick allows too much play to the lug strap and stick, with a consequent loss of power. The sweep-stick should be riveted at the end to strengthen it. Set the sweep-stick and lug-strap in a direct line from the picking-stick to the picking-arm when the crank shaft is just behind the top center, as it is at this time that the hardest pull comes on the pick motion. Failure to set the sweep-stick in this manner causes the studs in the picking arms to become loose, or if the stud is cast with the arm, tends to break it off, or makes the hole in the sweep-stick longer. It is also a cause of the picking-arm breaking because of being twisted. The sweep-stick and lug-strap should be set as nearly level as possible with the stirrup-strap on the outside of the stick. A leather or rawhide washer should be placed between the split pin in the picking-arm stud and the sweep-stick. Old pickers may be cut up for this purpose. Sometimes a sweep-stick is too long and it comes in contact with the dog as the picking-stick is drawn in. This will not only cause the loom to bang off, but will sometimes throw the shuttle. For looms with from 28 inches to 42 inches reed space, a sweep-stick of 6 inches to 7 inches will be found to give good results.

44. On narrow looms the picking-arm is changeable, being placed in a bracket fixed to the pick-shaft. When these get loose the result is either a soft pick or a hard jarring pick, according to the way they slip. An iron wedge is usually placed between the stick and set screw to prevent undue wearing.

45. When the pick-shaft is loose, it is forced away from the ball and there is a loss of power. Before fixing the picking-arm to the shaft it should be examined, and any rough places filed smooth. It does not pay to tighten up the arm unless it fits squarely on the shaft, as otherwise it soon becomes loose and spoils the shaft.

46. Loose driving pulley.

47. Different weights and sizes of shuttles cannot be used on a loom at the same time, as the power to drive them would have to vary proportionately.

48. Shuttles worn round on the back and bottom are

equally bad, as they cannot be driven straight, and often turn over in crossing the lay.

49. Worn wood pulley.

50. If the binder pin and hole is worn, there will be an uneven pressure on the shuttle, depending upon how the shuttle strikes the binder.

Explanation of Fig. 133 on Page 202.

A and B. Worn picking cones.
C. Worn picking ball.
D. Worn knob or pick shaft point.
E, F, and G. Worn pick points.
H. Worn bearing for bottom shaft.
I. Worn shoe.
J. Worn power-stick.

Shuttle Flying Out. A number of the causes of the loom banging off are also the cause of the shuttle flying out, so that in this section when the same cause occurs, reference to those points will be made by number and the explanation can be found in the previous chapter.

4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 19, 22, 24, 25, 26, 27, 28, 29, 32, 33, 34, 48.

50. Also, worn picking stick.
51. Worn shuttle.
52. Loose top shed.
53. Bottom shed too high off the race-plate.
54. Worn spindle-stud.
55. Yarn clinging together in the shed.
56. Race-plate loose.
57. Feelers too low in the shed.
58. Shuttle spindle-pin working through the back of the shuttle.
59. Harness spring broken or weak, not pulling the harness low enough for the yarn to be on the race-plate.
60. Loose crank-arms.

Reed over and under faced, that is, in some way the reed has become bent so that it is forward from the level of the back of the box. This causes the shuttle to strike against that part, be it ever so little, and the nose of the shuttle is turned out from the reed. The way to straighten this is to have a flat piece of iron held against the back of the reed, and straighten the end of the reed with a flat-faced hammer, also assist the reed by softening the pitch that is around the casing of the reed, and in this manner they can often be returned to a straight position, but if the whole reed is out of square, then it would have to be trued up, and sometimes this can be done by altering the lay cap. If the reed being over faced does not throw the shuttle out, it has a tendency to spoil the shuttle by splintering it at the back where it first comes in contact with the reed, and this often breaks the yarn out, because when the weaver is placing the shuttle in the box it is apt to be turned a little causing the splintered portion to rub against the yarn. A loose picker will cause the shuttle to fly out, because the picker slides on the stick to any position the shuttle forces it, and when the stick is at the end of the stroke, instead of the shuttle being slightly elevated at the back, it is down on the race-plate, and the top of the hole of the picker strikes the tip of the shuttle, and the nose of the shuttle is raised up, consequently it will usually fly out.

Another cause is the shed opening too late and there is not sufficient space for the shuttle to enter it, the result is either the shuttle is thrown out on the first pick, or it is retarded so much that it does not go far enough in the box at the opposite side, but still sufficiently to raise up the dagger, and on the next pick the picker strikes the shuttle when the pick is at its quickest time, and in this way the shuttle is often thrown out. The shed closing too soon will also have the same effect as too early a shed.

When that portion of the picking-stick is worn which comes in contact with the picker, it causes a jump to the picker and consequently jumps the shuttle. It is best to round off the corners of the worn place, or replace with a new stick. Worn shuttle means a shuttle that is round on the back and bottom, such a shuttle will not hug the reed, with the result that it often flies out. If the bottom shed is too high off the race-plate, the shuttle is thrown up as it leaves the box; a similar result occurs from cause 59. A worn spindle stud is the general cause of persons being injured by shuttles flying out. When the stud is worn and the picking-stick works forward, the stud has a tendency to work out from the box, which means that the picker will draw the back end of the shuttle to the back of the box, forcing out the front end of the shuttle;

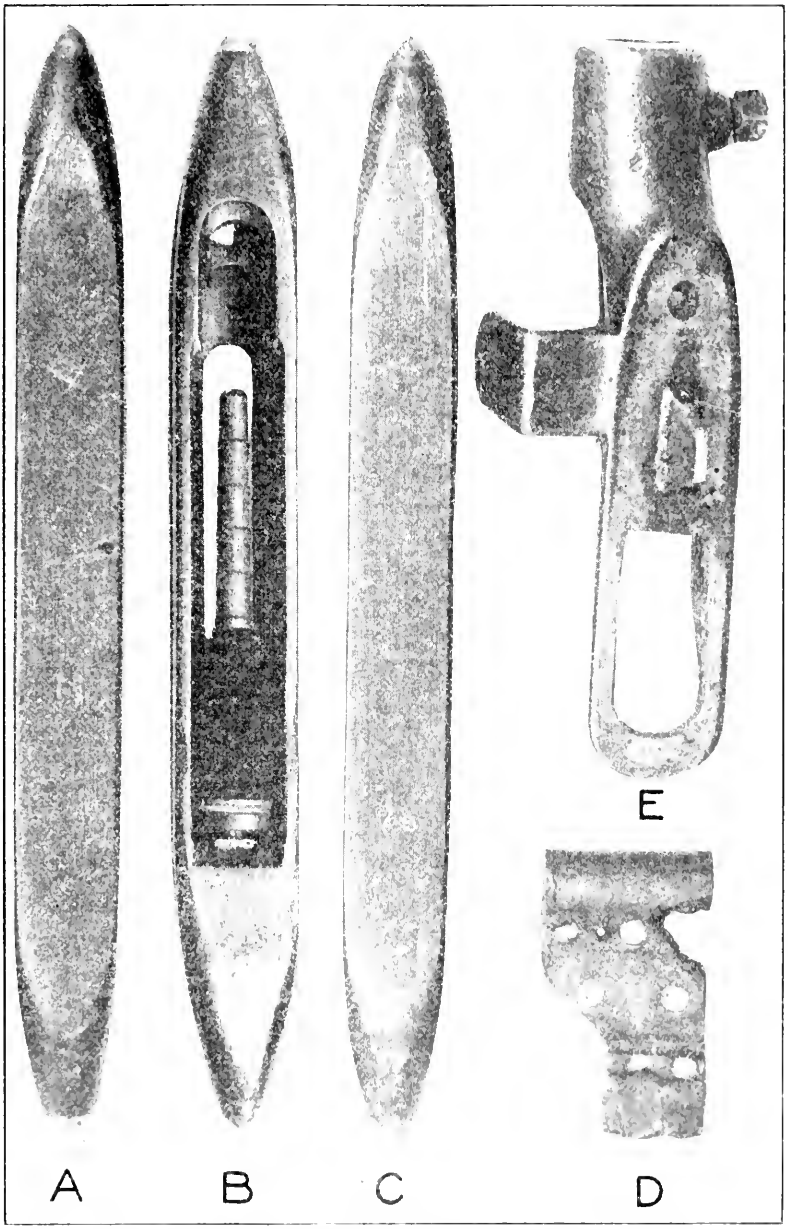

Fig. 134. Worn Parts of Loom Causing Shuttle to Fly Out.

the consequence is, instead of the shuttle being controlled in a measure, it is away from its support and will fly out. A common practice is to pack the worn stud with leather. It is dangerous to fix because the leather has a tendency to become loose after a few picks have been run. Steel cups can be purchased from the loom makers for the purpose of filling in the hole of the worn stud.

Yarn clinging in the shed may be the result of poor sizing, wrong timing of the shed, or too small a shed. Sometimes the race-plate becomes loose in the center, also at the sides, but more often the former, and in nineteen out of every twenty cases the fault is not seen until almost everything else has been done to fix the fault. This is owing to the yarn covering the race-plate. Such a fault will show itself on the shuttle, for the latter will be chipped on the top owing to striking the top of the boxes. If the filling motion feelers are low in the shed, they interfere with the passing of the shuttle across the lay. Sometimes the back of the shuttle will be so much worn that the spindle-pin protrudes and catches the reed. If a harness spring is broken or weak, it will not pull down the harness, so that the yarn is up off the race-plate. This causes the shuttle to run crooked. If the crank-arms are loose, there is an uneven motion to the lay, which causes the shuttle to fly out generally as the crank is passing over the top center.

Explanation of Fig. 134 on Page 213.

A and B. Worn shuttles caused by under or over-faced reed.
C. Worn shuttle caused by boxes being too high or too low.
D. Worn picker.
E. Worn projection on picking stand.

Uneven Cloth; meaning shady cloth and cloth with thick and thin places.

Late or early shed.
Small shed.
Loose rocker shaft bearing.
Odd crank-arms.
Loose crank-arms.
Loose reed.
Uneven shed.
Uneven filling.

Gudgeons or beam spikes bent.
Broken beam flanges.
Worn whip-roll.
Damp friction.
Take-up motion out of order.
Tin or sand roller bearing worn.
Loose perforated tin or tin roller.

Too deep in gear with beam head. Upright shaft binding. Worn stud on oscillating lever. Rough teeth on beam head. Pawl and spring worn. Spring worn in boss of upright lever. Oily friction strap. Worn ratchet.	Gear Let off.

Rope twisted around the beam head.
Cloth under friction band in a grimy condition.
Friction lever resting on the band or beam head.
Crooked beam head so that it touches the whip-roll when the crooked portion comes round.
Too much pull on the friction cloth roller will strain the cloth, and occasionally causes two teeth to be taken up on the take-up motion.
Uneven setting of the harness.

A number of the above causes suggest the remedy.

Uneven Cloth. This is one of the hardest things to contend with especially in a weave room where the humidity is not under control. The friction let-off naturally feels the effect of the dampness more than the gear let-off, although in some cases the strap that checks somewhat the let-off of the gear is influenced by dampness. The friction let-off is most certainly the best, take it as a whole, that is, the rope wrapped around the beam head, or it may be a chain, an iron band or raw hide. These most certainly give the best results if attended to, but if allowed to go as they please, as the common term is, they are the worst form of let-off. If the rope has become sticky, a little powdered black lead will soon remedy this defect. French chalk is often used, and with good results, but this is more liable than graphite to cake and become sticky with change of atmosphere or if some oil is accidentally dropped on the beam head. There are some fixers who have used oil on the beam head, claiming that it allowed the rope to slip more freely, but the very same fixers have been seen to take great pains in wiping off the oil under other circumstances. It sometimes happens that uneven cloth is caused by the spike or gudgeon in the beam having been sprung; this is caused by banging the beam on the floor, and as the yarn is drawn off, the uneven turn of the beam causes unequal let-off of the yarn.

The take-up motion is often the cause of uneven cloth. The

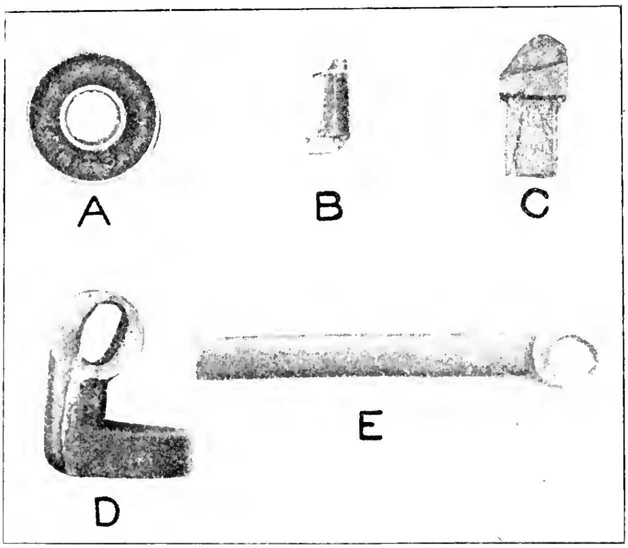

Fig. 135. Worn Parts of Loom Causing Uneven Cloth.

majority of take-up motions that are on the two pick principle, that is, receiving motion from the pick cam shaft, are constructed so that with a little change they can be made to take up two teeth at a time. Under this construction, it is natural then that the ratchet gear has a little play more than what is necessary to take up one tooth, because it is owing to the loss of a portion of a tooth by the check-pawl, and a portion also by the take-up lever that the motion only takes up one tooth. The converging of these points and the using of the loss of space travelled by the take-up lever and the check-pawl, enables the motion to take up two teeth. If the ratchet gear does not swing a little and work perfectly free, then one can expect an uneven cloth, because instead of swinging back a little to meet the check-pawl, the gear stays in the position to which it is drawn by the take-up lever, and this will occasionally cause two teeth to be taken up. Uneven spun yarn makes a bad looking cloth, and this is sometimes called a cockly cloth. The uneven setting of the harness will cause uneven cloth, that is, the harness not lifting equally at both sides, or an uneven shed, one lifting higher than the other. When using a gear let-off, a fixer cannot be too careful at the first starting up of the warp to see that all is straight, and that the gear which is in contact with the beam head is not too deep in gear. This is one of the most common causes of complaint, because the teeth around the beam head are not always as clean as they might be. Small chips of iron are on the inner edge of the teeth, and if the driving gear is too deep when the beam has been turned to where the rough teeth are, the warp will jump, and, in this way cause these places.

Sometimes the gear is in right pitch with the beam head, and yet thin places are caused; the possibility is that the beam spike is sprung causing an uneven contact with the driving gear. If the stud on which the rod is placed is worn, uneven cloth will be the result, and sometimes the spring that keeps the pawl in contact with the ratchet gear has lost its strength, and occasionally the pawl will slip over the teeth of the ratchet instead of engaging in them. This causes an uneven let-off. This little system of looking before one uses a wrench comes in handy, for by the moving of the small collar, a great difference in the let-off will be the result. On a let-off motion, a spring is often placed in contact with the upright lever. This assists in bringing back the lever and at the same time the pawl; if the spring should slip, uneven cloth is sometimes caused, but not often, as it cannot be called a vital point in the let-off motion. The pawl will sometimes miss turning the ratchet gear owing to the pawl being worn, and this point is often overlooked, the same as the spring. Uneven cloth is often caused by the arm that supports the whip-roll being worn, and if there is much vibration of the whip-roll, this has a tendency to raise a little out of the place that is worn, and if the ends of the whip-roll are worn unevenly so that if the roll moves around a little, it is raised higher up, consequently uneven cloth will be the result. A round whip-roll is the best if the bearings are kept clean and well oiled; it moves around with the yarn as it is drawn off the beam and there is less possibility of the yarn wearing grooves in the roll, as it often does in what is termed a flat whip-roll, explained more fully under the head of "Construction of a loom."

When the rocker shaft bearing is loose, there is an uneven movement to lay when beating up. If the crank-arm is loose, or one is slightly longer than the other, the reed does not beat up evenly; a loose reed gives the same result. If a beam flange is broken, when the heavier side is passing down, it goes down more quickly than when the broken side is passing down, especially is this so when fancy cloths are being woven, and it is not uncommon to add a weight to the broken side to balance the beam. When the bearing for the sand roller is worn, the roller jumps, causing cloudy cloth. Loose perforated tin will sometimes overlap, causing a thin place in the cloth. Occasionally the guide roller will come loose and turn, and if it has not been set straight, uneven cloth will be the result. If the cloth under the friction band is allowed to remain on too long, it becomes sticky, and allows the beam to let off in jumps. Occasionally when attaching the friction, the knot in the cloth is allowed to remain under the friction band and this will cause very uneven let-off. If the friction lever is allowed to rest on the band or beam head, it will prevent the proper letting off of the warp.

Sometimes the weight will touch the floor, or the weight from a top beam touches the lower beam. If the beam head is crooked, when it turns round it will touch the whip-roll. If there is too much pull on the friction cloth roller the cloth will be strained, and it will also occasionally cause two teeth to be taken up on the ratchet gear. If the harnesses are not set level, shady dyed cloth will almost certainly be the result, because the sheds being lower on that side the cloth is a trifle thicker, the consequence is that there is a difference in the absorption of the dye stuff. The center harness connection on the Knowles Loom was designed to overcome this. If one edge of the cloth is slack through the fault of the temple, shady piece dyed cloth will result. Sometimes there are distinct cracks in the cloth, and in nine cases out of every ten, they are caused by slack yarn, especially is this so with cam work of four or more harnesses. Notice the cloth that is woven and one will see the defects occur almost regularly. Then watch the loom, and the probable cause will be the yarn is slack on one certain harness, and when the filling is beaten up the slack yarn forms in a rub which prevents the close beating up of the filling, raising that harness up a little to tighten the yarn.

Explanation of Fig. 135 on Page 216.

A. Worn link.
B. Worn treadle-pin.
C. Worn treadle-plug.
D. Worn treadle-bowl.
E. Worn connecting rod of let-off motion.

EXAMINATION PAPER

WEAVING.

PART II.

Instruction to the Student. Place your name and full address at the head of the paper. Use any cheap, light paper like the sample already sent you, of a size about 7 by 9 inches. Study the Instruction Paper thoroughly before attempting to answer the Examination, and then answer in *your own words*.

---

1. What is the purpose of the filling stop motion?

2. Describe the alternate filling stop motion.

3. Of what value is the protection motion on a plain loom? Describe how this motion works. How would you set the dagger in relation to the receiver?

4. Describe fully the Crompton Gingham box motion.

5. What particular points must be attended to, when fitting a new set of boxes to the loom?

6. Describe what would occur from a worn receiving plate on the protection motion. How would this occur?

7. Describe the two distinct shapes of forks on the alternate filling stop motion. Has one any advantage over the other, if so, how?

8. Of what value is the lock-knife on the Knowles Gingham box motion? Give the timing of the lock-knife.

9. What is liable to occur from a worn picker and picking-stick? Describe fully.

10. Describe the center filling stop motion.

11. What is liable to occur from the following on the protection motion: worn dagger point, dagger too long, dagger too short? Describe how the faults occur.

12. Describe what faults occur from the boxes binding or being too loose in the slides.

13. If the small segment gear shaft was bent or sprung, what would take place? Describe how this would occur. Crompton motion.

14. Give the timing of the alternate filling stop motion cam. Is there any reason why this cam should not be on the opposite time? What is the reason, if any?

15. How would you set the feeler wires to obtain the best results? A full answer required.

16. Suppose the spring check finger on the Crompton motion did not rest squarely on the check studs connected to the disc, what would result? Tell how this occurs.

17. How would you set the picker in relation to the guide plates? Why?

18. Give the timing of the center filling stop motion.

19. Describe how you would set the boxes level with the race-plate, and how the leverage is adjusted on the Crompton box motion.

20. Does it require more power to drive the shuttle when the boxes are loose in the slides, than when they are fitted as they ought to be? If so, how?

21. Describe the grasshopper motion. Crompton Loom.

22. If the loom was stopped by the filling stop motion without the filling breaking, what would occur? How?

23. How should the picker spindle be set in relation to the boxes? What is liable to occur from the wrong setting or a worn spindle stud? How?

24. What is the value of the box protection motion? Describe how faults occur if this fails to work. Crompton motion.

25. What is the value of the multiplier? Describe how it works in relation to the box chain. Crompton or Knowles.

26. Is it better to elevate the back end of the boxes or not? In either case give reasons for answer.

27. Describe the Knowles Gingham box motion.

28. What points determine the practical value of a box motion?

29. When building box chains, what particular points need consideration?

30. After setting the first box level with the race-plate, how would you get the right leverage on the second box if it was below or above the race-plate when raised? How obtain the right leverage on the third and fourth boxes? Knowles motion.

31. What vital point needs consideration in the running of the picking-stick with the picker? Why?

32. Make out the box chain and multiplier for the following pattern, arranging the shuttles in the boxes to the best advantage. This is a four and one box loom: 60 blue, 10 white, 2 red, 2 white, 2 red, 2 white, 2 red, 10 white, 8 blue, 8 white, 8 blue, 8 white, 8 blue, 10 white.

33. Make out the box and multiplying chain for the following pattern; pick and pick loom, also show method of arranging shuttles in the boxes. 30 blue, 4 red, 20 blue, 4 red, 30 blue, 8 brown, 4 black, 8 brown, 4 black, 8 brown, 4 black, 8 brown, 4 gold silk, 16 black.

34. Give at least ten causes for loom banging off.

35. What is the cause and remedy for temple marks? Explain fully.

36. Would the same kind of burr temple be used on all classes of fabrics? Give full reasons for your answer.

37. Explain fully the advantage gained from staggering the harness.

38. What would you do to help a soft sized warp to weave?

39. Suppose the picks of filling are being laid in the cloth somewhat on an angle, what would you consider the cause?

40. Is it possible to run different weights of shuttles in the same loom, especially in a four and one box loom? Why?

41. What effect would a heavily built loom and lay have on a fine piece of cloth, especially if the eccentricity of the lay was very pronounced? How?

42. How would you treat an extra sized warp to get it to weave? Why?

43. Supposing that after the start up in the morning you found a number of looms banging off caused by excessive moisture in the room, what method would you pursue to overcome the faults? Why?

44. What effect would the following have on the cloth: rusty temple ring spindle, waste in the temple rings, crooked temple?

45. Make out the chain plan for the following pattern: 3 picks brown and white D. T. yarn, 3 picks white, 3 picks D. T. yarn, 3 picks white, 2 picks printed yarn, 3 picks white, 3 picks D. T. yarn, 3 picks white ~~yarn~~, 3 picks D. T. yarn, 2 picks printed yarn, 2 picks light blue, 3 picks white, 2 picks light blue, 2 pick fancy, 2 picks blue, 3 picks white, 3 picks D. T., 3 picks white, 3 picks D. T., 1 pick fancy.

46. Supposing four colors of filling were being used in a loom, and one was a soft spun filling, which box would you place that filling into? Why?

After completing the work, add and sign the following statement:
I hereby certify that the above work is entirely my own.

(Signed)

Date Loaned

RETURNED			