Scroll Picks

A scroll motion was introduced by Luke Smith in 1843, the object being to lift a striker C, Figs. 196, 197, 198 out

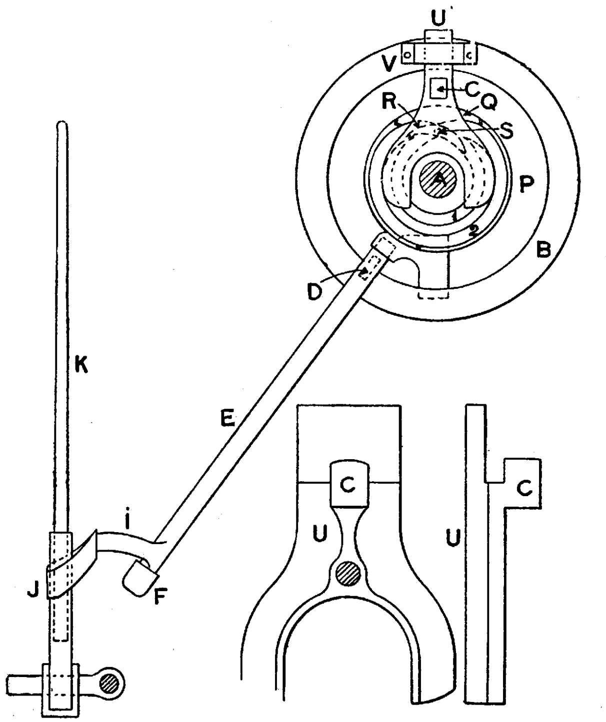


Fig. 196.

of range of an arm D by a stationary scroll P. A scroll is bolted to the end framing and bored to admit the crank shaft A; it consists of beads cast on one side of a disc in such a manner that two grooves 1, 2 are formed to run into

each other at the point P′, Fig. 198. Over P′ a movable

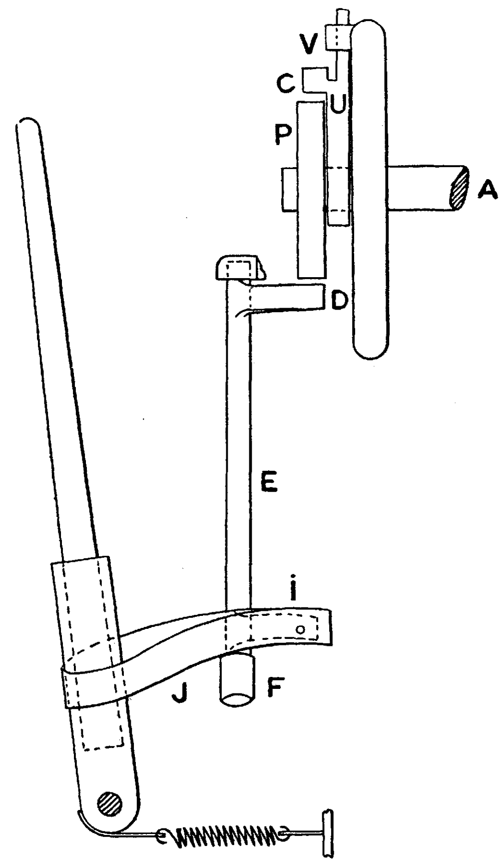


Fig. 197.

piece Q is curved inward for the purpose of turning a half-moon R out of one groove and into the other.

As the fly-wheel B rotates, Figs. 196, 197, a half-moon R

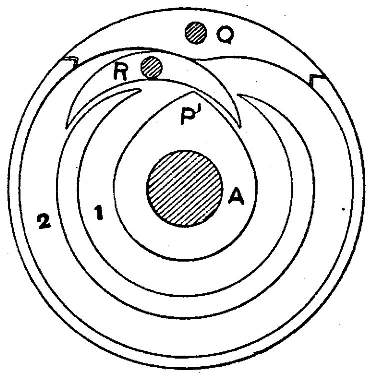


Fig. 198.

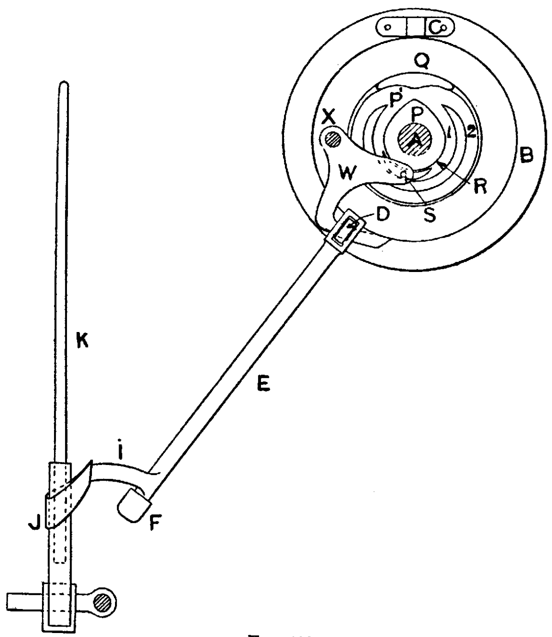


Fig. 199.

travels in the grooves 1, 2. The half-moon is connected to B by a stud S, which passes through a hole in the striker bracket U. A clip V is bolted to the fly-wheel B to carry U round with the wheel, also to permit it to slide in and out upon the face of B. The striker C is thus moved in when the half-moon R is in groove 1, and out when it is in groove 2. In the latter position the striker C is brought into contact with the arm D, and a pick is delivered.

In 1889 A. Clegg obtained a patent for a modification of the foregoing. It has a revolving scroll, Fig. 199, which lifts a latch D above a fixed striker C on the fly-wheel B when a pick is to be inoperative, but C, D make contact when a shuttle is to be moved. A three-armed lever W is hinged to the framing at X; a second arm passes beneath a latch D, and the remaining arm supports the half-moon R upon a stud S. The latch D is lifted whenever R is in groove 1, and lowered to pick whenever R is in groove 2.

If these contrivances are superior to those illustrated by Figs. 190 to 195, their advantages are not very apparent. The half-moons are frequently broken, the wear and tear is considerable, and scrolls do not lend themselves to conversion into pick-at-will motions.

Cone Under-Pick

The picking motion made by H. Schroer has been designed for and applied to silk looms, but there does not seem to be any reason why it should not be applied with advantage to cotton looms where an under-pick is desired. It is extremely smooth in its action as compared with any other under-pick, and this appears to be due mainly to the application of the cone picking principle to an under-pick motion.

Positive Picking

Positive picking dates back to the year 1678, when M. de Gennes attempted to weave by automatic machinery. It has been a favourite problem with mechanicians of many succeeding generations, but little real advancement has been made. The most extensively used motion of this class, for other than small-ware looms, was introduced by Lyall in 1868, and modified by him in 1870 and 1872; it contained many good features, and was less complicated

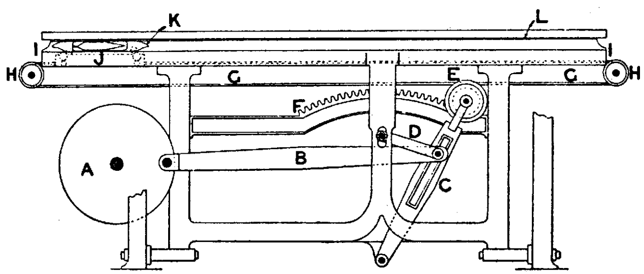


Fig. 200.

than some of the negative picks in general use, but it met with little favour in this country.

Lyall's mechanism is illustrated in Figs. 200, 201. A disc crank A is driven from the loom shaft by an end shaft and bevel wheels. Motion is conveyed from A by means of a connecting rod B to a block placed in a slotted arm C. A link D is also pivoted to the slay and attached to the block; as A revolves the block is moved up and down the slot, and C moves to and fro. At its upper extremity C carries a pinion and also a band wheel E; the former engages the teeth of a fixed curved rack F, which sets up a rotary movement in E as C oscillates.

A band G is wound round the periphery of E, led over two sheaves H, situated at opposite ends of the slay I, and the ends of G are connected to a carriage J. The carriage is mounted upon four wheels and placed upon a metal bed in the slay bottom. Hence as C vibrates the carriage is moved across the warp space to the right and left alternately.

The wheels are in pairs on horizontal pins fixed near the ends of the carriage J, Fig. 201, numbered 1, 2. The wheels 3, 4 project above but are journalled in J, so that they turn by contact with 1, 2. A shuttle K is placed upon and drawn to and fro by the carriage J. Two shuttle

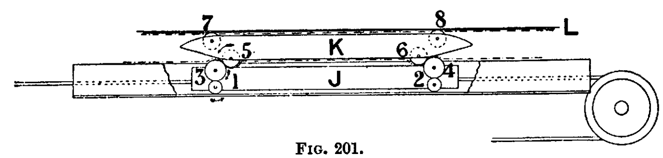


Fig. 201.

wheels 5, 6 rest against the insides of the wheels 3, 4, and two other wheels 7, 8 roll along the under surface of a bevelled rail L. By this arrangement a shuttle is held securely in its place.

Assuming a right to left motion to be given to the carriage and shuttle, the wheels revolve in the direction indicated by the arrows, and with the same surface velocity. Wheels 3, 4 lift the warp threads successively for the wheels 5, 6 to roll over without imparting a lateral movement to them. A shuttle moves at a constantly accelerating pace from one side to the centre of a fabric, and from the centre its velocity is correspondingly diminished until a pause is reached on the opposite side. This arises from two causes: the first is due to the crank A and the connecting rod B, and the second to the action of the link D. A shuttle begins to move when A is passing from its front or back centre. While A is on those centres the arm C is for an instant in a state of rest; but immediately either of them is passed the arm begins to move slowly, and increases in speed until at the bottom or top centre of A the forward velocity of C almost equals that of the crank pin, then a corresponding decrease takes place to the next centre. In the second place, as the arm C moves from either extremity of the rack F, the block is pushed by the link D nearer the fulcrum of C, to develop a greater velocity in the shuttle. The carriage and shuttle wheels are necessarily small in diameter, they cannot be lubricated, and yet, at a shuttle velocity of 44 feet per second, they would have to revolve several thousand times per minute. This is one of the weakest features of the invention.

The Zapata Picking Motion

An interesting development of positive picking is the one invented by the late Dr. Zapata, at one time Columbian Minister to Great Britain.

The weft mounted on a spindle or peg is contained in a cylindrical metal case with a pierced pointed end through which the weft passes. The metal case rests on a carriage and is drawn through the shed in a manner somewhat similar to that of Lyall's picking motion.

The metal weft case lies parallel to the warp and therefore the weft is laid well forward towards the fell of the cloth.

Another novel feature of the loom is that there is no moving slay, the weft being pushed into place by means of a revolving comb, so that the beating up is of a sectional character and follows the weft as it emerges from the weft case.

Owing to the death of the inventor the loom, which contains many interesting points, remains undeveloped, and the original is installed in the College of Technology, Manchester.

PART XI

PICKERS, PICKING BANDS, CHECK STRAPS, AND BUFFERS

As a shuttle enters a box a picker is very severely taxed, for the former delivers a blow, from a steel point, which cannot be distributed over an even surface. It has been estimated that on entering a shuttle box a calico shuttle strikes a picker with a force equal to a 1 lb. weight falling 3 feet; and as these looms make upwards of 200 picks per minute, it is not surprising that the wear and tear of pickers forms a serious item of expense in a weaving mill.

Pickers are made in a variety of forms and materials according to the requirements of a manufacturer. The materials used are buffalo-hide, leather, wood, iron, brass, canvas, and rubber, but the first named is in most general use. To be of real service pickers should be of good quality, well seasoned, of equal weight, and made from as few pieces as possible. A variation of $\frac{1}{8}$ of an ounce should not be exceeded for a given loom.

Picker-making is a separate industry, and numerous operations have to be performed before a finished article is obtained. They are briefly as follows:—The hides, shipped from India, Buenos Ayres, and other places, in a hard and hairy condition, are on arrival in this country steeped in clean water for one week, then in lime pits for from four to six weeks; the hair is next scraped off, and the skins are hung up to dry for from four to six weeks. In this condition hides are often sent to the picker maker, who macerates them in water until they are soft enough to retain any shape given to them. Hides are next cut into strips to correspond with the size of picker to be made—ordinarily about $3\frac{1}{2}''$ by $1'\ 0''$. This is followed by rounding, notching, and punching, after which the strips are passed through rollers and shaved down to a uniform thickness. Matching is the next operation, namely, strips of equal weight are selected, or failing that, equality is obtained by adding smaller pieces which at a later stage are folded inside the larger ones. After matching, the pieces are drilled, a staple is inserted, they are riveted, roughly shaped, and pressed by powerful machinery into a usable form. Finally pickers are slotted, punched, drilled, and sent to the manufacturer, but are by no means ready for use, as when new the moisture they contain renders them more or less pulpy. Pickers should be threaded upon a string and dried for six or more weeks in a place where there is a constant current of moderately warm air. They are next saturated in Gallipoli oil to increase their durability. But if pickers are not thoroughly dry before immersion, the oil will prevent the moisture from evaporating. If they are merely immersed in oil, three or more months will be necessary to effect complete saturation, but by the aid of a force-pump a few days will suffice. Then follows a gradual drying for from six to eight weeks.

Leather pickers are chiefly used on under-picked looms; they are often constructed by folding up several strips of

leather, each being equal to the depth of a picker, and securing the strips with rivets. Sometimes a picker is made by folding one piece of leather which is three times the depth required; this plan gives strength, firmness, and smoothness. At other times pickers are prevented from bursting at the sides by placing a thin strip of steel between the outer and inner layers of leather.

Picking Bands

Good strapping is of equal importance with good pickers; the best quality of leather, although more costly at first, is cheapest in the end, for it neither stretches so much nor breaks so soon as inferior qualities, and looms fitted with it are stopped less frequently for repairs.

A few picking arms are still slotted as at C, Fig. 176, but the majority have a ring groove made near the forward end for a picking band to enter. The end may be fashioned into a truncated cone and shielded with metal, so that the coned surface shall correspond, as nearly as possible, with the angle formed by a picking band and the arm when a pick is delivered. Or the end of the arm may have a lip into which a band is dropped edgewise. The methods of attachment also vary, and differences of opinion exist as to the best length of band, and the most economical way of connecting it to a picking arm and picker. While some prefer bands of from $12''$ to $14''$ long by $1\frac{1}{8}''$ to $1\frac{1}{4}''$ wide, others contend that bands from $23''$ to $50''$ long possess advantages over shorter ones. Both single and double, straight and tapered, bands are used, some being directly connected to the arm and picker, others to one or even to two secondary straps. For most looms, green, oak-tanned, or chrome bands are employed.

The following are a few of the methods of applying bands to narrow cone pick looms :—One end of a tab 8″ to 9″ long by 1″ to $1\frac{1}{4}$″ wide is pushed through the side and top slots of a picker; both ends are brought together, and a slit of about 2″ is made in them for a picking band to pass through; the latter is 23″ to 24″ long. Holes are punched at both ends of a band from $\frac{1}{2}$″ to $\frac{5}{8}$″ apart to facilitate length adjustment; the band is next bent round the ring groove in the arm and sewn across, both ends are inserted into the slotted tab, and secured by forcing a wooden peg, or a leather plug, through one pair of holes.

A band, from 23″ to 27″ long, may have a longitudinal incision made near its centre, and after fitting it in the ring groove in an arm, one end is drawn through the slit until both ends are level, then, as in the previous arrangement, the ends are passed through a slotted tab on the picker and fastened with a peg. A piece of string tied round the band, immediately below the arm, holds the band in position. This plan is often preferred to the first named.

A short, single band may have a slotted tab, 9″ long by $1\frac{3}{8}$″ wide, sewn upon an arm, and riveted with a wire staple to keep it in the groove. A band, 12″ to 13″ long, is then slit near one end and punched near the other; it is passed through the front and top grooves in the picker, the punched end is threaded through the slit, drawn tight, and made fast by a peg to the tab on the arm.

Single bands, 25″ to 50″ long, have one hole punched near the lower end, and an indefinite number of holes punched, about $\frac{3}{4}$″ apart, near the other end. The band is drawn through the front and top slots of a picker, and a piece of leather is pushed into the single hole to prevent

the band from slipping out when working. The free end is twisted spirally round the arm, and a wire pin, driven into the arm, passes through one of the holes to retain the band in position. A wire staple, or a strip of leather screwed to the arm, bridges the ring groove and holds the band in its place. Instead of employing a leather plug to connect a band and picker, a band may be slit near a picker, and the punched end passed through the slit to couple them. Long bands are advocated for the reason that they generally break near a picker, and the damaged part of a long one can be cut away, a portion unwound from the arm, a fresh hole may be punched, and the band again secured at both ends as before. A similar operation may be repeated several times; but a short band when once broken admits of few readjustments.

A band may be double, if each end be passed through a separate side slot in the picker, and both drawn through the top slot, and also through the loop thus formed. A band may be bolted to a picker, or it may be held by metal clips secured upon a picker. But whatever the method adopted, a band should not touch the box spindle or it will wear rapidly.

The Check Strap

Robert Pickles claimed to have invented the check strap in 1839, but it was patented by Crook, Eccles, and Lancaster in 1845, and is now fitted upon quick-running looms, whether furnished with a fast or a loose reed. A check strap is a simple and effective contrivance for destroying the momentum of a shuttle as it enters a box.

It consists of a leather strap A, Fig. 202, about 1″ wide and of equal length with a slay. It is supported by four guides B, which are screwed to the slay front, and permitted to partake of a sliding motion. At its centre a piece of leather C, $\frac{1}{2}''$ long by $1''$ deep, is nailed to work between two centre guides, that allow $3\frac{1}{2}''$ of traverse in A. Each end of A is secured to a tab D, $6''$ long and $1\frac{1}{2}''$ wide; both tabs are punched near one end for a picking spindle to pass freely through, and both are slit at the other end to receive the strap A. When in position A is fastened to D, D by a piece of wire. Instead of slotting the tabs, a buckle may be sewn upon each, for either plan provides a ready means

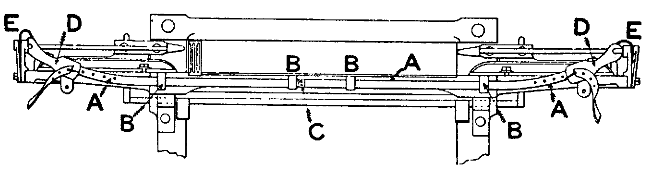


Fig. 202.

of adjustment. The tabs D are placed upon the spindles but behind the pickers. A strap A is not adjusted until the loom is ready for work; it is then usual to place the cranks upon their bottom centres, and, when one picker is at the box end, to tighten A until the remaining picker is slightly more than $1''$ from the end of the other box. Two pieces of leather E, called guards, are about $1\frac{1}{2}''$ broad by $5''$ long, and punched at both ends. One end of each is pushed on a spindle in front of a tab, the other goes behind a spindle plate. If E, E are properly adjusted a check strap will work satisfactorily, even if the piece C be removed. If spiral springs are employed to check the momentum of a shuttle, a collar is loosely mounted on a box spindle behind a picker and so shaped that it impinges against a spiral spring threaded upon a supplementary spindle. A

spring is compressed each time a shuttle enters a box. Should a picker strike a box end, the shuttle will rebound, a cop will be knocked off, or the shuttle pin will be broken. These defects may be due to a check strap being imperfectly adjusted, to a pick being too strong, or the swells too weak. Spindles are fixed over shuttle boxes in various ways; some have caps set-screwed over them as in Fig. 202; others are screwed at the outer end, and locked by nuts. A spindle may also pass through a forked clip furnished with a screw and lock nuts, and through the box end; the clip then impinges against the box and holds the spindle secure.

Buffers

A buffer should prevent a picker from striking a spindle stud; it may consist in superposing three or four pieces of leather, all $6''$ long by $1''$ wide; then folding them to bring the ends together, and riveting them with a wire staple, but a loop is left large enough for a box spindle to pass through, and a slit made near the free end. Into this slit one end of a strap is pushed and fastened by a piece of wire, the opposite end is bolted to the slay front. A buffer may be made by doubling a strap at one extremity, and punching it to receive a spindle, the opposite end being treated as described above. By another method a leather band is closely coiled and a hole is cut through the coils for a spindle to enter; the straight end is then secured to the slay. Or, instead of connecting the straight end of a buffer strap to the slay, that strap may be looped and connected to the free end of a bow-spring which is bolted upon the slay.

PART XII

WARP-PROTECTORS, OR FAST AND LOOSE REED MOTIONS

If, from any cause, a shuttle fails to reach its proper box, a loom must either be instantly stopped by a fast, or gradually stopped by a loose, reed motion. In the latter event a shuttle may remain amongst the warp while the slay vibrates, without doing damage. All looms are provided with curved levers or springs, called swells; these, in fast reed motions, serve the twofold purpose of preventing a shuttle from rebounding after entering a box, and of protecting the warp from injury should a shuttle remain amongst the warp as the slay advances to beat up.

The fast reed stop motion was patented in 1796 by Robert Millar, but has been greatly improved by later inventors. It now consists of two swells A, Figs. 203, 204, which are often made of iron, although many wooden ones are to be met with. One of the chief defects of a wooden swell is that it wears rapidly at the shoulder. It has then either to be replaced with a new one, or planed to its original shape. A simple method of preventing wear, and also of increasing or diminishing at will the obliquity of its surface, was patented in 1893 by Messrs. Collier, Evans, and Riley.

The invention is shown in Fig. 204, where a swell front A has a thin steel coating B firmly secured upon it at C, and at D a screw is passed through a slot in B to hold the rear end. At E a screw F passes through the wood and is retained in position by a lock-nut and a plate G, affixed to

the back. Upon F a second nut H is made to impinge against the inside of B, hence by screwing or unscrewing F

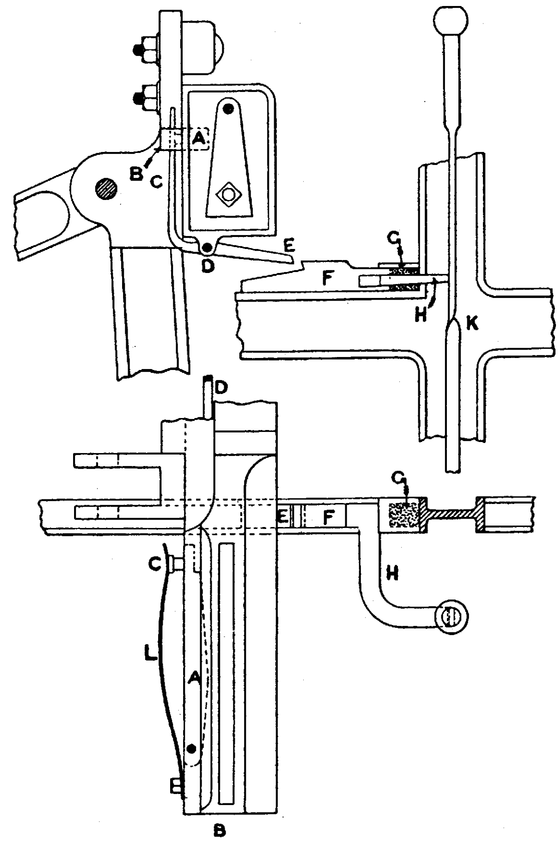


Fig. 203.

the shape of a shoulder can be altered. B also provides a partially elastic cushion for a shuttle to strike against. A swell A, Fig. 203, is usually hinged to the back and near the outer end of a shuttle box B; its curved face is made to protrude inside B, by a lever C and a blade spring L. A blade spring has been coiled at one end like a watch spring, and the coiled end fastened to an adjustable pin. But, however shaped, a spring puts a shuttle under control, and reduces wear and tear. In 1894 T. Pickles and B. Blakey patented a swell that permits of movement about its longitudinal and transverse axes. This swell is made from two pieces of wood, the back piece having the grain running length-wise and the front piece cross-wise. The ends are convex and rest against the box back, hence the latter limits the inward movement, while a blade-spring holds the swell forward. A swell so constructed and controlled can move in and out throughout its entire length, and also make a rolling movement. Its control over a shuttle is, therefore, more efficient than that of a hinged swell. A shuttle box is invariably wider than a shuttle by at least $\frac{1}{8}''$ at the outer end, and often by $\frac{1}{4}''$ at the entrance. When a swell is placed in a box back, a shuttle is pressed against the box front, and therefore out of line with the reed. Further, a shuttle will not be moved in a straight line, for when it is fully boxed, a swell tends to tilt its tip away from the reed; but when acting near the outer end of a shuttle, the tip is tilted towards the reed, and the change from one position to the other occurs in a moving shuttle.

A swell may be placed in front of a shuttle, in which event it is generally made of malleable iron, so that, by bending the swell, its shoulder may be increased or reduced in size. A box front may then be dispensed with, and any shuttle in a multiple box loom is free to be adjusted by hand without disturbing the boxes. By exerting pressure upon the front of the shuttle, a swell, if suitably made and

operated, will hold that shuttle against the box back, and therefore in line with the reed. If faulty in construction or action, a front swell may tilt the tip of a shuttle away from the reed at the moment it leaves a box.

Below a swell B a rod D oscillates in bearings shown attached to the slay sole, but such bearings are preferably fixed upon the swords. The rod D extends across a loom, and upon it two levers C are set-screwed to rest against the swells A; upon D, two flattened blades E are also welded. In front of, and directly in the path of E, two buffers F, known as frogs, are each provided with a shoulder to engage the blades E whenever a shuttle is absent from a box

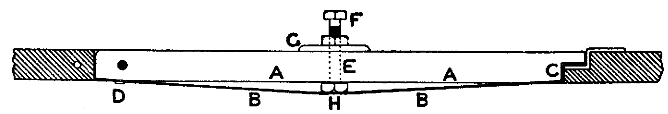


FIG. 204.

as a slay advances to beat up. Both frogs F rest upon a portion of the framing with their forward ends abutting upon rubber cushions G, or spiral, or flat springs. One frog F may be connected by an arm to a break on the fly-wheel, so that a forward movement in F will put a drag upon the wheel, and speedily bring a loom to a state of rest.

In order to avoid slipping, the blades E and the frogs F dovetail into each other. When in contact they could, without other aid, bring a loom to a sudden stand, but violent shocks of impact between E and F would thereby occur while the driving strap exerted its full force to carry the slay forward, and breakages would result. This defect is avoided by attaching an arm H to one of the frogs F, and placing its free end immediately behind the starting handle

K; then as that frog recedes from the blow of E, the arm H will partake of a similar movement, push the handle K out of its notch, and transfer the driving belt to the loose pulley. The blade springs L may press upon the arms C and so assist in holding the blades E in striking position, or a spiral spring may be hooked upon the under side of E and upon the bracket on a slay sword to effect a similar purpose. So long as a shuttle is moving correctly a loom will continue in motion; for, as the former enters a box, it pushes back a swell A and an arm C far enough to lift E clear of F; but should a shuttle fail to reach a box, the parts remain in their normal positions and the loom is stopped.

The points requiring most attention are: the length and position of the blades, and the size and shape of the swells. Some loom builders employ a single blade E, but two blades are preferable, as a slay is then less liable to twist. The blades should be long enough to avoid breaking the threads when a shuttle is in the warp as a slay advances to beat up. But if the blades are too long they will strike the frogs before a shuttle has time to lift them clear. They should be from $\frac{1}{8}''$ to $\frac{1}{4}''$ above the frogs when a shuttle is fully boxed. A rod D should be mounted upon the swords, and hold the blades E horizontal when in contact with the frogs, for then the rod centre sustains the shock, and there is no risk of it rotating. If a rod centre is above the frogs, its tendency to rotate will be proportionate to its elevation, and part of the energy of impact will be transferred to the arms C. If the springs upon the blades are too strong, increased force will be required to drive a shuttle, and, in addition to waste of motive power, both shuttles and swells will wear rapidly. Worn swells, narrow shuttles, and wide boxes cause a loom to stop when it should be active, and

worn blades, worn frogs, and weak springs allow a loom to run when it should be stationary. A fast reed motion throws considerable strain upon many parts of a loom, but the rigidity of the reed recommends it for the production of heavily wefted fabrics.

Loose Reed Motions

In 1834 Hornby and Kenworthy patented a loose reed motion, which was improved by Bullough in 1842, and by many later inventors. For light, fast-running looms it has remedied most of the defects of the fast reed motion; by its aid a starting handle is moved from its driving detent immediately a shuttle is trapped, but the loom cranks may make several subsequent revolutions without injuring the warp.

The parts of a loose reed motion are shown in Fig. 205, where the reed A has its upper rib pushed into a groove in the slay cap B, so that B may form a pivot for A to swing upon. C is a strip of wood, or a bar of iron, extending across the loom; it is supported by and pressed against the bottom rib of A by the action of a series of arms D, which are fixed upon a rod E, that resembles the stop rod of a fast reed loom. An additional arm, furnished with an adjusting screw, is also secured to the rod E. By pressing against the rear of a slay sword this screw regulates the pressure of C upon the reed A. A rod E has two curved levers F set-screwed upon it at equal distances from the swords. As a slay moves forward the ends of F are carried against the upper or lower faces of two wedge-shaped frogs G; these latter are held rigidly in brackets H, bolted to the framing. When in its driving position, a starting handle J holds a buffer K facing a dagger I upon the shaft E, but normally the point of I is below the corrugated surface of K. Outside the end framing an arm upon E carries at its extremity an antifriction roller L; as the slay falls back, L makes contact with a bow

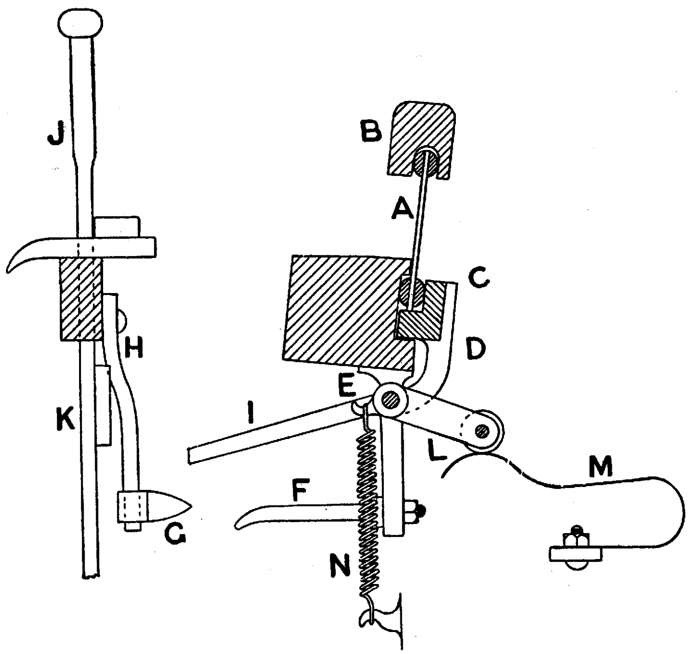


FIG. 205.

spring M, bolted to the framing. The function of the parts L, M is to steady the reed A as a shuttle moves across the warp. Two light spiral springs N are attached to hooks on the rod E and the slay swords respectively; they hold the reed steady when L, M are apart, but they permit A to yield to any unusual pressure.

Should a shuttle be trapped in the warp a reed must give way freely, but it must be rigid when weft is to be beaten up. To accomplish the latter the fingers F will, when the reed and fabric are in contact, have passed beneath the points of G $\frac{3}{8}''$ or $\frac{1}{2}''$, and the bar C should bear tightly upon the reed A, to ensure a smart blow upon the weft. When the driving cranks are on their top centres, only the force stored in the springs N is available to prevent the reed from falling back. At this time the space between F, G will vary with the throw of the cranks, but in calico looms it is about 2″, so that in case a shuttle is trapped, the warp resistance will be sufficient to stretch the springs N, force back the reed A, and cause the bar C to lift the levers F upon the upper slopes of the frogs G; the dagger I should then strike the buffer K. If K and I are not properly adjusted to each other, the reed-case C will liberate the reed A before contact is made between K and I. In that event, I will sink below K without pushing the handle J out of its driving notch, and the loom will continue in motion until the weft fork causes it to stop. In some looms a pendent catch holds I up and thus ensures its correct action.

While the dagger I pushes the starting handle from its detent, the levers F and the frogs G release the reed A, and the loom is stopped without violent concussion. Owing to the difficulties experienced in making a reed sufficiently firm to beat up, and sufficiently sensitive to prevent a trapped shuttle from damaging a warp, loose reed mechanism is ill adapted for the production of heavy fabrics. Attempts have, however, been made to combine in one device the advantages of a fast with those of a loose reed.

In 1879 T. Sager patented what he designated a "fast and loose reed motion." By this invention he aimed at locking the reed just before and while the weft was beaten up, and unlocking it at any desired point without the application of external pressure. It consisted in attaching a bracket to the end framing for the support of the lower end of a link, whose upper end was secured to a catch fulcrumed upon a slay sword. In place of the levers F, a pendent arm was keyed upon a stop rod E. As a slay advanced to the cloth fell the link lifted the catch into the path of the pendent, and both became locked when the reed was $\frac{1}{2}''$ away from the cloth fell. As a slay receded from the fell the link drew down the catch and loosened the reed. By an alternative plan, the catch was provided with a curved slot to receive a bowl, fixed upon a pin in the framing. As a slay moved the curved slot against the bowl, the catch rose and fell.

In 1889 Messrs. J. W. Shorrock and J. K. Hacking patented the application of a hooked bracket, which passed through a slot in the back board of a shuttle box, and was loosely mounted on a picker spindle. As a shuttle entered a box, it pushed back the bracket until the hook passed over a lever from the stop rod, and locked the reed. So soon as a shuttle left a box a spiral spring moved the sliding bracket forward and released the reed. In case a shuttle did not reach a box the stop rod lever was not acted upon and the reed was free to be pushed back. See also p. 435.

Swells in a loose reed motion prevent a shuttle from rebounding, and assist in guiding it while under the influence of a picker. If they are defective, the cops are liable to be knocked off, and the shuttles, pickers, and bands wear rapidly. Many loose reed swells are similar to those used with fast reeds, but a fulcrum pin has a

tendency to convert a swell into a wedge, and remove a portion of the swell from a fully boxed shuttle.

In 1890 Messrs. W. Harker and J. Grayson patented a double spring which controls the shuttle better than most swells, for it changes its position with relation to the shuttle, and when the latter is driven home, the entire length of the spring is effective.

Fig. 206 is a plan view of this swell: A, A is the back board of a box, B is a bolt and C a screw, which fix the spring D in position; at E the spring protrudes slightly

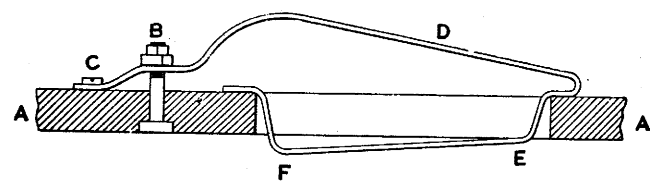


FIG. 206.

in front of A, but at F it is $\frac{5}{16}''$ beyond A. When a shuttle is received it engages the spring at E, and D gives way; but when it is more than half-way in a box, the spring gives way at F and acts in conjunction with D.

PART XIII

SHUTTLE-GUARDS

WITH every increase in the speed of a loom flying shuttles became a source of greater danger to work-people, and eventually guards were rendered imperative. From the year 1868, when Wrigley and Wright obtained the first patent, to the present time, inventions for shuttle-guards have been both numerous and varied. But a simple and reliable appliance for preventing shuttles from flying out without entailing additional labour upon the weaver is still a desideratum. In practice most of the available guards are found to be inefficient at some point. They may be weak in construction, imperfectly fitted, cumbrous, or complicated, or by casting shadows upon the warp and fabric may prevent a weaver from detecting faults. After being in use for a short time, the brackets often break or become loose and require frequent attention. A guard should be secured to a slay cap by bolts, and the moving parts should have broad, firm bearings.

Few guards will, under all circumstances, prevent a shuttle from flying out, but most of them prevent it from flying up; and as the latter evil is more to be feared than the former, even imperfect guards serve a useful purpose. If more of them were constructed to withstand the severe shocks occasioned by beating up, it is probable they would be welcomed by weavers instead of being merely tolerated.

Wing and Rigid Guards

Guards are of four classes—namely, wing, rigid, semi-automatic, and automatic. A wing guard does not prevent a shuttle from being ejected, but it generally prevents injury to work-people. It consists of a piece of wood, or of framed wire netting, which is rigidly held between two slay ends, and its function is to catch a flying shuttle. In breadth it corresponds to the distance between the breast

beam and the most backward position of a slay. For general work, guards of the second class have met with most favour. They may consist in bolting two or more metal brackets, each 4″ to 5″ long by 2″ broad, upon a slay cap. These brackets hold a fixed rod about $\frac{1}{2}$″ in diameter over the shuttle's course, slightly above the upper warp line, and from 2″ to $2\frac{1}{4}$″ in front of the reed. Other guards are made by bending an otherwise straight or a wavy rod at each extremity, to enable it to be bolted upon a slay cap and project in front of the reed. In 1896 J. Holt patented a guard which is typical of many stationary ones: it is made by screwing a number of light, malleable iron brackets, about $\frac{5}{8}$″ wide, upon a slay cap at from one-half to three-quarters the length of a shuttle apart. Each has its foot bent to be parallel with, and only slightly elevated above, the upper line of warp. Such a guard offers little obstruction to light or to manipulation of the warp. All fixed guards are simple, yet they cannot prevent a shuttle from flying out at the edges of a fabric, for at these places there is no guide of any kind. But an iron plate may be bolted on a slay front near the entrance to each shuttle box, and bent over to the cap. Such plates are spoon-shaped, to catch a flying shuttle, yet what a weaver gains by them in safety is lost in increased labour when changing shuttles.

Semi-automatic Guards

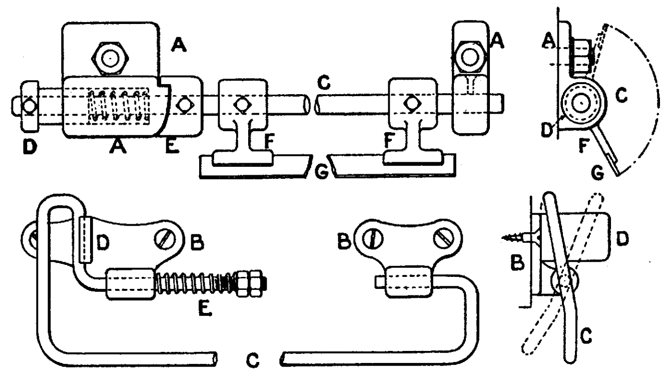
Semi-automatic guards are varied in structural detail; but they should automatically move into working position at the first beat of a slay. R. Hall and Sons bolt two brackets upon a slay cap to serve as bearings for a swivelling guard bar, made of $\frac{7}{16}$″ round iron. When this bar is in working position it is locked by forcing it over two conical pins situated in chambered recesses in the brackets, and against fixed stops. A spiral spring is placed in each recess, and the shank of a conical pin passes through the spring, also through a hole at the back of the chamber, where it is secured by a nut. Each pin will therefore slide back when sufficient pressure is brought to bear upon it. Before drawing warp into the reed, a guard bar is turned up manually to rest upon the slay cap. When so placed it does not interfere with the weaver's movements, but before restarting a loom the guard must be turned down again manually. The manipulation consists in moving the bar up and down; beyond this the contrivance is simple and firm.

Guards have been constructed from two flat bars that extend across the warp, and open and shut like a parallel ruler. When open the bars are rigidly locked, and one of them passes in close proximity to the temples. This introduces an element of risk to the weaver, as the blade and the temples act as shears.

In 1892 G. E. Hamblet and H. Clifton bolted two brackets A, Fig. 207, upon a slay cap to form bearings for a light shaft C. One bracket has a clutch face, and is chambered out to admit an open-wound helical spring. The shaft C passes through A, A, and upon one end a sleeved hoop D is fixed with a set-screw. The sleeve of D enters the chamber, and the spring impinges upon it, and also upon the bracket. A collar E with a clutch face is also fast upon C, both halves of the clutch are united by the spring to normally hold the guard over the shuttle race. The shaft C carries a set of arms F, for the support of a flat bar G. In case warp threads are to be drawn in, G is turned up by hand, and the inclined surfaces of

A and E compress the spring. When a loom is started the vibration produced by beating up is sufficient to cause C to slide longitudinally and place the guard in its active position.

In 1894 C. Marshall patented one of the most successful of these inventions. It is mounted upon a slay cap in brass brackets B, Fig. 208, and consists of a cylindrical rod C, which is bent at both ends, and cranked in the



FIGS. 207 and 208.

middle, where a third bearing is placed. The rod C has an open spiral spring E threaded upon it, and E draws C against a cam face D formed on one end bracket B. The pull of this spring is regulated by a screw and lock nuts; it should be such that vibration in the loom will not give an end-long motion to the guard, but after C is turned up will cause it to move automatically into working position with the first beat of a slay.

Many guards are so constructed that a spiral, or a flat spring will hold a guard against a slay cap when the former is inoperative, and also hold it steady when operative. Of these T. Yates patented, in 1892 and 1894, one of the best known; its rod is either bent to act as a stop, or a bracket is mounted on the rod to limit the outward throw of a guard. When a guard is half-way out the pull of the spring is in the plane of the guard rod, but when a rod is above or below that position the spring pulls it out of, and into, working position. The adjustment is such that a rod automatically assumes its active position when a loom starts.

Two or more rods of varying thickness have been loosely mounted in stepped brackets, so they could be pushed back by hand to the slay cap. When a loom was started the thinnest rod rolled to the front, the next in thickness was arrested by a decrease in the width of the slot, and if a third rod was used it was similarly stopped before the second was reached.

In 1894 C. H. Wilkinson patented a guard consisting of a plate fastened to a slay cap; on the plate two hinged brackets are so secured that they may be turned against a cap. The brackets are provided with curved slots of varying lengths to hold three rods, and permit one to slide farther from a slay cap than another. At regular intervals chains are made fast to the plate and to the rods. Alternating with the above-mentioned chains are a second series which depend from the plate and the front rod to form loops. Finally, a fourth and shorter rod is slung by chains between the slotted brackets. Should a shuttle rise from the race board, it will be caught in the pendent chains. The rods if pushed back will cause the hinged brackets to turn against the cap, but they will gravitate to their active positions on starting a loom.

Much attention has been bestowed upon the construction

of brackets to hold guards; unless they are considerably in advance of a slay cap, a rod, when pressed back, will fall against the reed face and render it difficult to draw in warp threads. The lubrication of guards is a difficult matter, for the brackets are placed where oil-drops are likely to fall upon a warp. On this account buffalo hide has been tried, as its lasting qualities are great, and it can be used for a long period without oil.

Automatic Guards

The fourth class of shuttle-guards is also a large and varied one. All devices of this kind must contain parts that automatically move out of the way when a loom is stopped, and are automatically restored to their working positions immediately a loom is started. Most of these guards are operated by the starting handle, and therefore they are out of action for two picks before a loom stops; and during this time shuttles are specially liable to be ejected.

When a starting handle is moved to put a loom in action it may vibrate a lever, from which wire connections, and an intermediate lever, convey the movement to a light shaft mounted behind a slay cap. Upon such a shaft two arms are then set-screwed to support two flat bars that pass between the slay swords and the ends of the reed. As the shaft oscillates, its arms and bars thrust one or two rods over the shuttle's course. So soon as a driving handle is moved to stop a loom the rods are drawn back against the upper part of the reed face, in which position they offer little obstruction when warp is being repaired.

An automatic guard-bar has been placed under a cap, and moved in and out by a cam, by levers, and links. It moved out each time a shuttle passed across, and in when a shuttle was boxed. Electro-magnets have also been applied to a shuttle, and armatures to a race, to cause a shuttle to press against both reed and race as it moved across, but without success.

PART XIV

MULTIPLE BOX MOTIONS

NUMEROUS attempts were made to weave by power fabrics that require more than one shuttle, but many years elapsed before success was achieved. In 1792 Dr. Cartwright divided a flat tray into compartments, each large enough to hold a shuttle, and he contrived, by pushing and pulling the tray automatically, to move the proper shuttle in line with a picker. Another inventor placed a series of shuttles inside the segment of a circle, and pivoted the segment above the shuttle race, so that by swinging it to and fro any shuttle could be carried into a working position. A third fixed the shuttle boxes outside the segment of a circle, and fulcrumed it below the race board; but these and other plans were unsuccessful. At the present time shuttles are moved on the "rise and fall" and "revolving" principles. The former was invented and applied to hand-looms by Robert Kay in 1760; but Squire Diggle, in 1845, was the first who successfully applied it to power-looms. Revolving boxes were invented by Luke Smith in 1843. Both principles

are now found in considerable variety of detail, but of the two, rising and falling boxes are most varied.

Multiple boxes may be applied to one end or to both ends of a slay. In the former case alternate picking is imperative, in the latter either alternate or pick-at-will devices are available. A multiple box is longer by from $5\frac{1}{2}''$ to $9''$ than a single box, hence additional floor space must be provided in a weaving shed for such looms.

A box motion should be positive in action, and so connected with other parts of the loom that it will be impossible for the boxes to get out of harmony with the shedding and picking devices whether a loom be moved forward or backward. Provision should be made for stopping either a loom or a box motion, in case a picker or shuttle fouls the boxes, also if the boxes are not moved into their proper positions; failing this, a positive movement will cause smashes. Any shuttle should be capable of being brought into action at any time; and if the movement imparted to the boxes is not a smooth one, vibration will necessitate a reduced speed in a loom. It is undesirable that shuttles should be driven from their boxes when a loom is turned backward, for a weaver must replace them before restarting. Trouble is caused by a loom continuing to run for two or more picks after one weft has broken, for if a breakage occurs immediately before the boxes change positions, two or more picks of another weft will be driven through the warp. These must be removed and the boxes restored to their proper places. If from this data box mechanisms are examined, many will be found wanting in one or another particular.

Negative Drop Boxes—Diggle's Chain

In 1845 Squire Diggle patented an efficient and simple box motion that at once became a favourite, and held its place for many years. For most purposes it has been displaced by more modern appliances; but it is still used on comparatively slow-running looms, where only two shuttles are required. The details have been modified for special work, yet, as generally applied, it remains essentially as Diggle left it.

Motion is derived from a pinion wheel A, Figs. 209 and 210, which is keyed upon the crank shaft, and drives a slide wheel B, containing four times as many teeth as A. Upon the inner side of B a flange or slide C is cast, concentric with its periphery, but C is broken on opposite sides of the centre, and in the middle of each break a stud D is fitted. The slide holds an eight-sided star wheel E stationary, until, on alternate picks, the studs give it motion, by engaging the notches and carrying it through $\frac{1}{8}$ of a revolution. E is supported on a stud in the end framing, and is compounded with an octagonal chain barrel F, round which an endless chain G is passed. G is composed of links of varying thickness; the thinnest brings the top shuttle in line with the picker, and thicker ones are placed to bring the remaining shuttles into picking position at the proper time. In length a link equals one-eighth of the circumference of the barrel F; a chain is formed by passing studs H through holes in pairs of links, and securing them by split pins. The studs are made longer than the links, so that their ends may enter notches in the barrel F. By this means the chain is moved when motion is given to F.

A bowl I revolves on a stud in the lever J, and rests upon the centre of a link in the chain F. The lever

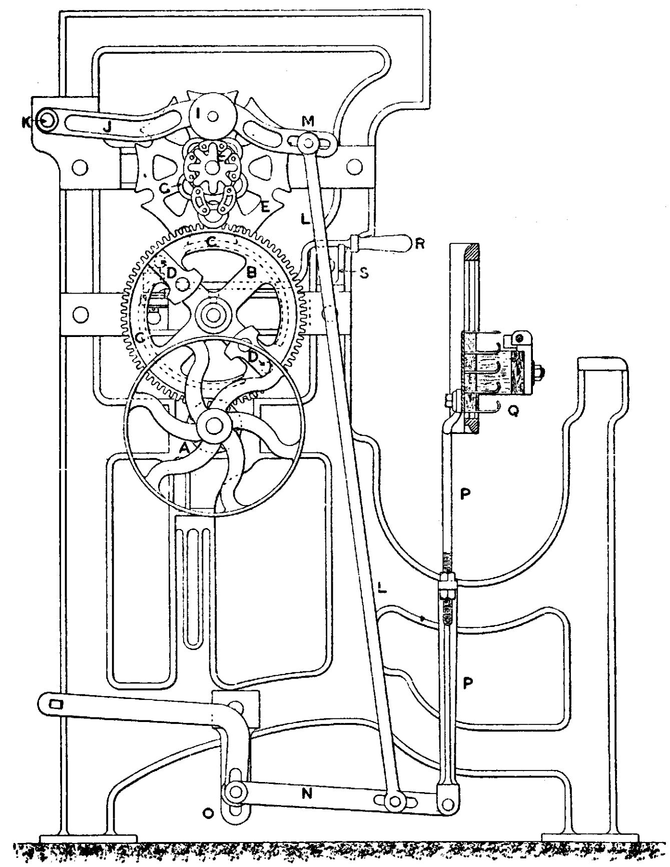


Fig. 209.

J is centred at K; it has a rod L jointed to it at M, whose lower end is attached to a lever N, and N is fulcrumed at O. Finally a spear rod P connects N with the shuttle boxes Q. When the boxes are lifted half-way, the centre of the pin that connects N, P should coincide with the centre of the rocking shaft. A thick link lifts the bowl I, a thin one allows it to fall, and an up and down motion is thus imparted to the shuttle boxes.

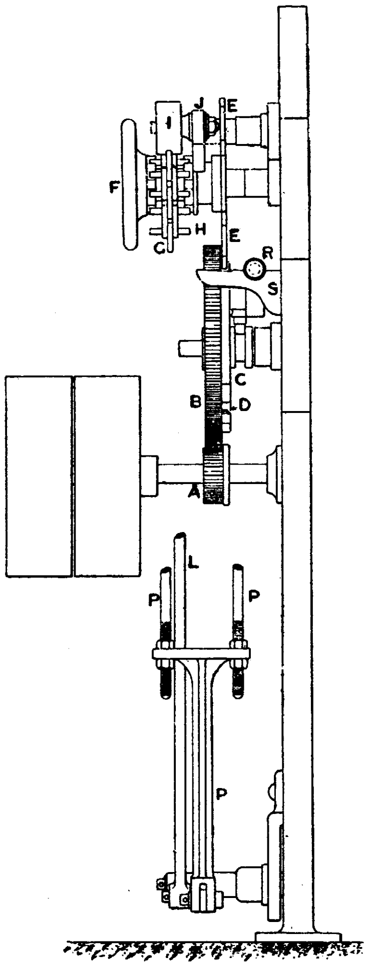


FIG. 210.

If for any purpose it is necessary to move the boxes manually, the slide B must be put out of gear with the star E. This is done by mounting a lever R upon a pin fixed to the framework and causing a stud in R to take into a ring groove in the boss of the wheel B. When R is moved a notched bracket S holds it in position. In 1881 W. Walker connected the slide wheel B to the weft fork for the purpose of disconnecting B, E automatically whenever a weft failed. On restarting a loom, B was automatically restored to its normal position.

Theoretically any shuttle can be instantly moved in line with the race board, but in practice not more than one box is skipped in either direction, for the boxes fall negatively, and if they fall a considerable distance they rebound. This is a fatal defect in high-speed looms. The chain is also ill adapted for long patterns; it is heavy, costly, and if long, it becomes almost unmanageable.

SMITH'S LINK ECONOMISER FOR DIGGLE'S CHAIN

In 1858 Mark Smith introduced an important modification of Diggle's chain. By its aid long patterns may be woven with a short box chain, but other defects in the original motion remain unchanged. Smith's additions permit a link to remain stationary until a change in the boxes becomes necessary. A block A, Figs. 211, 212, is fitted loosely on a stud that carries the slide wheel N, and A is rotated by means of two projections that pass from A through N and into grooves in the boss of N. The projections terminate in pins L, for driving a star wheel M. A to-and-fro movement is given to A in order to draw the pins L out of reach of M when no movement in the shuttle boxes is required. The chain barrel O may thus be moved at short or long intervals. The time for movement is determined by a forked lever B, which takes into a ring groove in the boss of A. The lever B is set-screwed upon a light shaft; near its centre B holds a bowl C against a cam D, formed on one side of the slide wheel. The full parts of D thrust C outward and cause the prongs of B to draw out the block A. But the cam D also lifts a lever E, hinged upon a stud, and connected to the shaft of B by a crank and arm F. Upon the forward end of E a feeler G is held over an octagonal card barrel H. The cam D lifts the feeler G out of the way when the barrel H is partially to rotate. A second star wheel I is secured on the shaft of H to engage with a second slide wheel J that forms part of the boss of N.

The star wheel I moves the card barrel H every pick for

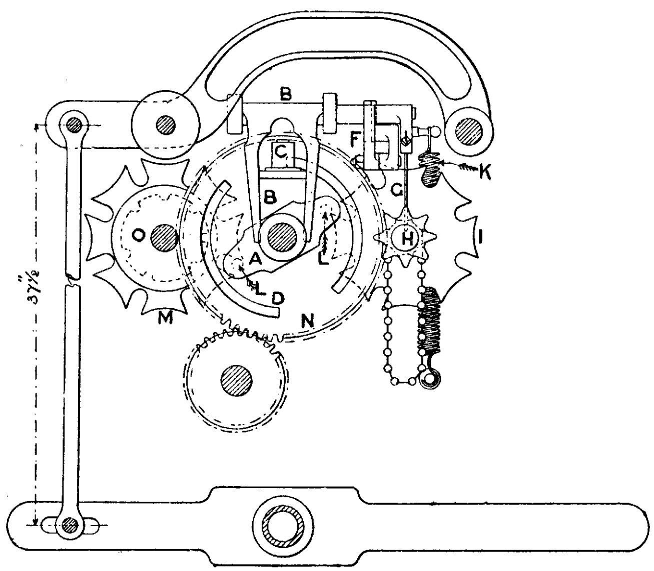


FIG. 211.

pick-at-will looms, but on alternate picks for looms with multiple boxes at one side only. By this means thin steel cards are successively placed under the feeler G. A blank card holds G, F up, and draws the driving pins L away from the star wheel M, but a hole permits G, F to fall; the pins L then engage the star wheel M, and change the boxes. A spring K is attached to a pin in E, and also to

a similar pin in the framing, to hold G in contact with a card on H when the cam D is not acting upon it.

Where dobby or Jacquard shedding is used the barrel H, the star wheel I, and the chain of thin links are discarded, and all shuttle changes are controlled from the shedding motion. This plan not only saves time when a loom is gaited, but it reduces the number of parts that require adjustment after unweaving. In place of the discarded parts a light lever is mounted upon a vertical pin, and

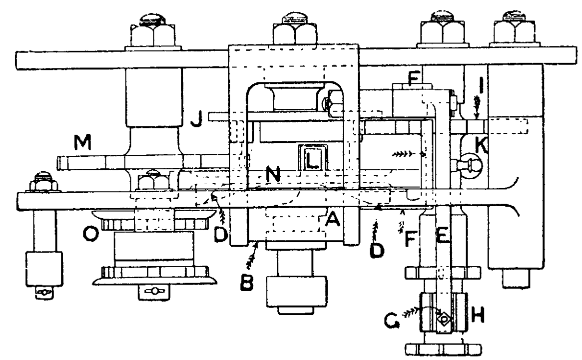


FIG. 212.

one end of this lever passes beneath the feeler G to serve as a blank card. By moving the lever the feeler is free to fall, and that equals a hole in a card. A cord attached to the shedding motion withdraws the lever from G and a spiral spring restores the lever to its original position so soon as the cam D lifts the point of the feeler high enough.

KNOWLES' CHAIN

The Knowles, Whitesmith, Cowburn and Peck, and several other four-shuttle motions, have two lifting agents which are arranged in the proportion of 1 to 2; they work either as one or both additional, or as cancelling each other. In a device patented by L. J. Knowles in 1874 the shedding, picking, taking-up, and shuttle-box mechanisms are all connected and worked by

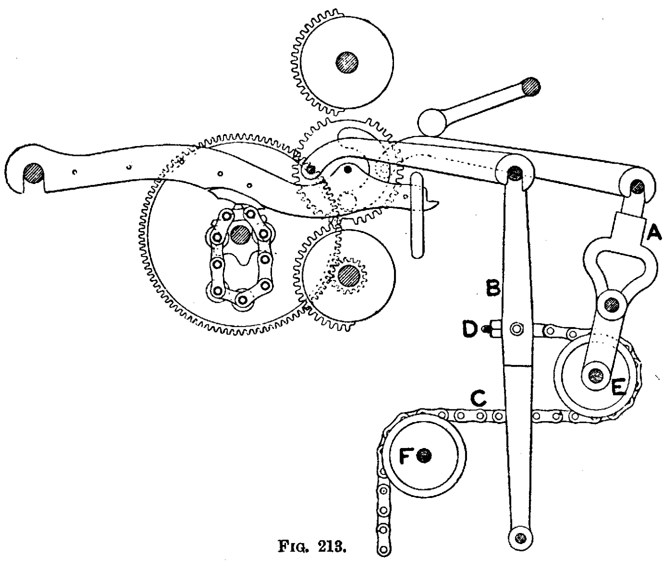


FIG. 213.

similar parts from one centre. For a description of the shedding motion see pp. 122 to 129.

In order to move four boxes, two vibrator levers, two gears, and two connectors are used. The connectors operate two levers A, B, Fig. 213: A being of the first order, and B of the second. A chain C is fixed to B at a point D; it passes round a flanged pulley E, which is suspended from A, thence over and under two or more guide pulleys F to the shuttle boxes.

By altering the relative positions of D, E, any one of four shuttles may be placed in line with a picker. In Fig. 214 the gears A′, B′ are shown in all possible positions. The top box is level when both crank pins are on the

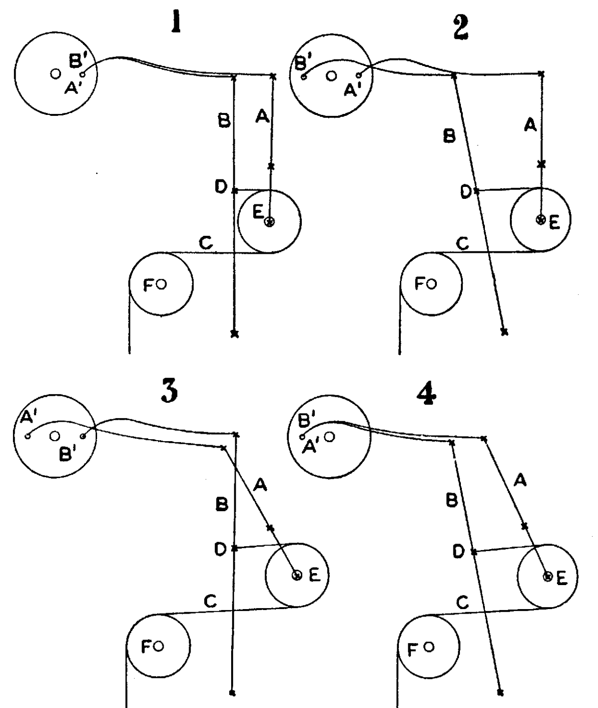


FIG. 214.

right of the centres of wheels A′, B′, as shown in division 1, for then D, E are as close to each other as it is possible to place them. By moving the pin of B′ to the left of its centre, number two box will be level, as in division 2, because the lever B has a lift of one box, ∴ box

$1+1=$ box 2. By turning the pin of B′ to the right, and that of A′ to the left, as in division 3, number three box will be at the race board, because A has a lift of two boxes, ∴ box $1+2=$ box 3, also box $2+2-1=$ box 3. When both crank pins are on the left of their centres, as in division 4, number four box is in line with the picker, for $A=2$ and $B=1$, ∴ box $1+2+1=$ box 4, also box $3+1=$ box 4. Six shuttles may be manipulated in a similar manner, by employing three sets of parts instead of two.

In this motion the boxes are not taken down positively, but vibration is effectively prevented by paying out the chain C slowly at the beginning and end of a change, and quickly at the centre, as is the case with movement when derived from any crank that turns from one dead centre to another. The cylinders L, M, Fig. 74, have each two sets of teeth, one for operating the shedding, the other for operating shuttle boxes and picking, the latter segments being adjustable to permit the boxes and picking to be timed differently from the shedding.

Positive Drop Boxes—Wright Shaw's

In 1857 R. Roberts and W. and S. Shaw obtained a patent for a positive box motion, and in 1889 Wright Shaw procured his last patent for the same device. Its parts are shown in Figs. 215 to 220. A cam A, with a throw equal to the lift of one box, is fixed upon the tappet shaft, and a sliding cam B, with a throw of two boxes, is connected to A, and rotated by a stud. An open coiled spiral spring is loosely threaded upon the shaft normally to hold B away from A. Either A or B constantly acts on a flanged bowl D, mounted upon a lever E; the latter is centred at F, and from its forward end a double rack G is

suspended. G, D, E, therefore, rise and fall once in two picks, and a flat spring 18′ steadies the movement when B engages D. The rack G spans a pinion H, and H is com-

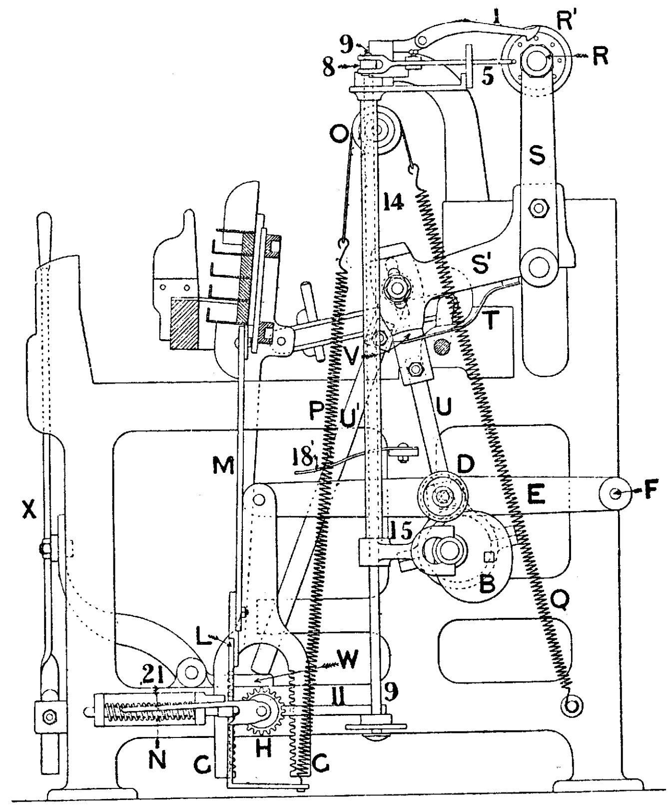


Fig. 215.

pounded with another pinion and also a disc, all of which fit loosely upon a stud. The disc is furnished with six notches, and into the upper one a spring pin fits to hold the boxes steady. The second pinion gears into a rack L where the pitch line coincides with the axis of the rocking shaft. L forms part of the spear rod M, and both rack and pinion are kept in contact by a spring N, which is strong enough for normal conditions; but, in case of defective picking, it prevents smashes by contracting, and thus permitting the rack to disengage itself from the pinion. The shuttle boxes may be adjusted manually by lifting a handle 21, for this thrusts back the spring N and takes the rack L out of gear with its pinion. Two helical springs P, Q are used to balance the boxes; both are

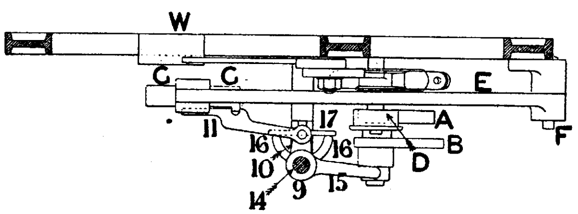


Fig. 216.

hooked into a strap that passes round a flanged pulley O, but P is connected to a bracket on the foot of rack L, while Q is made fast upon a fixed stud in the framework. When the top shuttle faces the picker both springs are stretched, and the force stored in them assists the boxes to rise.

An eight-sided card barrel R is supported on a cranked lever S, and a conditional vibrating motion is given to it by an eccentric upon the tappet shaft. The eccentric strap-rod has bolted upon it a slotted piece U, containing a lug V for the lever S to rest upon. A flat spring T is bolted to the under side of the arm S′ and goes beneath V to unite S and U. As the eccentric pushes up U, the barrel R is forced out positively; but its inward traverse

depends upon the pull of the spring T against the lug V. Hence T must exert sufficient force to carry R forward until some unusual obstruction presents itself, when the resistance of T is overcome, and U continues to descend without moving the card barrel.

A stud on the arm S′ passes freely through a slot in U to support a flat bar U′, that terminates at the loom rail. The office of U′ is to prevent the barrel R from rotating after the weft-fork lever has acted to stop a loom. This is accomplished in the following manner: An arm W rests upon the loom framing; it is set-screwed to a sliding rod that traverses a loom, in front of the rocking shaft. At the opposite extremity to W, this rod is connected to a pattern handle X, and X is placed alongside the starting handle. When the starting handle is moved into its driving notch, a bracket upon it carries X simultaneously into a detent; but the starting handle can be removed from its notch without influencing X. This permits a weaver to turn a loom by hand. As the weft-fork lever acts, an arm thrusts X from its notch, and W is placed beneath the bar U′, to arrest the barrel R in its forward movement, before a pawl 1 can engage a stud in the lantern R′ of the barrel R, and thus prevents it from rotating.

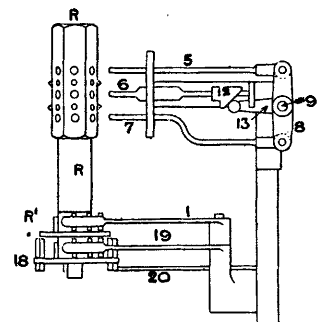


Fig. 217.

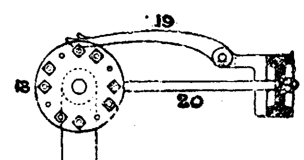


Fig. 218.

In Fig. 219 five steel cards of a pattern chain are shown.

On examination it will be found that there are only three distinct cards, for if the left end of C is laid over against the right end of D, both will correspond. Also, F and E are similar when one is turned over. Therefore, B, C, and F are the only cards necessary. They are fastened

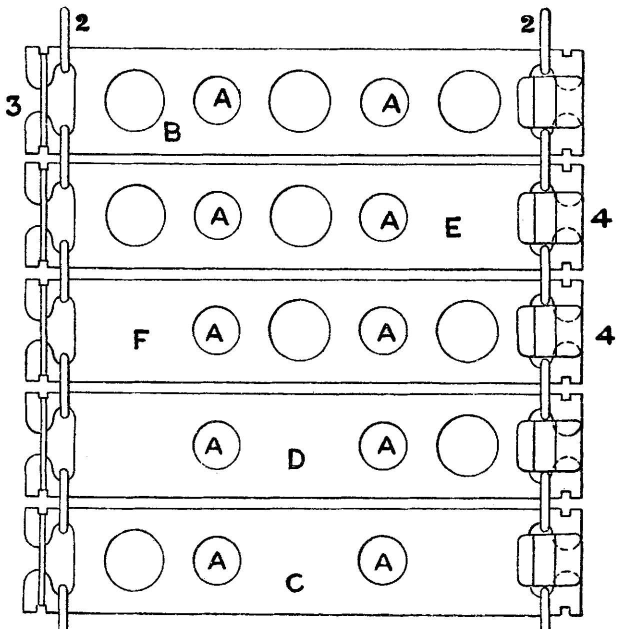


FIG. 219.

together to form a chain by placing rings 2 in suitable grooves, and holding them in position by rubber bands 3, or, better still, by the small steel clips 4, shown detached in Fig. 220. Oval rings may be used without end clips of any description. This chain is passed round the barrel R, Figs. 215 and 217, and the rotary movement

of R presents each card in succession to three needles 5, 6, 7. Needles 5 and 7 are jointed to a swivel piece 8, which is fast upon the top of an upright shaft 9. At the foot of 9 an arm 10 is hinged to a groove piece 11. The groove of the latter receives a projecting lip from the inner arm of the double rack G; therefore, if either needle 5 or 7 be pushed back, 8 and 9 swivel, and cause 10, 11 to either pull or push one of the racks G into gear with the pinion H. At the next upward movement of G one shuttle box will be taken up or down.

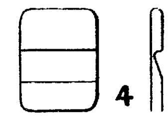


FIG. 220.

The needle 6 has a piece 12 fixed to it, and when pushed back, the inclined surface of 12 causes 14 to vibrate by acting upon an arm 13, attached to the top of a tube 14, through which the shaft 9 passes. A forked arm 15, on the base of the tube 14, takes into a ring groove in the boss of the sliding cam B, and as 15 vibrates B is pushed under the bowl D, thus imparting additional movement to the lever E, the rack G, and the shuttle boxes, presuming that either 5 or 7 is pushed back with 6. After needle 5 or 7 has been pushed back by a card, it must assume the position shown at Fig. 215. This is accomplished by causing a spiral spring to force a T-shaped hammer 17 against two curved pieces 16 on the foot of shaft 9. A similar effect is produced on needle 6 by the spring that holds the cam B out of contact with the bowl D, for this spring thrusts out the forked arm 15, and presses 13 upon the inclined surface of 12.

Two metal pegs, fitted in every face of the barrel R, pass through the small holes A of the pattern chain, Fig. 219, and hold its large holes exactly opposite the needles. When standing in a working alley facing the cards, the outside needle will enter holes on the right, and the inside needle those on the left. A card B with three large holes effects no change. A card E with two large holes lifts one box, and F sinks one. A card C with a single large hole produces an upward movement of two boxes, and D sinks two boxes. Hence to drop a box, the inside needle is pushed back; to lift one, the outside needle is pushed back; if the middle and inside needles are moved, two boxes will drop; and the middle and outside needles will lift two boxes.

In order to economise a pattern chain, a disc 18, Figs. 217 and 218, is mounted loosely upon the axle of the barrel R. This disc has on one face twelve pegs; as the barrel moves out, one peg is caught by a pawl 19, and one-twelfth of a revolution is made. On the opposite side of 18 a series of twelve holes are tapped to receive adjustable screw pins which, as the barrel moves in, impinge against a fixed stop 20. Whenever this occurs, the lantern R′ does not advance far enough for the pawl 1 to act, consequently the barrel R does not turn, and the same card will be again presented.

If all holes in the disc 18 are empty			each card	=	2	picks.
If alternate holes are filled with screws			,,	=	4	,,
If two holes are filled and one missed			,,	=	6	,,
If three	,,	,,	,,	=	8	,,
If five	,,	,,	,,	=	12	,,
If eleven	,,	,,	,,	=	24	,,

Shaw's mechanism may be summarised as follows: It is positive in action, and the pattern chain is stopped when a weft breaks. If the picker is not clear of the boxes, or if a shuttle is imperfectly boxed at the time a change is to be made, the spear rod disconnects itself from the driving pinion to prevent smashes. Only one box of the series can be skipped at any movement, and the card-saving appliance

is useless where two picks of one colour are required, also where the picks of any colour are not 4, 6, 8, 12, 24, or multiples of those numbers.

The Eccentric Motion

Between the years 1857 and 1870 Isaac Whitesmith introduced and developed a theoretically correct arrangement for working drop boxes positively. He compounded two or more eccentrics by placing one inside another, and moved them independently or conjointly. If two were employed, the smaller had a lift of one box, and the larger, a lift of two boxes. By suitably manipulating them, any one of four shuttles could be instantly and steadily moved to face a picker.

The value of eccentrics for this purpose is admitted by all, but the mechanisms for controlling them vary greatly. One of the best-known plans was originally patented by W. H. Hacking in 1877, but it was modified in 1889. As illustrated in Figs. 221 to 223, it controls four boxes. The parts are driven from the crank shaft by a pinion A of 18 teeth, which gears with a stud wheel B of 36 teeth. At one place in the periphery of B there are three extended teeth, and on one side a bead forms a cam, while from the centre a sleeve projects for the purpose of receiving a stud, and of carrying two slotted hoops F. A card cylinder G swings on a fixed pin and is furnished with a bowl H, that rests against the cam on B. In rotating this cam pushes the cylinder from the points of two horizontal needles, and at the same instant the three broad teeth on B take into a wheel I, of 20 teeth on the shaft of the card barrel G, and move G one-fourth of a revolution. By so doing, a series of metal cards are positively moved to face the needles, but a spiral spring J draws them into contact.

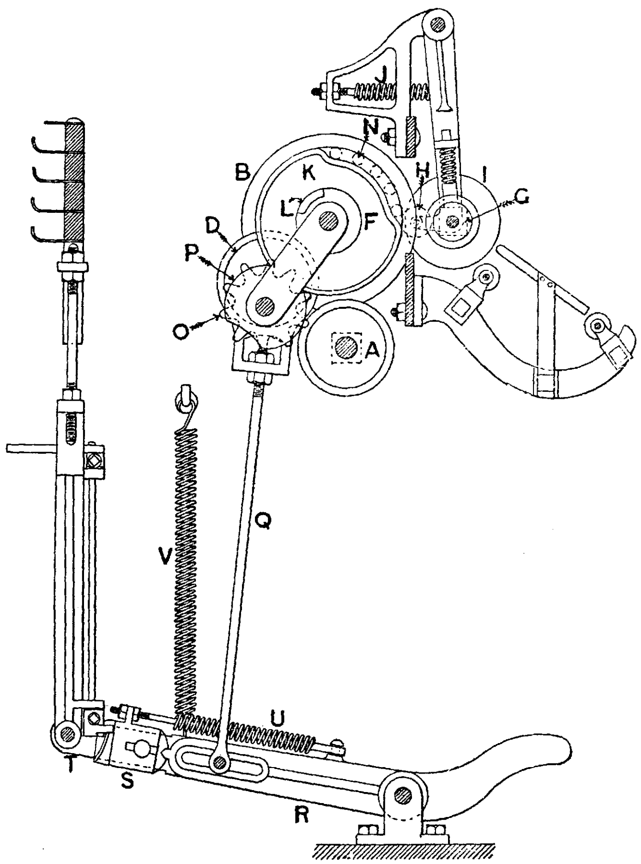


Fig. 221.

Two peg wheels K face each other and slide freely upon the sleeve of B. They are uniformly rotated by

projections L, which fit loosely in the slots of the hoops F. When the needles are inoperative both wheels are kept apart by the pressure of a spiral spring E, threaded upon the sleeve. The peg wheels can, however, be moved towards each other by the needles and two grooved cams combined; the latter are formed in the bosses M of the peg wheels K, and the former are pushed into the grooves by blank cards. Five pegs N are cast on the inside of each peg wheel to serve as teeth, and when both wheels approach each other, the pegs N drive two star wheels O. Both will be moved if a blank card is opposite each needle, but a blank opposite one needle will produce a change on that side only.

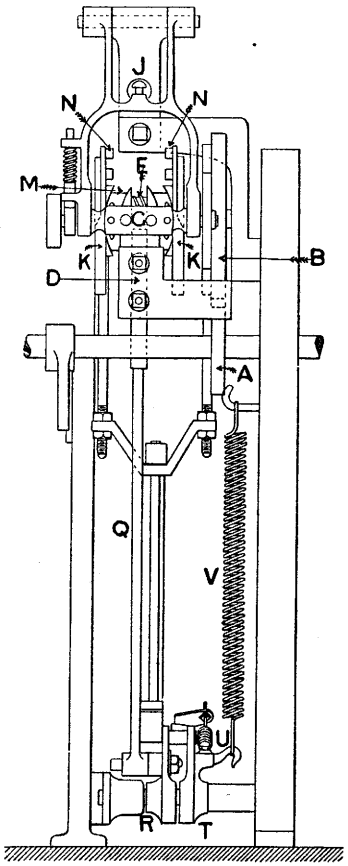


Fig. 222.

Each star wheel O has 10 teeth, and is compounded with an eccentric D, and a locking plate P. The small eccentric is loose on a spindle, the large one encloses it, and is in its turn enclosed by a ring. On the small eccentric O and P extend outward, on the large eccentric they face the loom. A locking plate is a disc with two pieces cut from opposite edges to coincide with the full surface of a peg wheel K, hence before a change can be made a depression in the surface of K must be presented to that of the plate P. When a peg wheel engages a star wheel, its eccentric is moved from one dead centre to another; this gives a slow movement to the boxes at the beginning and end, but a quick one in the middle of each change.

A rod Q on the eccentric ring is jointed to a short lever R, having a wedge-shaped terminal fastened by a slip catch S to a longer and parallel lever T, upon which the spear rod is mounted. The slip catch is notched and free to slide upon a pin in T, but is pulled by a spring U over the wedge of R. Hence when the picking and box motions are working properly both levers move as one; in case either a picker or a shuttle is jammed in a box, U stretches, the connection between R and T is severed, and the eccentrics move without the boxes. If the pull of U is excessive, too much force will be needed to detach the boxes; if insufficient they will be liberated when they should be united, or they will not be moved flush with the race board. To enable the mechanism to work as light as possible, a spring V is hooked into the spear rod lever and upon the framing, to serve as a balance.

Fig. 223 shows the eccentrics in all possible relations to each other. The small one gives a movement of one box, the large one gives a movement of two boxes. When the top box is level with the race board, the small sides of A and B are at the top. To place the second box level, the large side of A and the small side of B must be uppermost. The third box requires the large side of B and

the small side of A to be up. The fourth box is level when both large sides are up. Or if the top box is level with the race board, by pressing back the outside needle, number two box will rise to the picking position, $\because$ box $1+\text{A}=$ box 2, or $1+1=2$. From that point number three box will be brought into range of action by operating both needles, $\because$ box $2+\text{B}-\text{A}=$ box 3, or $2+2-1=3$. From box three, box four can be reached by moving the outside needle, $\because$ box $3+\text{A}=$ box 4, or $3+1=4$. In moving from box four to box three, the outside needle must be again operated; because the eccentrics always move in the same direction, hence, if the first half of a revolution lifts a box, the second half will sink one. To place box two in position both needles must be thrust back. Box one can then be reached by moving the outside needle.

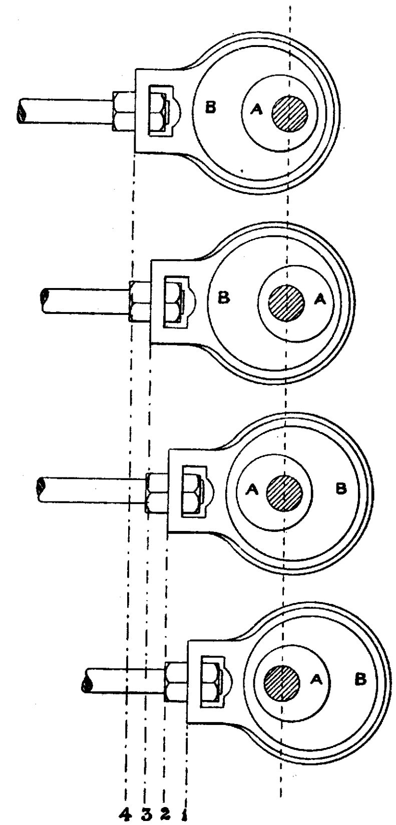


FIG. 223.

Owing to the eccentrics moving in one direction only, similar cards at different parts of a chain produce dissimilar results. For instance, a blank in a card when opposite the small eccentric needle may produce the following results :—

A change	from	box	1	to	box	2
,,	,,	,,	2	,,		1
,,	,,	,,	3	,,		4
,,	,,	,,	4	,,		3

If a blank faces the large eccentric needle, any of the following changes are possible :

Box	1	to box	3
,,	3	,,	1
,,	2	,,	4
,,	4	,,	2

If a blank faces both needles, the changes may be from

Box	1	to box	4
,,	4	,,	1
,,	2	,,	3
,,	3	,,	2

If a hole faces each needle the boxes will not change. This makes a chain of cards difficult to read without first observing the initial positions of the eccentrics.

To reduce and increase the lift of the boxes the rod Q is respectively moved away from and nearer to the fulcrum of R. The first peg of a wheel K should engage with a star wheel O, when the cranks are on their top centres, and the first lengthened tooth of the stud wheel B should gear with the cylinder wheel I, when the cranks are similarly placed for the following pick.

Changes in the foregoing mechanism have been made from time to time. One consists in retaining only those cards that have perforations facing both needles. Clips are then pushed over the cards to stop up the requisite holes, and thus provide for changes in the boxes. Another modification aims at reducing strain upon the needles by causing each to move a pegged segment instead of the entire peg wheel. A third change offers facilities for adjusting the boxes from the front of a loom. This is effected by lifting a light cranked lever.

The most important change was made in 1891 by W. H. Hacking, who applied parts by which similar cards always produce similar results. In working out this scheme the inventor displayed more ingenuity than was needed to produce the original motion. The additions and alterations are shown in plan and elevation in Fig. 224. Two cranked levers A are mounted upon a pin above the peg wheels K. Each horizontal arm terminates in a disc weight B, and the back of each vertical arm is furnished with a stud C that faces a cam groove in one of the bosses M. These studs take the places of needles in the previous plan. Two T-shaped pieces D are separately hinged upon the vertical arms of A, and are further supported by two spiral springs E, that impinge upon the under surfaces of D and upon a second pair of cranked levers F; two bolts, in addition to forming yielding connections, hold the springs in position. A stud L is cast upon the outside of each locking plate P, and as the plates move from one dead centre to another they vibrate the levers F. In doing this the spiral springs tilt up the heads of the T-pieces D.

The pieces D are acted upon by four needles G. A needle consists of a cylindrical pin secured at the centre of a vertical plate H. In the rear of each plate are two pins I, upon which spiral springs are threaded. The needles are supported by passing the ends of I, I through holes in a drilled plate. In addition to the pins there are two pro-

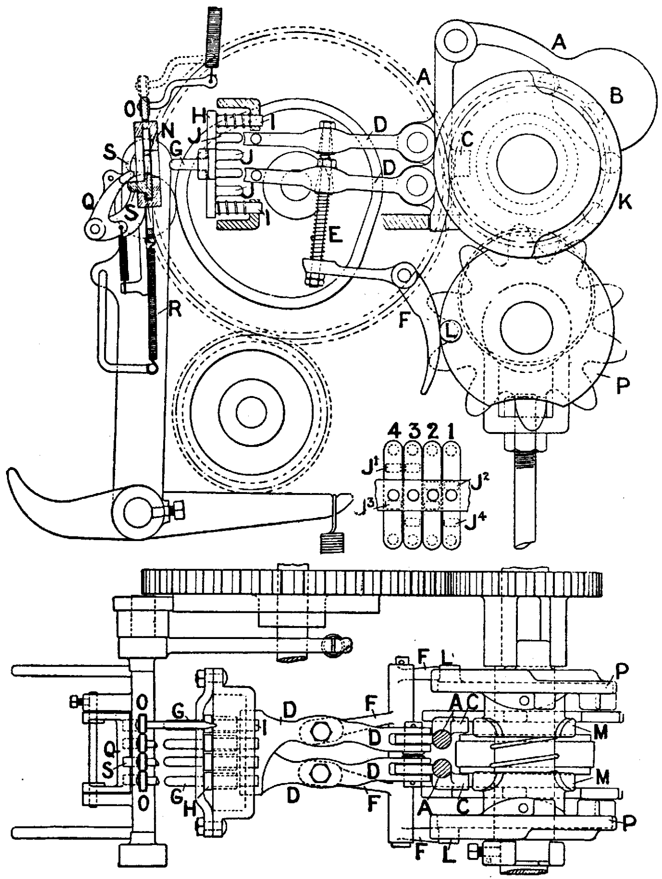


FIG. 224.

jections J at the back of each plate H, but their positions differ on every plate. Collectively they form four lines,

so that if a stud L, in the locking plate for the large eccentric, lifts the upper T-piece and a needle be pressed back, a projection J in the top line will force back that T-piece, and cause a stud C to put the large eccentric in motion. After a locking plate has made half a revolution its stud L is removed from a lever F, and the upper T-piece falls to the second line of projections, where it may again be pressed back to operate the large eccentric. The lower T-piece, if lifted by a stud L in the small eccentric locking plate, will be pressed back by a projection J in the third line; if left down it will be operated by a projection in the bottom line. Each time the lower T-piece is pressed back the small eccentric will move. The positions of the studs L upon the locking plates, therefore, control the height of the T-pieces, and the projections J upon the needle plates, together with a backward movement of the needles, cause the boxes to rise and fall.

When the top box is level, the full sides of both eccentrics are at the top, because the rod Q, Fig. 221, is behind instead of before the fulcrum pin of R; both studs L, Fig. 224, in the locking plates are at the front, and both T-pieces are lifted. Counting from top to bottom:—

Number one needle has projections J in the second and fourth lines.

Number two needle has projections J in the second and third lines.

Number three needle has projections J in the first and fourth lines.

Number four needle has projections J in the first and third lines.

Each needle, if pressed back, will always bring a box of corresponding number to face the picker.

The accompanying table shows the position of every part for every movement of the boxes.

Boxes.	Large eccentric.	Top T-piece.	Stud in large eccentric plate.	Small eccentric.	Bottom T-piece.	Stud in small eccentric plate.	Needle.
Top box level	up	up	front	up	up	front	
Change from							
1 to 2	up	up	front	down	down	back	No. 2
2 to 3	down	down	back	up	up	front	No. 3
3 to 4	,,	,,	,,	down	down	back	No. 4
4 to 3	,,	,,	,,	up	up	front	No. 3
3 to 2	up	up	front	down	down	back	No. 2
2 to 1	,,	,,	,,	up	up	front	No. 1
1 to 3	down	down	back	,,	,,	,,	No. 3
3 to 1	up	up	front	,,	,,	,,	No. 1
2 to 4	down	down	back	down	down	back	No. 4
4 to 2	up	up	front	,,	,,	,,	No. 2
1 to 4	down	down	back	,,	,,	,,	No. 4
4 to 1	up	up	front	up	up	front	No. 1

Instead of moving the needles G by cards they may be worked from a dobby or a Jacquard, in which event the card barrel and its driving wheel are removed. In their stead a flat plate N is mounted in a cradle, and rocked in the usual manner by a bead on the stud wheel. The plate N is slotted vertically in four places. In each slot a sliding shutter O is fitted to face a needle, and when O is in its lowest position a hole is presented to a needle; this equals no change. When a shutter is lifted a blank faces a needle, and produces a change in the boxes. Only one shutter can be lifted at any time, for by lifting one any other that happens to be up will automatically sink. This is effected by a lever Q whose edge is placed parallel with the shutters. Each shutter is held down by a spiral

spring R, and each is furnished with a lip S. In rising, the curved side of S thrusts out Q, liberates a lifted shutter, and the spring R draws it down. Once a lip is lifted to its proper position a spring draws Q beneath that lip, and the shutter remains suspended until the following change is made. It is the office of the dobby or the Jacquard to lift these shutters when required.

Hodgson's Box Motion

In 1893 F. Leeming and G. Hodgson introduced a multiple shuttle box motion which resembles Whitesmith's in so far that two pieces of mechanism act in the proportions of one to two, and may be employed separately or conjointly to move any box of a set of four into line with a picker. In Fig. 225 the parts are shown in plan and elevation; A is a spur wheel upon the crank shaft; B a carrier; C a wheel mounted loosely upon a stud D and containing the same number of teeth as A. The wheel C drives a boss W, in which two sliding segments E, F are fitted. A fork G, fixed upon a shaft H, enters a ring groove in E. A similar groove in F receives a fork I, attached to a shaft J. If a lever K, on the shaft H, be lifted through the medium of a dobby or a Jacquard, the fork G will move the teeth of E to face those of a star wheel M, and M is compounded with a disc crank N, whose throw gives a lift of one box, namely, the throw equals half a box and the leverage of S gives the other half. By lifting the lever L, on the shaft J, the teeth of F will face those of a star wheel O, also compounded with a disc crank P, but the throw of P gives a movement of two boxes. Both M, N and O, P rotate upon studs X bolted to the framing. A connecting rod Q is attached to the crank pin of N, and at R to the spear rod lever S. Another connecting rod U, mounted on

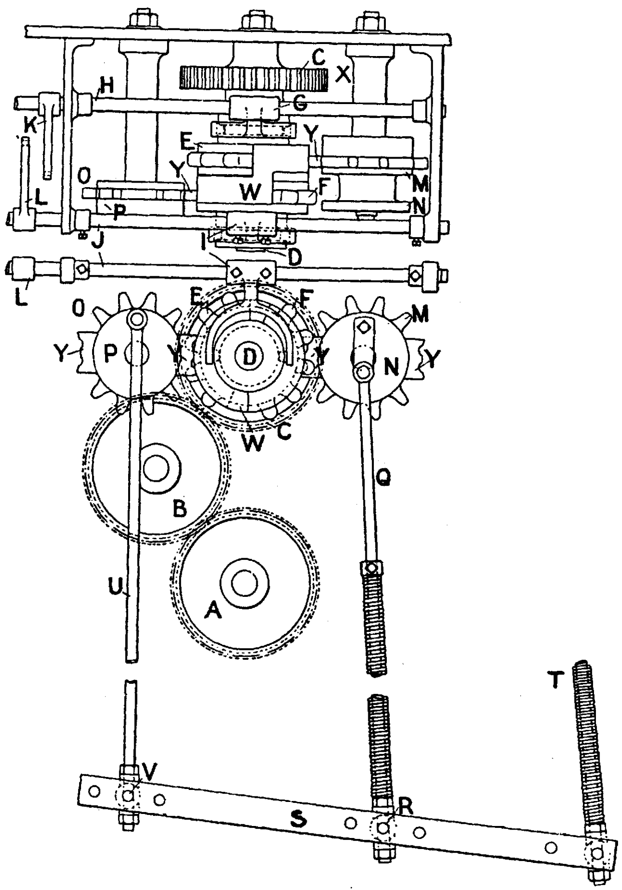


FIG. 225.

the pin of P, is united with S at V. The spear rod T is also attached to the same lever. In the event of a shuttle or

a picker becoming jammed, one spiral spring on Q and another on T furnish escapements for upward and downward movements in the boxes. As a crank N or P moves, V and R respectively become the fulcrum of S. But when both cranks move together no part of S is stationary, yet by reason of the small throw of N, R becomes the fulcrum.

A crank N or P when moved by the rotating segments E or F passes from one dead centre to another, and always in the same direction. Yet a like card in a box chain will always bring the same shuttle to face a picker. This arises from forming the teeth of each star wheel M and O in two sections, one section being in a different plane from the other, so that when the levers K and L are unlifted one line of teeth in M, O face those in the sliding segments E, F. Also, when K, L are lifted the other line of teeth in M, O face those in E, F; but in each case half the periphery of M, O is plain. If the teeth in M or O are on the driving side of and facing those in E or F, the former will make half a revolution and the boxes will change, but after the first movement, and with the levers K, L unaltered, the blank portions of M, O will face the teeth in E, F, and the boxes will be stationary. Each segment has a portion of its last tooth cut away to enable it to engage with a recess in the sliding pieces E, F. When stationary both cranks are locked by the curved surfaces Y, which coincide with the surface of W.

Cowburn and Peck's Motion

In 1888 and 1889 J. Cowburn and C. Peck introduced a motion in which Whitesmith's principle forms the central feature, but instead of using eccentrics they employ a double crank and two discs. Each disc, A, D, Figs. 226 to 229, is free to turn on a stud in the framing, and each has a pinion A′ formed on its boss. The outer disc D carries a stud that gives a throw of one box. On this stud a crank C, with a throw of two boxes, is loosely fitted, and its pin passes freely through a slot in the disc A. The crank C supports an arm E, which is made in two pieces and hinged to the spear rod lever F. Two flanges on E are drilled to receive a rod E′; the latter is screwed to take two adjusting nuts, and a spring threaded upon it impinges against a shoulder on E′ and a flange on E. In case a picker or shuttle is trapped as E moves down, the spring contracts, and a smash is prevented. Similar connections on the spear rod provide for a similar contingency as E moves up.

A cradle G is rocked on a stud by an adjustable crank H and a connecting rod I. At the outer end of G two racks J, K are centred to fall from the disc pinions A′ by gravitation, and rest against the rear ends of two horizontal needles L, M, Fig. 228. A blank card in pushing back a needle causes a rack to engage a disc pinion, hence the disc's motion depends upon that of the rack; and since contact is only made as the racks descend, a disc always moves in one direction, and through exactly half a revolution. This carries the crank pin or the crank C from one dead centre to another. When not in action, each disc is locked by a flat spring that forces a catch N into the uppermost of two notches cut in the disc's rim. Vibration is thus prevented until a change is to be made. As a needle recedes from a blank card, it bears on the base of a catch N and lifts its upper end clear of a notch in A or D.

A four-sided card barrel O has a star wheel Y fixed on one end of its shaft. O is mounted upon the top of a

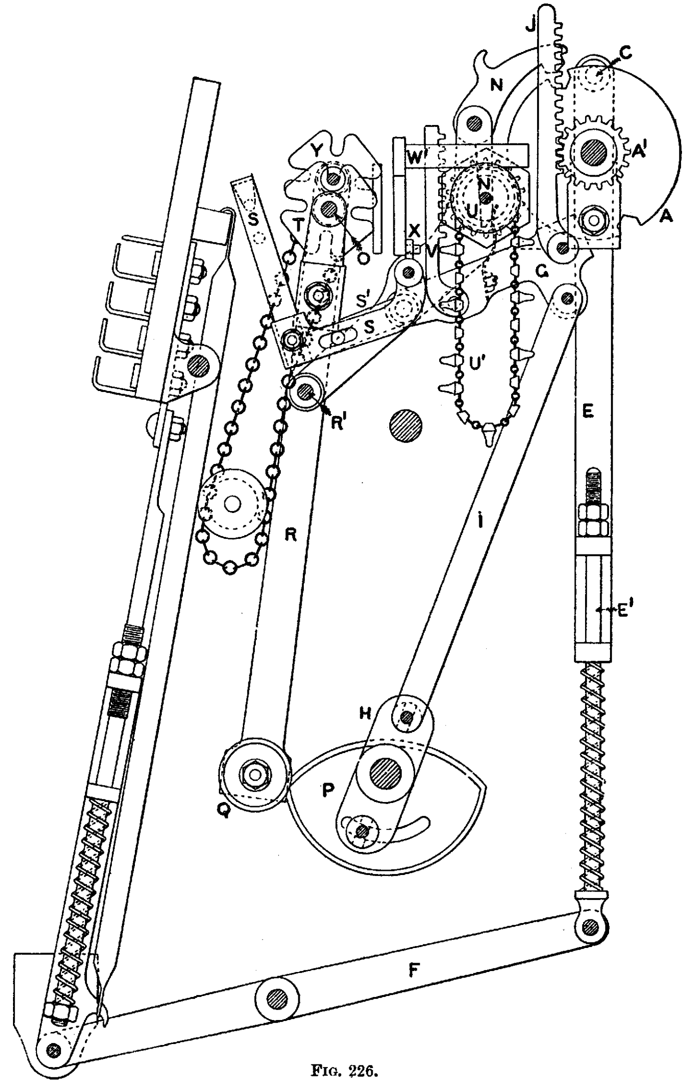


FIG. 226.

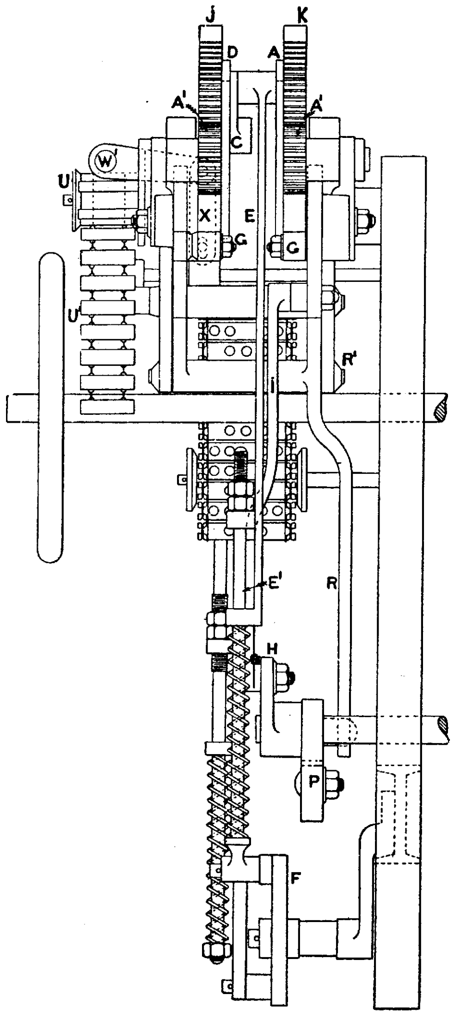


Fig. 227.

bar R, which is centred on a stud R′. At the base of R a bowl Q rests against the cam P upon the bottom shaft. The barrel O is rotated by one of two pins in an L-shaped pawl S, that engages the notches of a star wheel Y or T. The necessary vibrating movement is given to S by

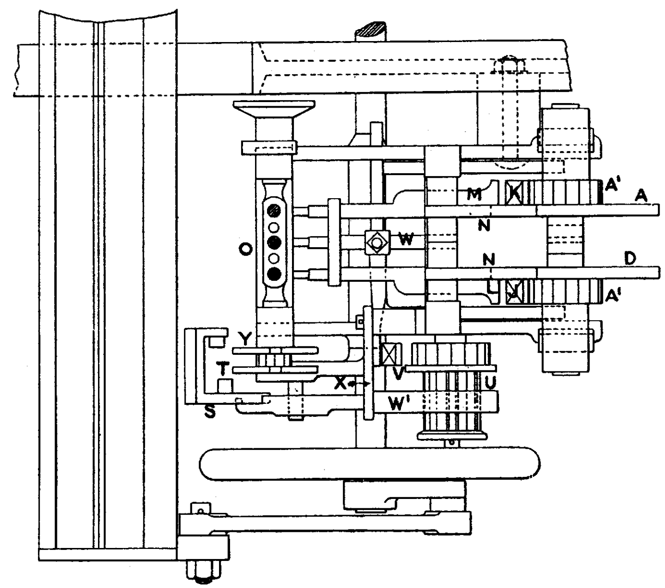


Fig. 228.

keying an arm S′, Fig. 226, upon the axle of the cradle G, and passing a pin from S′ through a slot in the lower arm of S.

Any box can be moved to the shuttle race as follows:—When the stud and the crank C are on their top centres, the top box is in position. When the stud is turned down and C left up, number 2 box is level. When C is down and the stud up, number 3 box is level, and by turning the stud and C upon their bottom centres, number 4 box will be level with the race board.

A link-saving motion is a feature of this invention. It consists of a hexagonal lattice barrel U, round which a chain of wooden lags U′ is passed. The lags have either raised or flat surfaces, the former being equivalent to pegs, the latter to blanks; they are alternately raised and flat, except for scarves and handkerchiefs, when two consecutive raised or two flat lags are necessary at two places to carry the pattern chain forward from the middle to the border cards, or *vice versa*. Since a raised lag followed by a flat one reverses the direction of a pattern chain, it thus becomes possible to weave long patterns with few cards. Lags of medium thickness are also used; in such cases their surfaces are sufficiently raised to move both pins of the pawl S out of contact with the star wheels Y, T. The barrel O then ceases to rotate, and the same card of the pattern chain is presented to the needles on two successive vibrations of O.

The barrel U is only moved when a pattern chain has to be reversed, or when one card has to be presented to the needles twice; this is accomplished by causing a third rack V to engage a pinion wheel upon the inner end of U, whenever the middle needle W is pushed back by a blank card. The rack V is also rocked by the cradle G. A cylindrical bar W′ is parallel with the needles, and rests upon a lag; it is bolted to a cranked lever X, and as the lags lift W′ the vertical arm of X imparts a lateral movement to the shaft of the pawl lever S, and so takes the upper pin out of gear with the star Y, and puts the lower pin in gear with the star T. The star T is connected to the chain barrel O by pinions, one on the barrel shaft,

the other on the boss of T. As a sequence the barrel O will turn in one direction if Y drives, and in the other direction if T drives.

Medium lags are required when it is necessary to reverse on two picks, or any multiple of 4+2 picks. For example take the following pattern:—

6	picks of	white
4	,, ,,	indigo
2	,, ,,	red
2	,, ,,	sky
2	,, ,,	red
4	,, ,,	indigo
20		

Assume that card one, at the top of Fig. 229, will carry the bottom box level with the picker, and that the shuttles are filled as follows:—

No. 4 = white weft
,, 3 = indigo ,,
,, 2 = sky ,,
,, 1 = red ,,

Card 1 = box 4 level = 2 picks of white, with a flat lag on the top of the lag barrel.
Card 7 = box 4 level = 2 picks of white, but the lag barrel has changed to a medium lag = card 7 repeated.
Card 7 = box 4 level = 2 picks of white, and a change to a full lag.
Card 1 = box 3 level = 2 picks of indigo, and no change in the lag barrel.
Card 8 = box 3 level = 2 picks of indigo, and no change in the lag barrel.
Card 3 = box 1 level = 2 picks of red, and no change in the lag barrel.
Card 2 = box 2 level = 2 picks of sky, and the barrel changed to a medium lag.

Card 2 = box 1 level = 2 picks of red, and a change in the barrel to a flat lag.
Card 3 = box 3 level = 2 picks of indigo, and no change in the lag barrel.
Card 8 = box 3 level = 2 picks of indigo, and no change in the lag barrel.

20 picks

This motion is usually made for four shuttles, and the difficulties experienced in laying and reading a pattern chain are clearly shown in the accompanying Fig. 229.

Revolving Boxes

Circular boxes were invented by Luke Smith in 1843; they are now in extensive use in many branches of the textile industry. The shuttles are arranged in chambers formed in a wooden cylinder, which is moved forward or backward as required to take each shuttle into contact with the picker. Those with six compartments are in general use. In many cases the maximum movement equals one shuttle, but some are capable of skipping one or two shuttles.

The cylinder A, Figs. 230 and 231, is supported by a semi-hoop B at its inner end, and by a spindle C at its outer end. Upon C a disc D is fitted, which contains a similar number of equally spaced pegs to the compartments in a cylinder. A star wheel E is also fitted upon the spindle, so that a spring hammer by pressing against the under side of E will hold the boxes true. Two drawing hooks F, G are forced by flat springs H into contact with the pegs of D and engage them at opposite sides of the disc. F and G are centred on two bent levers I, each having at its rear end a vertical hook J which is passed through a slot in a

Cowburn and Peck's Cards for Four Boxes

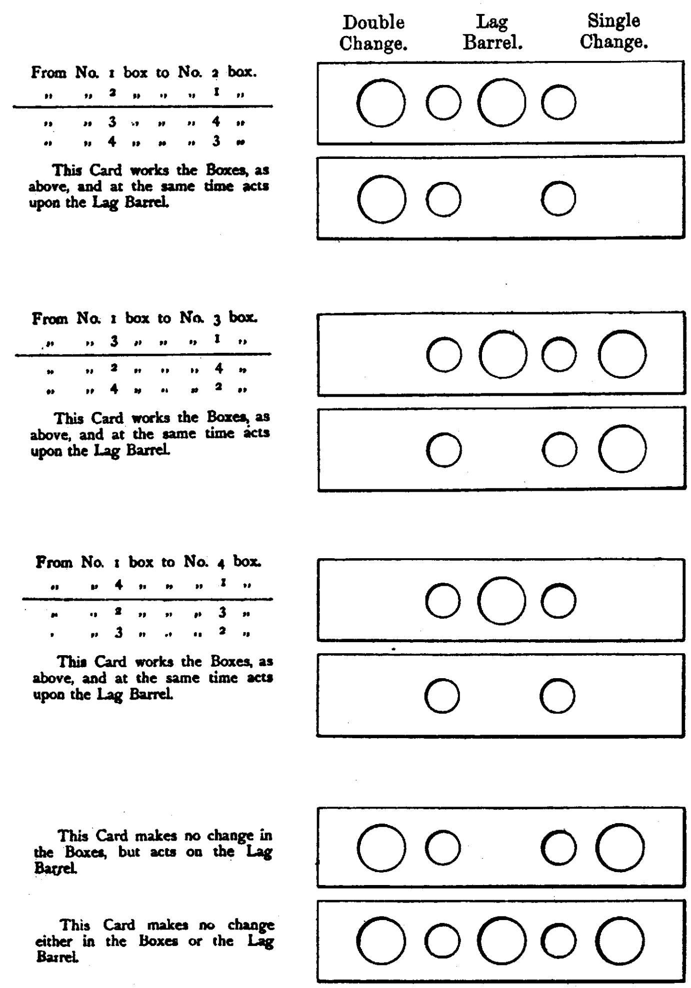


Fig. 229.

lever K and another in L. The lever K is oscillated on a pin by causing a cam M on the bottom shaft to act upon a bowl N. At O a knuckle joint is formed in K, and a

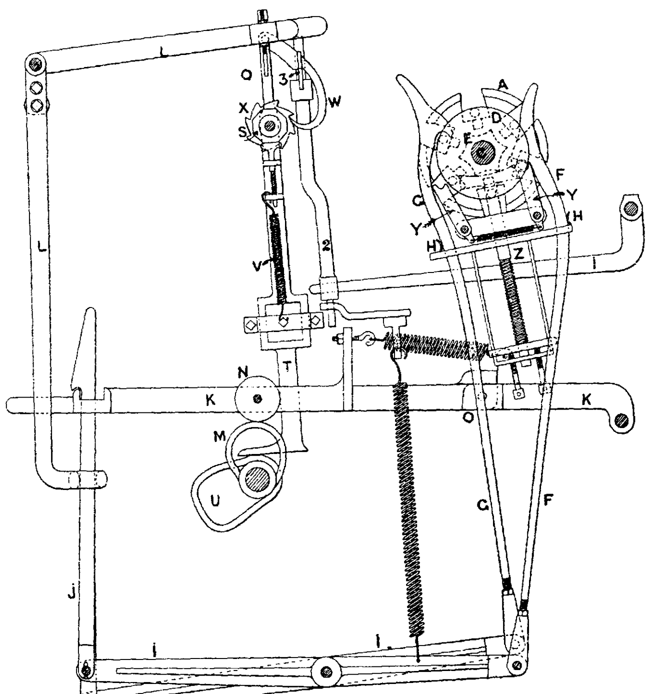


FIG. 230.

spiral spring is stretched above it to keep the lever straight until a shuttle is trapped; the joint then gives way and prevents a smash. The foot of an L-shaped bar T rests upon a cam U, but its head supports an octagonal card barrel S. The full part of U lifts T, S, but a spiral spring V pulls them down; a spring hammer meanwhile

keeps S steady. A catch W is hinged upon the framing to engage a ratchet wheel X on the barrel shaft and cause S to make one-eighth of a revolution each time T and S move down.

A feeler Q is attached to each cranked lever L, and when S is in its highest position a blank card causes L, L to vibrate and thrust back both hooks J from the solid part of the lever K. In its next upward movement K misses the hooks J, and the boxes remain unaltered. But one hole in a card leaves a feeler Q undisturbed; a hook J is then left over the solid part of K, and when K ascends it will take J with it. By this means the rear of I rises while its forward end falls and a hook F or G turns the boxes.

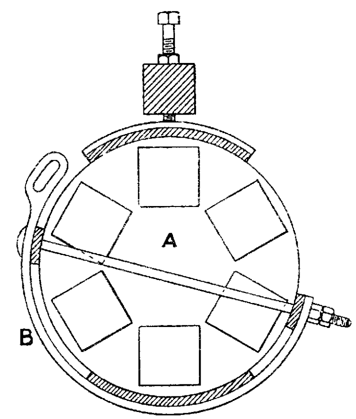


FIG. 231.

The parts I, J, L, Q being duplicated, whether the boxes move forward or backward will depend upon which cranked lever L is actuated. At half the lift of the levers I, the pins that connect them with the drawing hooks F, G should have their centres coincident with the centre of the rocking shaft, or the boxes will not move at a uniform speed in both directions.

A spring hammer cannot prevent shuttle boxes from moving too far, hence a stop of some kind is added. A stop may consist of two detents Y, each mounted on a pin placed beneath, but at opposite sides of the boxes; in which event a helical spring Z is employed to pull both detents apart at the top. The detents Y rest against the inner curves of the drawing hooks F, G, until one of the latter is brought into operation, when one detent is thrust under a peg on the disc D, to stop further movement in the boxes.

A means for preventing a pattern chain from moving after a weft has broken is found on most revolving box looms. It consists in fitting an arm 1 upon the finger rod of a taking-up motion; 1 passes through a slot in an upright piece 2, and 2 holds a bar 3 beneath the levers L. When a weft breaks, the arm 1 lifts the bar 3 and the cranked levers L to put the hooks J out of action, thus preventing any change in the boxes. Curved plates are fixed at each end of the boxes to hold all shuttles in position until they are again required, and two cone-shaped rollers push forward the outer tips of such shuttles as the boxes turn. Without some similar contrivance boxes could not be moved at all times.

Compared with drop boxes, the advantages are, that an increase in the number of shuttles does not necessitate a decreased speed in a loom, for the movement being rotary, the weight on one side of a cylinder balances that on the other side, and the power required to move it is fixed, or nearly so. Since there is no rebound, high speeds are practicable. They have, however, disadvantages that to some extent counterbalance the advantages. In the first place, a loose reed is general, because a stop-rod finger and swell act on the front or back of a shuttle, whereas in a revolving box the shuttle top is presented where a finger would act. In such looms stout cloth cannot be economically made. Unless the checking apparatus acts suddenly, and with certainty, boxes tend to move too far. If the boxes constantly revolve in one direction the wefts are partially twisted, and there is a risk of drawing a portion of a wrong weft into a shed with the correct one.

In 1890 A. Sowden made use of a fast reed by causing an incoming shuttle, as it thrusts back the picker, to tighten a strap attached to a lever, and thereby lift the stop-rod blades above the frogs. A cranked lever has also been secured in each box chamber, in such a manner that an incoming shuttle causes the lever to vibrate, and act, through other levers, upon the stop-rod blades.

Revolving Boxes that Skip

Revolving boxes are made to change instantly from one compartment to any other of a set of six. This has been accomplished by various mechanical devices, but the one generally adopted was patented in 1869 by R. L. Hattersley and J. Hill. It consists in positively moving a revolver by one of three cams, which operate separate griffe levers, separate hooks, one bottom lever, and a duplex rack similar to Shaw's, see p. 405. When necessary the rack engages teeth on either side of a spur wheel fixed upon the revolver axis. The cams respectively move a revolver one, two, and three compartments. Any of these changes may be made by a box chain, a dobby, or a Jacquard acting upon the usual cranked levers. A fourth cam, with its complement of levers and hooks, determines the direction of movement in the revolver, and unlocks and locks it before and after each change. When a box chain is used, a fifth cam rotates the card barrel of an indicating apparatus, and moves the feelers away from, and into contact with the cards.

The details of this device are shown in the accompanying Figs. 232 and 233, where B, C, D, E, F are a series of cams fitted upon the picking shaft A. On alternate picks the outside cam B may give a movement of one shuttle; the second, C, may skip two shuttles; while the third, D, may skip one shuttle. These cams act through antifriction bowls H, upon three griffe levers G, which are severally jointed upon a pin I. At J, Fig. 233, the first griffe lever G^1 has two flanges on the inside; the second, G^2, is slotted; and the third, G^3, has two flanges on the outside. The flanges and slot support three vertical hooks K, all jointed upon the first bent lever L^1. A pin N, Fig. 232, unites the forward end of L^1 to the base of a double rack M.

A spur wheel O is fixed upon a revolver spindle, and enclosed by the rack M, but the teeth of M do not engage those of O until the cam E, acting upon the griffe lever G^4, lifts the hook K^5, or K^6; the latter then pulls or pushes one rack M into gear with O. The griffe lever G^4 has two flanges on the outside, and also two slots; it operates the hooks K^4, K^5, K^6. Hook K^5 is jointed to the bottom lever L^3, and at the opposite end L^3 carries a connecting rod P. On the top of P a lever Q, with an open step formed upon it, works against the lower half of the boss of wheel O. The lever Q is provided with two projections R which fit inside smooth flanges upon the rack M. A second lever S is hinged upon the box frame, and its rear end is pulled up by a spiral spring T. It is the office of S, T to support the lever Q, but to yield whenever the latter is moved by the rod P. By drawing down P, a projection R will engage the front rack with the driving wheel O, and the revolver will be moved forward when M descends.

The inside bottom lever L^4 moves upon a pin U in

the loom framing, and the hook K^6 is jointed upon it. A stud V in L^4 takes into a slot in L^3; hence, hook K^6, acting through the lever L^4, will reverse the action of

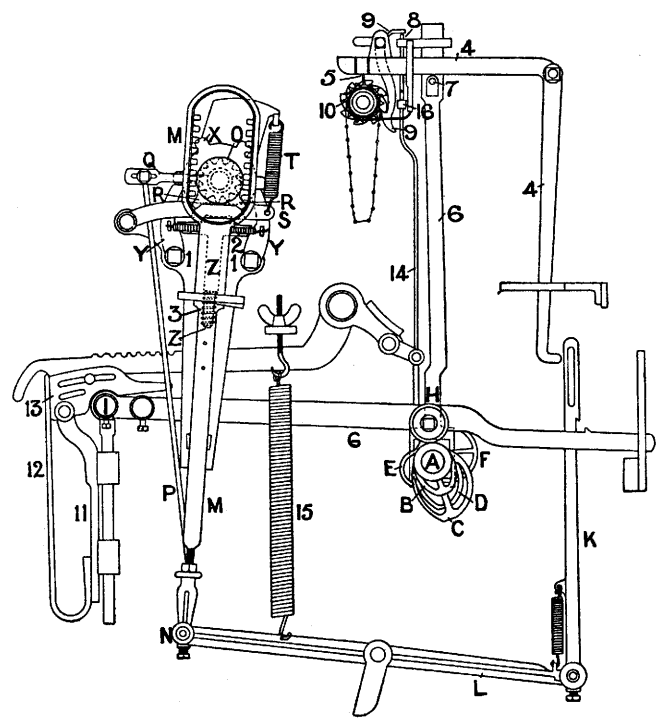


Fig. 232.

hook K^5 upon the lever L^3, and lift P, Q until a projection R engages the back rack with the spur wheel O; this causes the revolver to be moved backward when M descends.

Whether backward or forward motion be required, the rack and spur wheel remain engaged until the full distance has been turned; but excessive or insufficient movement is prevented by a star wheel, two locking detents, and a hammer. Momentum is arrested at the proper place as follows: A star wheel X with one tooth for each shuttle compartment is fixed upon the box spindle adjacent to the wheel O. Two detents Y, fulcrumed upon studs in the box frame at 1, 1, and connected by a lateral spring at 2, draw the free ends of Y into contact with the teeth on X. Sufficient movement is ensured by placing between the detents a hammer Z, so shaped that when depressed it opens the detents to clear the star wheel. The shank of Z has the usual vertical spring at 3 to furnish an upward pressure and is jointed upon the forward end of the lever L^2. The head of Z, by engaging a projection upon X, completes the movement of the revolver. The hook K^4 passes between the flanges on the griffe lever G^4, and governs the lever L^2. Near the top of K^4 a finger W projects across the hooks K^5, K^6, so that neither can be moved outward without putting hook K^4 into operation. K^4 will, therefore, unlock the boxes by withdrawing the hammer Z and the detents Y from the star wheel X.

Five cranked levers 4 have their vertical arms in contact with the hooks K^1 to K^5, and each horizontal arm is provided with a feeler 5 for cards to operate when required. An upright bar 6 holds a stud 7 beneath the horizontal arms of 4 and is lifted by a cam F. As 6 falls the feelers 5 drop upon a card; if upon a blank, no effect is produced, but if into a hole, a revolver will move. When the bar 6 rises, the card barrel 10 is turned by a catch 9 jointed upon a lever 8, and a finger on 8 covers the fourth and fifth crank levers; hence motion in 8 is imparted through 4. The direction of motion

in a revolver, together with the unlocking of the boxes, is determined by the position of a hole in a card. If a hole is beneath the fourth feeler, the boxes will

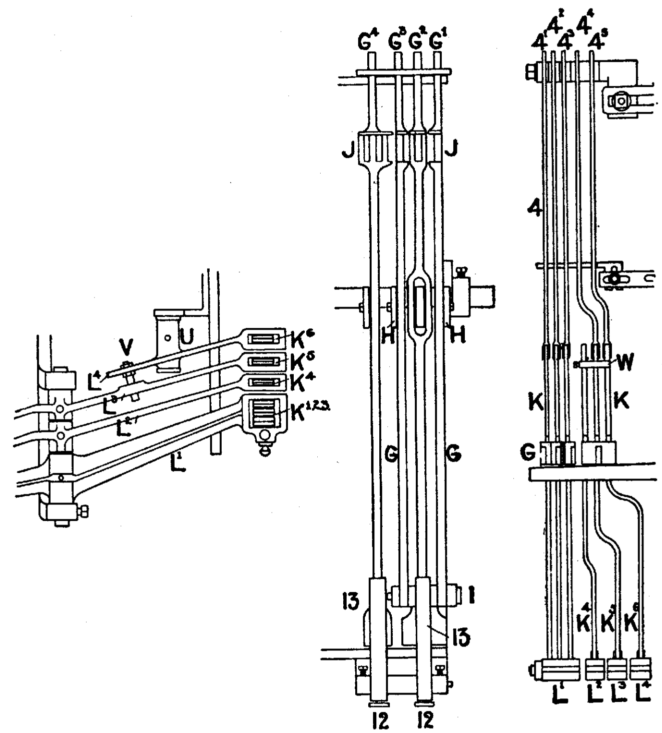


FIG. 233.

move forward, if beneath the fifth, they will move backward.

In case a picker or a shuttle fails to act correctly, breakages are prevented by mounting two cross heads I upon the vertical stud 11: the first head forms a fulcrum for the griffe levers G^1, G^2, G^3, and the second for lever G^4. Under ordinary circumstances a flat spring 12 bears upon a cap 13 with sufficient force to hold down the fulcrum I, but 12 is weak enough to permit 13 and I to rise when the rear ends of levers G^1, G^2, G^3 are prevented from moving. If cards are employed to control the mechanism, changes from one compartment to another cannot be made after a weft has broken, for a rod 14 unites an ordinary brake lever with the rear arm of the catch 9. Thus, immediately the brake is applied, the rod 14 rises, thrusts back the catch 9, and a finger moves the crank levers away from the barrel 10, hence, no matter what card is uppermost, the boxes do not rotate.

The operation is as follows: In order to move one compartment forward or backward, a hole in a card, beneath the first feeler 5, will cause the crank lever 4^1 to push the first hook K into gear with the griffe lever G^1, and G^1 will be operated by the first cam B. Before this can be done, however, the rack M must be placed in contact with the spur wheel O, the hammer Z and the detents Y must also be drawn from the star wheel X. Hence, a hole in a card beneath the first feeler must be accompanied by a hole for the fourth or fifth feeler, according to the direction a revolver is to move. If a hole is under the fourth feeler, the cam E which is set a little in advance of cams B, C, D, lifts hook K^5, pulls down the connecting rod P, and the lever Q, and the rear projection R draws the front teeth of M into gear with the spur wheel O; the rack being securely held until a forward change is completed. Meanwhile, the hammer Z is withdrawn from the star X and its extremities hold open the detents Y until the rack has almost completed its movement; the springs 3, 2 then cause Z and the free ends of Y to engage the teeth of X. When the rack M is released by the cam E from contact with O, a strong spring 15 lifts M into its normal position. If a revolver is to move backward, a hole under the fifth feeler will act upon L^4, and by reason of the position of its fulcrum, and its connection with L^3, the rod P will cause the front projection R to engage the back teeth of M with the spur wheel O.

In order to move two compartments forward or backward, place a hole in a card beneath the third feeler 5; it will cause the third hook K to engage L^1, and cam D will depress the rack twice as far as when operated by cam B. To move three compartments in either direction, a hole beneath the second feeler 5 will cause hook 2 to engage with L^1, and cam C will depress rack M the required distance. In all cases a hole beneath the fourth or fifth feeler will cause the finger W to be pressed back far enough to engage hook K^4 with the griffe lever G^4 and unlock the revolver.

In looms of recent construction, several cams, griffe levers, and hooks are dispensed with. One cam, one griffe lever, two hooks, and a lever compounded with the bottom lever, are employed to effect all movements in the revolver. The first hook when lifted moves the revolver one compartment, the second moves two compartments, and if both hooks are lifted together they move three compartments. The usual locking and reversing gear is retained.

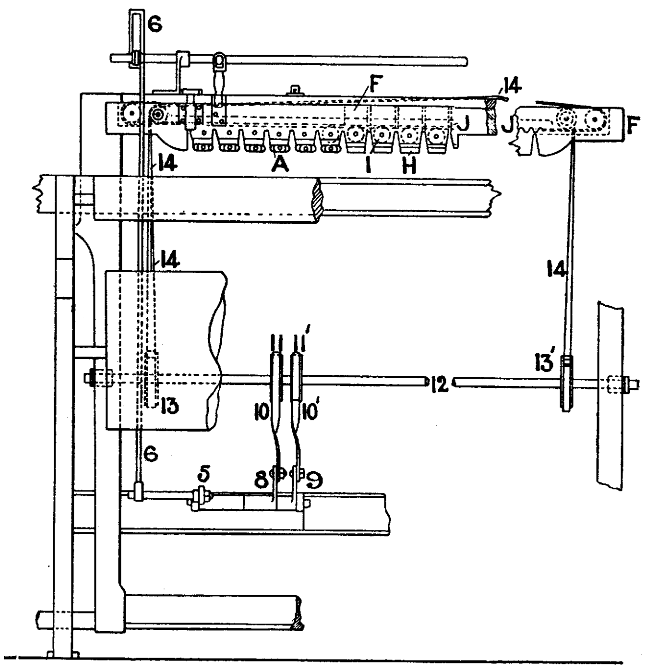
PART XV

SWIVEL-WEAVING

SWIVEL-WEAVING produces small figures in extra weft upon piece goods of indefinite width; it is relatively to picking, what lappet weaving is to shedding. Both methods give a fabric an embroidered appearance, and both prevent waste, by using figuring material only where figures are made. For variety of detail, and general excellence of workmanship, swivelled fabrics are superior to lappets, but the latter are more economical to manufacture. Each pick of swivel weft is placed above a pick of ground weft; hence the length of fabric produced in a given time is determined by the number and closeness of the ground picks inserted. These fabrics have been made in power-looms for many years, but they are still chiefly produced in hand-looms. The number of shuttles in use, the elaborate mechanism required to manipulate them, and the absence of detectors to stop a loom when a figuring thread breaks, increase the weaver's work, and entail frequent stoppages of the machine.

Swivel-weaving consists in so applying small-ware shuttles to an ordinary loom that they may be lifted above the upper warp line, dropped upon the race board, and moved through the warp at pleasure. But the space between adjacent figures has been governed by the size of the swivel shuttles and the appliances employed to give them motion, and this varies from 1″ to 5″. There is, however, an attachment on most looms by which figures may be equally distributed. The shuttles and their holders are capable of being moved laterally to place a second line of figures midway between those of a former line. Or they may be moved to form diagonal or other schemes of distribution. In power-looms, swivel shuttles are fitted in a carrying frame attached to the front of a slay, and this is raised and lowered by the indirect action of a Jacquard. By leaving cards blank at suitable places, all parts of the swivelling mechanism will remain inoperative. By suitably perforating cards the frame may be dropped upon the race board, the picking motion may be put out of action when the swivels are to move, and the long racks operated to drive the small shuttles.

In Fig. 234 a swivel shuttle is shown at A in plan, and at A′ in end elevation. It is made of wood and hollowed out in the centre to hold a spool B. This spool is loosely mounted upon a pin, one end of which is straight, the other end bent at right angles. The straight end enters a hole in one side of A, the bent end is pressed into a groove in the opposite side. A spring bears against the centre of B to prevent the weft from unwinding too freely, and an eye is formed in the shuttle at A″. Two glass rings are secured to spiral springs fixed on opposite sides of a shuttle eye. Weft is threaded through both rings and through the eye; the springs regulate tension and prevent loops from forming round the edges of a figure. A more perfect tension results from mounting a collar loosely upon a spindle, then attaching one end of a spiral spring to the collar, and passing its remaining end through a hole in the spindle. A sleeve, with four protruding flat springs, covers the spiral and fits tightly upon the collar. The spool is passed over the sleeve and lightly pressed by the flat springs.



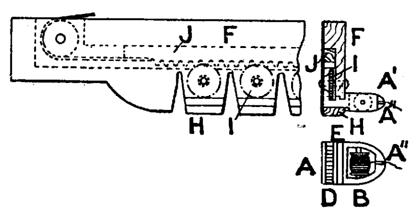


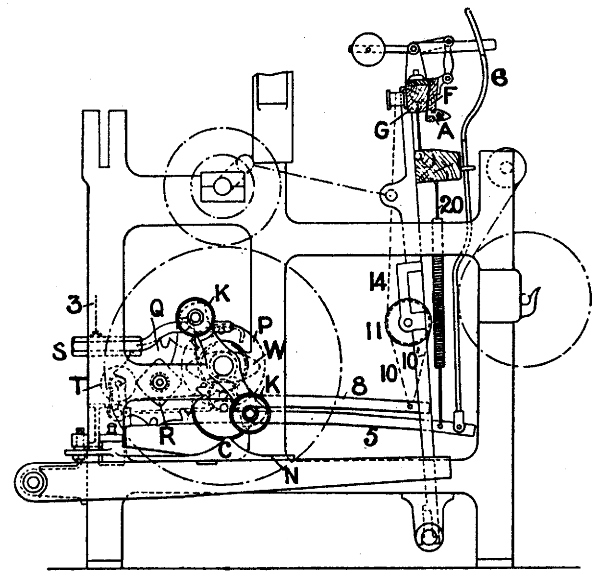
FIG. 234.

If weft is drawn away in excess of requirements, the spiral exerts sufficient force to rewind four to five inches.

A rack D, consisting of metal or leather teeth, is secured in a groove formed in the upper edge of A. In front of D a groove E is cut parallel with D to receive a lip on the swivel frame F. This frame extends across the reed space and rests against the slay cap G, Fig. 235. Behind F a thin metal plate is fixed; at its foot a support H is provided for the under side of each shuttle. These supports are detached, and the plate F is slotted in order that warp threads may be lifted between the shuttles A when the latter are upon the race board. F also carries axles for a series of pinions I, which are placed over the shuttles so that their lower teeth may engage those in the shuttle racks D; while the upper teeth in I take into a rack J that also extends across the reed space. J is free to move to and fro longitudinally, and in so doing it puts in motion the pinions I and the shuttles A. If J moves to the right, the shuttles will be driven into adjacent holders on the left; and by reversing the direction of motion in J, the shuttles will be restored to their former positions. The number of holders, therefore, must exceed that of the shuttles by one.

So long as a loom is weaving ground texture only, the swivel mechanism is inoperative, but the frame F is lowered for the first swivel pick, and the rack J drives each shuttle across the gap that separates one from another. The frame F is then raised and a pick of weft from a ground shuttle is passed through the texture. This is followed by the descent of F, and the swivel shuttles in moving through a second shed are restored to their first positions, when the frame is again raised. The process is repeated until a set of swivel figures is completed. Before the frame F is lowered for the first pick of the next set of figures, it is moved a certain distance endwise to place the shuttles in the required positions. After those figures are completed the frame is moved back again; hence alternate sets of figures are woven in the same longitudinal line.

There are several plans for effecting the various movements enumerated above. That illustrated in Figs. 234 and 235 was developed, between the years 1890 and 1896, and patented by W. T. Birchenough and A. Wood. The ground shuttle is controlled by mounting a star wheel Q, Fig. 235, upon a stud and actuating it by a peg wheel P. The star wheel may be compounded with a barrel and chain which, by means of connections R, S, T, U, V, and O, act upon each picking lever N to bring the required nose C under the picking bowls, see Figs. 184, 185, 186. Instead of a barrel and chain the star wheel Q may be compounded with a four-winged cam R, that acts upon a bowl T fixed on a cranked lever V; the remaining arm of V being passed through a slot in the bar O. In vibrating, V moves the picking plates in and out of action. The peg wheel P is free to slide longitudinally upon the picking shaft X. It is rotated by securing two studs, 1, 2, upon its inner face and causing them to enter corresponding holes in a disc Y, which is fast upon the picking shaft. The swivel motion is controlled as follows:—A lever S is fulcrumed at U to the framework and has a cord 3, from a spare hook in the Jacquard, tied upon its weighted end. As the rear of S rises, a bowl L, at the front of S, bears upon a cam face 4, formed on the boss of the peg wheel P, and takes the pegs out of contact with the star wheel. But L also thrusts a projection from P against a bowl on a lever 5, whose office is to draw down a slotted rod 6, and thus permit the swivel frame F to fall by gravity. As P continues to slide, the studs 1, 2 pass through the



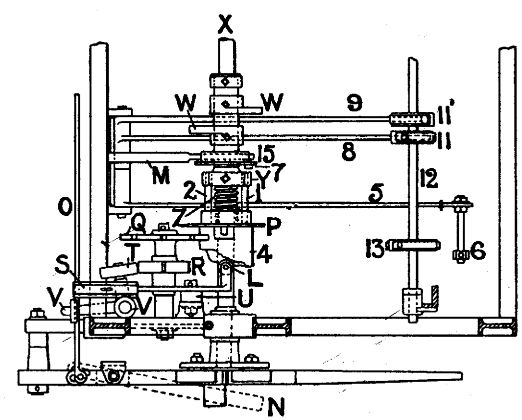


Fig. 235.

disc Y. Either 1 or 2 engages one of two projections 7, on a disc 15 fixed upon the sleeve of two cams W, and W, W are loose upon the tappet shaft X. On contact being made between 7 and 1, or 2, the cams make half a revolution, the point of one bears upon a bowl and depresses either lever 8 or 9. Both 8 and 9 are connected by straps 10, 10′ to opposite sides of two pulleys 11, 11′, while 11, 11′ are upon a rocking shaft 12, whose bearings are in the slay swords. 12 has two other pulleys 13, 13′ fixed upon it, and two straps 14 are made fast to these pulleys. The straps 14 are led over guide pulleys in the swivel frame F to opposite ends of the long rack J, which is thereby moved endwise to drive the shuttles A.

Between the fixed disc Y and the boss of the peg wheel P a coiled spring Z is placed. Immediately a Jacquard has released the weighted end of S, the action of Z causes P to slide back along the tappet shaft X until the projection on P is free from the lever 5. The studs 1, 2 are then out of contact with 7, 7 on the cam boss. The lever 5 is at once raised by a spring 20, attached to 5 and to the slay sole. As 5 ascends, the slotted rod 6 lifts the swivel frame F out of action, and the ordinary picking motion becomes operative. At the next sliding movement of the peg wheel P, 5 and 6 again lower the swivel frame. If the stud 1, in making contact with a projection 7, caused lever 8 to be depressed for the first movement, stud 2 will now act through the second projection 7 to cause a cam W to depress lever 9, and so drive the swivel shuttles in the opposite direction. In order to prevent the cams from moving incorrectly, a plate spring M is secured to the frame, and by bearing upon the cam boss, locks it after each half-revolution has been made. When swivelling, the peg wheel P moves the star wheel Q once for each revolution, and when not swivelling, P moves Q twice for each revolution.

If swivel shuttles move simultaneously with a ground one, two sheds are necessary—the lower one for ground weft, and the upper one for figuring material. But great strain is thereby thrown upon figuring threads, and breakages are numerous. If this scheme could be carried through successfully, the production of a loom would be doubled, see Howarth and Pearson's Jacquard, Fig. 105.

Swivel shuttles may be supported vertically to form a single line, or to form four or five parallel lines. In the latter case four or five colours may be employed in the evolution of one figure. All the shuttles are then suspended from frames, in which a separate groove is cut for each line, and a rack on the top of every shuttle engages pairs of pinions pivoted in a holding frame. In order to conform to the shed lines, and to facilitate refilling, shuttles placed in this manner become shallower as they recede from a reed, and each holder is hinged to the lower edge of a fixed frame, so that any set of shuttles may be instantly turned into a handy position for manipulation.

Circles

Where not more than two colours are required, circles can be successfully employed as substitutes for swivel shuttles, and compared with the older method, a greater number can be placed in a given width. A circle consists of a piece of metal shaped to resemble a horse-shoe; each turns inside two flanged plates, but when in a state of rest the points are towards the warp. Every circle carries on its face a weft spool, and at its rear a series of pins project far enough to gear with the teeth of a long driving rack. When a frame is lowered, the openings in the shoes permit warp to rise, the rack is moved, and the circles make a complete revolution, in doing which the weft spools enter at one edge of the divided warp and emerge at the other side. On the following figuring pick the rotation is reversed.

So long as the axis of each spool was held at right angles to the warp, it was necessary to leave a transverse space between two figures at least equal to the length of a shuttle. But by placing a spool axis parallel with the warp it is possible to have two spools to an inch. To do this each shuttle holder is made wedge-shaped at the base so that rising warp threads, in sliding along the sides of the wedges, will be pressed far enough apart to make room for the shuttles to drop between them. A swivel rack of this description can either move the shuttles in the opposite direction for the second pick to that they moved in for the first, or in the same direction every time they enter the warp. In the latter event, after rising from the warp each returns to its starting-place, and this gives a closer approximation to embroidery than ordinary swivelling, as well as figures that may cover every part of a fabric.

PART XVI

BEATING UP

BEATING up follows picking, and consists in causing a reed to drive each weft thread into its proper position in a fabric. This is best accomplished by a quick forward

stroke, but the slay should recede slowly to afford time for a shuttle to cross the warp.

A slay has been pulled back slowly by the action of cams, and after a shuttle had completed its course, flat springs, placed behind the swords, were suddenly liberated, the energy stored in them being used for beating up. An adjusting screw rendered it possible to obtain a light or a heavy blow. In the pneumatic loom a slay moved in grooves, and two cylinders, with the usual pistons and rods, were employed. At the proper moment compressed air was admitted into both cylinders to drive a slay forward with the requisite velocity, but it was pulled back by weighted straps.

Both these appliances permitted a dwell of any duration, and the intensity of a blow was unaffected by the velocity of other parts of a loom. To this extent they were well adapted for the work to be done, but since such slays could move through various spaces, a constant stroke depended upon the regularity with which a fabric was drawn away. Any variation in this respect would increase or diminish the forward traverse of the slay, and produce thick or thin places in a fabric.

Several positive appliances have been used, such as parabolic wheels, cams, and cranks, but they alter the force of impact between cloth and reed as the speed of a loom changes. In order that the reed might give a sharp stroke upon the cloth, and also leave as much time as possible for a shuttle to move, Dr. Cartwright, in 1788, fixed an elliptical wheel upon the main driving shaft, and geared it with an eccentric wheel upon a crank shaft. When a large side of the elliptical wheel geared with the small side of the eccentric, a superior speed was available for beating up, and when a small side of the elliptical wheel geared with the large side of the eccentric, a slay moved at an inferior speed, for one was equivalent to a large driving and a small driven wheel, and the other to a small driving and a large driven wheel. Two eccentric wheels have also been employed to produce a like result. Another method of driving a crank shaft differentially is illustrated in Fig. 236, where A is the crank shaft, and F an arm firmly secured upon it. A bowl E is mounted at the extremity of F and rotates between two flanges D,

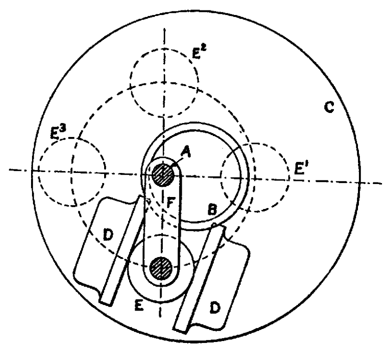


Fig. 236.

which are cast upon a flywheel C. The wheel C turns uniformly upon a hollow boss B; hence, as it rotates, the flanges D carry E, F, and the crank shaft A round in the path indicated by the dotted circles E^1, E^2, E^3. Since E^1 is nearest the centre of C, the shaft A will there move slowest, but at E^3 the bowl is farthest from the centre of C, and the crank shaft will move at its maximum velocity. The position E^1 represents a reed when farthest from a cloth; that of E^3 when in contact with a cloth. A modification of the foregoing was patented in 1870 by A. V. Newton, who bent an extra crank upon one end of

the main driving shaft and passed the end of that crank through a slot in a wheel set eccentric to the cranked shaft. As the slotted wheel revolved the crank was acted upon by different parts of the slot, and turned at a high speed to beat up, and at a low speed when a shuttle was in the warp. For all but wide looms these arrangements are unnecessary.

By one application of cams for governing a slay a grooved cam is fixed upon each extremity of a straight driving shaft. An antifriction roller mounted upon each connecting arm then enters a cam groove. As the cams revolve, the slay is moved to and fro at varying speeds.

In most looms a rocking shaft A, Fig. 237, is supported in bearings bolted to the end framing. Near each extremity of A two arms or swords B are fastened to support a slay sole C. The latter is a piece of sound wood, usually pine, but occasionally ash; it must be strong enough to resist the recurring shocks caused by beating up. A sole C extends across a loom, and upon its upper surface a thin race board is fastened to serve as a shuttle guide. Most race boards are made of birch or beech; they are about half an inch thick, and extend from shuttle box to shuttle box, but iron forms the bottom of the majority of boxes. In 1903 T. Pickles employed lignum-vitæ on account of its hardness and smoothness, and he carried this material through the shuttle boxes. A longitudinal groove E at the back of C is wide enough to receive the lower rib of a reed F. The slay cap G is similarly grooved on its under side to take the upper rib of F, and when G is bolted upon the swords B, the reed is firmly fixed in position. F should, however, be free to make a slight lateral movement, in order that it may adjust itself to the position of the warp. In single shuttle looms a sole equals the length of a slay, but if two or more shuttles are employed, separate boxes are fitted at one or both ends of C.

Two connecting arms K are fastened by metal straps, gibs, and cotters upon two cranks H which are bent on the

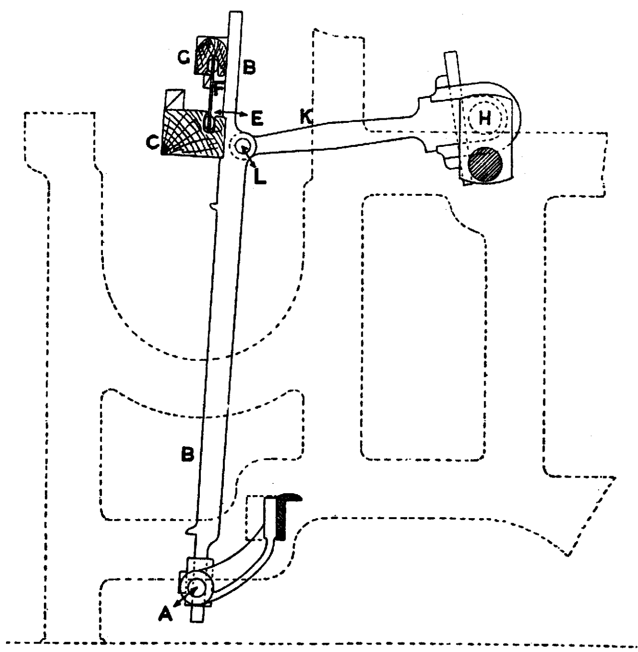


FIG. 237.

main driving shaft. The arms K are fulcrumed to the swords B by pins L. As these cranks revolve, a swinging motion is given to a slay. When the latter is pulled from the fabric a shuttle is driven across; when it is pushed towards the fabric a weft thread is forced into position by the reed. In some looms the connecting arms K are made

in two pieces, as at K, K′, Fig. 238. A supplementary pair of swords B′ are then centred upon the loom framing at A′ and united by pins R to the arms K′. The object of these additions is to hold the forward portions of the arms K′

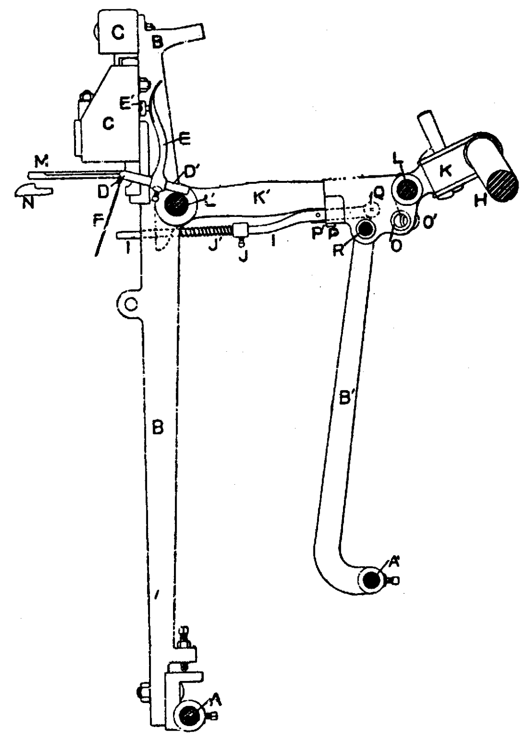


FIG. 238.

almost horizontal as the cranks H revolve. By this means the pins L that connect both halves of the arms K, K′ move in a similar arc to that in which the pins L′ move, and thus upward or downward strain is taken from the slay swords B and the rocking shaft A. The plan also increases the eccentricity of a slay's movement. Eccentricity may also be regulated by causing the crank pins to work in curved slots formed in two levers united to the slay by the usual arms K.

In order to apply cranks in the best manner, it is important to consider the points where their usefulness may be affected. These points are:—(*a*) The relative positions of the cranks and connecting pins; (*b*) the diameter of a circle described by the cranks; and (*c*) the length of the connecting arms. By raising or lowering the connecting pins without altering the crank shaft centre, the eccentric movement of a slay will be modified; therefore their best relative positions should be defined.

The positions of the crank shaft, the rocking shaft, and the connecting pins may be fixed as follows: Let point A, Fig. 239, represent the centre of a rocking shaft, and the vertical line B a slay sword, for in many looms swords are vertical when a reed and fabric are in contact. C is the centre of a connecting pin which, in narrow looms, may not be more than $1\frac{1}{2}''$ behind the vertical line, but in wide looms it may be carried back to the extent of 14″ by ears cast upon the swords. This permits short connecting arms to be used, and avoids unduly enlarging the cranks. With A, C as radius describe an arc D, to show the path of C when motion is imparted to it. Next find the position of C at the end of its journey by cutting from C, on line D, a point C′ equal to the diameter of the required crank circle. Bisect the line C, C′, and draw a line A, A′ through the pin course at C″, which is midway between the extreme points of oscillation in C. A line E, drawn at right angles to A, A′ and passing through C″, will contain the centre of the crank F. To fix the position of F, with C″ as centre cut from line E the length of the connecting arm, and the parts will give sufficient eccentricity to a

slay, while in C there will be an equal and minimum divergence from a horizontal plane.

If the swords are vertical when a reed touches a cloth,

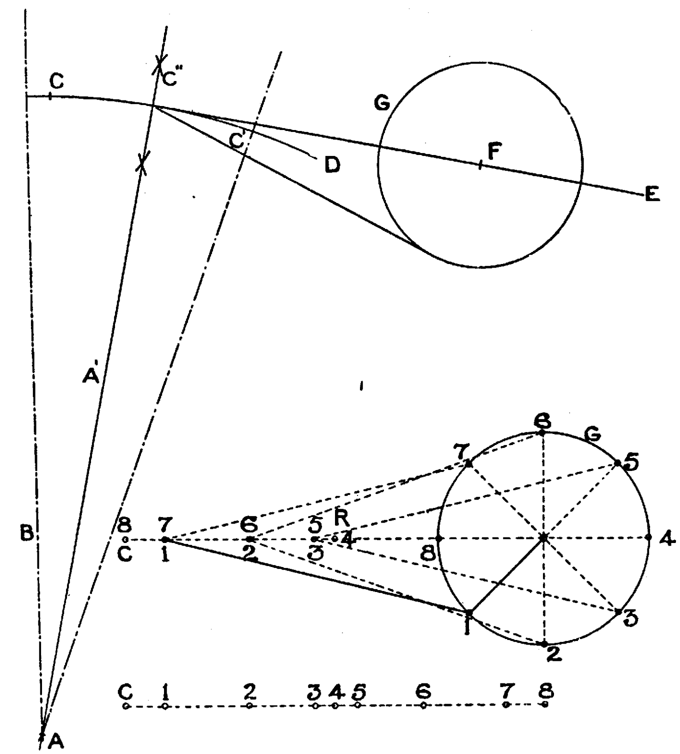


FIG. 239.

and if large cranks are used, the race board in moving backward is liable to be carried too low to permit the bottom line of warp to rest upon it; and unless contact is maintained, shuttles are in danger of flying out. In such cases the swords are often vertical when the cranks are on their top centres. If the swords are vertical, under the last-named conditions, a slay will pass and repass the centre of the rocking shaft twice for each revolution of the cranks, and this is considered objectionable. A claim is made that a stroke from vertical swords is effective because it is at right angles to a cloth; but this is not the case, for a cloth slopes from the breast beam to the harness. Hence to push the weft at right angles, the swords must slope backward when the cranks are on their front centres. But whether the swords are vertical, inclined forward or backward, the method for finding the relative positions of the rocking shaft, the connecting pin, and the crank centres applies, provided the first line erected represents the most forward position of the reed. The race board must be parallel with the bottom shed when a shuttle is moving across.

Valuable eccentricity in a slay is represented by the difference in the velocity of a connecting pin, as a crank passes through a given number of degrees above the front centre, and an equal number of degrees below the back centre. If the rotary motion of a crank is converted into reciprocating rectilinear motion, equal angular spaces in a crank circle will give unequal rectilinear movement to a connecting pin. With a long arm the difference is slight, but with a short one it is considerable. In the lower detached diagram, Fig. 239, a crank circle G is divided into eight equal angular spaces. C 8 is the length of a connecting arm, and C a point to be moved in a horizontal plane. If the crank is moved:—

To the end of division 1, the point C will have travelled from C to 1
At the end „ 2 „ „ 1 „ 2
„ „ 3 „ „ 2 „ 3
„ „ 4 „ „ 3 „ 4

and in like manner back again to 8.

All the spaces C to 4 are unequal, 1, 2 being the largest and 3, 4 the smallest, but the difference between the spaces 7, 8 and 3, 4 is of most importance, as 7, 8 represents the speed of a slay for beating up, and 3, 4 its speed while a shuttle is in the warp.

Cranks and connecting arms cause a slay to move irregularly, because the arms are pulled in a more or less diagonal direction; this places the forward ends of the arms at varying distances from the crank centres, while their rear ends are held at a fixed distance from those centres. Therefore if the cranks move through 90 degrees from the front to the bottom centres, they will pull a slay through a space equal to the radius of a crank circle, plus the difference in length between a straight and a tilted connecting arm when measured on a horizontal line. Further, as the cranks pass from the bottom to the back centres, the movement of a slay, when measured as stated above, equals the radius of the crank circle, minus the increased length of the arm due to changing it from a tilted to a horizontal position.

The precise amount of variation can be readily found by means of a diagram. In Fig. 240 A is the circle described by a crank, and B, C the length of a connecting arm. When the crank has passed from C to C′, the arm is tilted as at B′ C′, and therefore shortened if measured on the line A, B. To find how much it is reduced in length take B, C as radius, and from point B′ describe an arc C′, 3; the space 2, 3 represents the loss in length, and C, 3 the actual movement of the connecting pin. The crank has caused the pin to be moved through a space equal to C, 2; and tilting the arm B, C′ has moved it through an additional space 2, 3.

Calculations can be made to ascertain the variation; thus, if the crank circle has a radius of $2\frac{1}{2}''$, and the connecting arm is 10″ long, the actual movement of the pin B, while the cranks are moving from the top to the front centres, and from the bottom to the back centres, can be found by assuming that two sides of a right-angled triangle are given to find the length of the third. For the radius of the crank circle equals the altitude, the length of the arm equals the hypothenuse, and the base is required. The length of the base is found by squaring both sides, subtracting one square from the other, and extracting the square

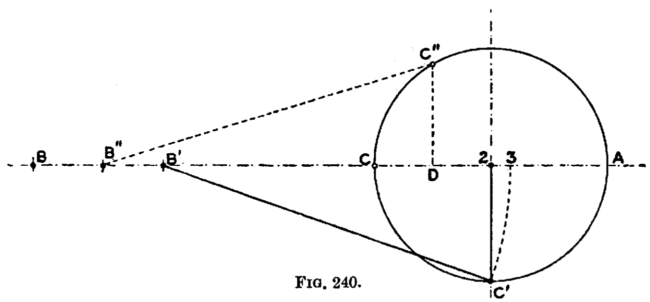


FIG. 240.

root from the remainder. Thus : $\sqrt{10^2 - 2{\cdot}5^2} = 9{\cdot}68''$ = the length of a tilted arm, or a loss of $10 - 9{\cdot}68 = 0{\cdot}32''$; hence the actual movement of a connecting pin for each quarter of a crank's revolution is :—

Top centre to front . 2·5″ the radius of circle $+ 0{\cdot}32 = 2{\cdot}82''$
Front centre to bottom 2·5″ „ $+ 0{\cdot}32 = 2{\cdot}82''$
Bottom centre to back 2·5″ „ $- 0{\cdot}32 = 2{\cdot}18''$
Back centre to top . 2·5″ „ $- 0{\cdot}32 = 2{\cdot}18''$

10·00″ =

the complete movement of a connecting pin for one revolution of a crank. In these calculations the fact that a connecting pin moves in the arc of a circle has been neglected, because the difference is so small that it is unimportant.

It is more difficult to determine the travel of a connecting pin for other than 90 degrees of angular movement, for the altitude of the triangle formed is not known. But by the aid of the accompanying table of natural sines and versed sines the movement may be obtained :—

TABLE SHOWING THE MOTION OF A CRANK

(Crank = 1 inch)

Degree.	Sine.	Versed Sine.	Degree.	Sine.	Versed Sine.	Degree.	Sine.	Versed Sine.
1	·0174	·0001	31	·5150	·1428	61	·8746	·5152
2	·0349	·0006	32	·5299	·1519	62	·8829	·5305
3	·0523	·0013	33	·5446	·1613	63	·8910	·5460
4	·0697	·0024	34	·5592	·1709	64	·8987	·5616
5	·0871	·0038	35	·5735	·1808	65	·9063	·5773
6	·1045	·0054	36	·5877	·1909	66	·9135	·5932
7	·1218	·0074	37	·6018	·2013	67	·9205	·6092
8	·1391	·0097	38	·6156	·2119	68	·9271	·6254
9	·1564	·0123	39	·6293	·2228	69	·9335	·6416
10	·1736	·0152	40	·6427	·2339	70	·9397	·6579
11	·1908	·0183	41	·6560	·2453	71	·9455	·6744
12	·2079	·0218	42	·6691	·2568	72	·9510	·6909
13	·2249	·0256	43	·6819	·2686	73	·9563	·7076
14	·2419	·0297	44	·6946	·2806	74	·9612	·7243
15	·2588	·0340	45	·7071	·2929	75	·9659	·7411
16	·2756	·0387	46	·7193	·3053	76	·9702	·7580
17	·2923	·0437	47	·7313	·3180	77	·9743	·7750
18	·3090	·0489	48	·7431	·3308	78	·9781	·7920
19	·3255	·0544	49	·7547	·3439	79	·9816	·8092
20	·3420	·0603	50	·7660	·3572	80	·9848	·8263
21	·3583	·0664	51	·7771	·3706	81	·9876	·8435
22	·3746	·0728	52	·7880	·3843	82	·9902	·8608
23	·3907	·0795	53	·7986	·3981	83	·9925	·8781
24	·4067	·0864	54	·8090	·4122	84	·9945	·8954
25	·4226	·0937	55	·8191	·4264	85	·9961	·9128
26	·4383	·1012	56	·8290	·4408	86	·9975	·9302
27	·4539	·1089	57	·8386	·4553	87	·9986	·9476
28	·4694	·1170	58	·8480	·4700	88	·9994	·9651
29	·4848	·1253	59	·8571	·4849	89	·9998	·9825
30	·5000	·1339	60	·8660	·5000	90	1·0000	1·0000

The sine of any angle is in proportion to the length of a line dropped from a point in the periphery of a circle, at right angles to, and upon the diameter line (see C″, D, Fig. 240). The versed sine is the distance between the sine and the periphery of a circle when measured on the diameter line, as C, D. For example, let A, B be the diameter line, C″ a point 60 degrees from C, then the sine of 60 degrees is in proportion to C″ C, which is also the altitude of a triangle B″, D, C″ B″; and D, C is the versed sine which shows the movement of a pin due to a crank. If the circle has a radius of 4 inches, and the arm is 12 inches long, the sine of 60 degrees being 0·8660, and the versed sine 0·5 for a circle 1 inch in radius, then for a circle 4 inches in radius, $0·866 \times 4 = 3·464$ inches, and $0·5 \times 4 = 2$ inches $\therefore \sqrt{12^2 - 3·46^2} = 11·5$ inches, the length of the base, and also of the inclined arm, or a loss of $12 - 11·5 = 0·5$ inch, and $2 + 0·5 = 2·5$ inches, the motion of a connecting pin. To find the eccentricity of a slay take a given number of degrees above the front and below the back centres. Ascertain the movement at each place, and subtract one from the other. The more a connecting arm is tilted the greater the eccentricity; hence, increasing the throw of a crank, shortening a connecting arm, or both, will increase eccentricity. Also, by reducing the throw of a crank and lengthening a connecting arm, opposite results will follow.

Eccentricity may be definitely increased or diminished. For example, a $2\frac{1}{2}''$ crank in turning through an angle of 180 degrees from the front centre will, during the first 90 degrees of movement, pull the connecting pin of a 10″ arm $2·5 + 0·32 = 2·82''$, and for the second 90 degrees will move it $2·5 - 0·32 = 2·18''$, hence $2·82 - 2·18 = 0·64''$ the eccentricity (see p. 460). What size of crank must be used with a 10″ arm to give 0·8″ eccentricity?

$$0·64 : 0·8 : : 2·5^2 : 7·8125$$
$$\sqrt{7·8125} = 2·795'' \text{ the crank required.}$$

For Proof.

$$\sqrt{10^2 - 2·795^2} = 9·6014$$
$$10 - 9·6014 = 0·3986'' \text{ due to tilting the arm.}$$
$$2·795 + 0·3986 = 3·1936$$
$$2·795 - 0·3986 = 2·3964$$
$$\overline{}$$
$$0·7972 = \text{eccentricity.}$$

To determine the length of stroke to be given to a slay, the breadth of loom and the make of fabric must be taken into account, the former because the number of revolutions made by the cranks in a given time must be reduced as breadth is increased. There is a speed above and below which a loom does not increase its productiveness, but manufacturers seldom follow any definite rule in fixing the relative velocities of wide and narrow looms that produce similar fabrics. The most efficient speed may be determined by comparing the lengths of weft consumed in a given time by looms weaving wide and narrow pieces of similar quality. If the loom using the greatest length of weft is taken as a model, the plan for speeding one of any other breadth is to cause the shuttles in both to move at the same velocity.

The space through which a reed moves is greater than the throw of a crank, in proportion to the height of the connecting pins and the beating-up point of a reed. Thus, if the centre of a rocking shaft is 28″ from the centre of a connecting pin, 31″ from a fabric, and a crank describes a circle of 5″, the movement is as 28 : 31 : : 5 : 5·33″.

In carpet and certain other heavy looms it has been found necessary to give weft two blows in quick succession, and the plan adopted is to straighten two arms which are knuckle-jointed twice during each revolution of a crank. Each time these arms are straight the weft receives a blow. In Fig. 241, A is a sword, B a crank, C a connecting arm, D the knuckle joint, E is an arm hinged to the framing, and F another arm attached to a slay by the usual connecting pin, and to E by the pin D. In one drawing the

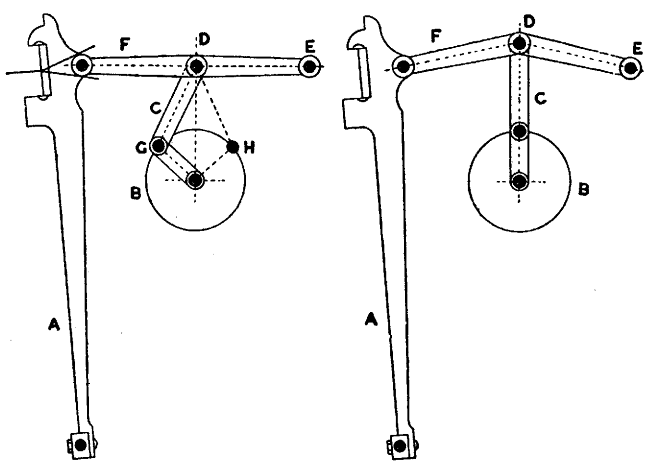


FIG. 241.

arms E, F are straight, but when the crank B moves from point G to the top centre, D is pushed up, and E, F are bent. When B reaches point H on the opposite side, the arms are again straight. The time that elapses between the first and second straightening can be increased either by moving the crank centre up or by lengthening the arms G. It can be reduced by lowering the crank or shortening C.

PART XVII

THE REED

A REED is used to beat up weft inserted by a shuttle; it also helps to keep warp threads in their proper positions; it forms a back guide for a shuttle to run against; and it determines the fineness of a fabric.

Prior to 1733 reeds were made of cane or split reed, but in the above-named year John Kay substituted flattened brass or iron wire, and the change was welcomed as an important improvement. Reeds are now made from iron and brass wire, which is flattened by rollers, and its edges are straightened by leading it in a serpentine course, amongst a series of pegs; the ribbon is then cut to a uniform width equal to that of the dent required. The edges are next rounded and smoothed by files placed to act on every part of the wire as it passes along. After being straightened on the flat, the wire is forwarded to the reed-maker, who feeds it into a machine that automatically cuts it into equal lengths, inserts each strip in position, winds tarred bands between the strips and round two pairs of ribs, and compresses all to the required gauge, at the rate of from 300 to 400 dents per minute.

A finished reed consists of a series of parallel flat wires D, see A, Fig. 242, which are secured at their extremities by passing tarred cotton cords C between the dents and round two semicircular wooden rods B. The cord usually consists of strands of fourfold 32^s twist, varied to suit the space between dent and dent. But round iron wire is occasionally used in place of wooden ribs and cotton cord, in which event the whole is fastened by solder.

In 1896 T. Pickles, and J. W. Smith, secured one end of every dent between two rods B by tarred cord in the usual manner, but bound them lightly together at the other end with spirally wound wire, or untarred thread, their object being to permit the dents to yield more readily to the passage of knots or other obstructions. Reeds are sometimes made double by placing two sets of wires between laths, so that those of one set face the spaces of the other. Such reeds prevent loose fibres of unsized warps from matting together and choking the sheds.

Reeds are also constructed to produce definite effects in fabrics. In reed E, for example, groups of dents D are set obliquely in the ribs B, and each dent is much longer than usual. When in use this reed is slowly raised and lowered by the action of a cam, and its oblique dents draw some groups of warp threads closer together, but permit others to open out; thus destroying the parallel arrangement of a warp by throwing the threads into wavy lines. At F all the dents D converge towards the top rib B. If such a reed be raised and lowered by a cam, the fabric produced will vary in breadth; when the beating-up point is near the bottom rib a piece will be broadest, and when near the top rib a piece will be narrowest. This reed is used in the manufacture of slipper uppers, and for other purposes.

At G and H two reeds are shown in plan and elevation. Both have soft-metal ribs B, and in both the dents D are parallel, but the plans show one dent set in advance of another. At G they form a curved line, at H a zigzag line. With such reeds weft will not be beaten up at right

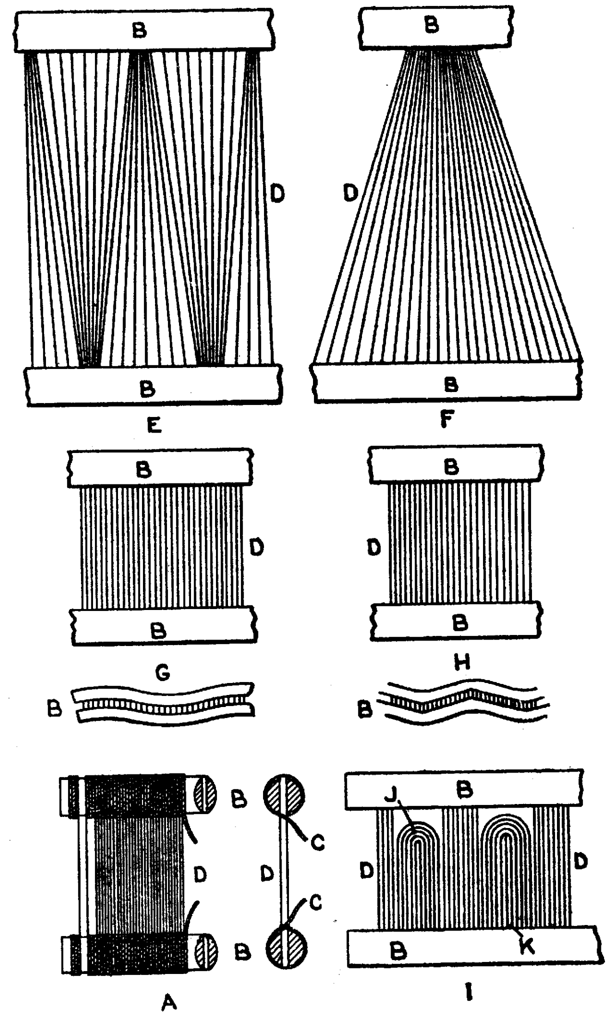


Fig. 242.

angles to warp, but will correspond with the facial conformation of a reed. At I two kinds of dents, D and J, are used. Those at D are of the type illustrated at A. But the dents of J are either formed by bending a wire and fastening both ends in the lower rib B: or two straight pieces of wire have brass curves brazed upon their upper ends. Such a reed is used for gauze weaving. All threads are free to cross in their respective dents, and in addition the threads drawn into the curved dents are capable of crossing threads contained in intervening dents. The scheme of construction admits of almost indefinite variation. Any number of straight dents may be soldered upon the inside of a curved dent, as at K, but, unlike the gauze reed, Fig. 141, these are also used to beat up weft.

For cotton fabrics reeds have from 6 to upwards of 120 dents to the inch. A reed-maker calls each flattened wire a "dent," namely a tooth, but manufacturers generally call each space between two wires a dent. A reed contains a definite number of dents on a given length; this is termed the count, the pitch, or the number of the reed. The counting of reeds has, however, been unnecessarily complicated by varying the basis of nomenclature.

The following classified list of reeds in use will probably place the matter in its simplest form:—

Certain reeds are named from the number of dents contained on one inch, as—the Radcliffe, the Huddersfield, and the American.

Other reeds are named from the number of dents contained on a certain number of inches; of these the most important are—the Stockport, which is on 2″, the Scotch on 37″, and the Macclesfield on 36″.

Reeds are also named from the number of groups of 20 dents on a certain number of inches, each group being

called a beer, or porter, as in—the Bolton reed, which is based on $24\frac{1}{4}$″; the Bradford on 36″; the Dundee on 37″; and the Worsted on 54″.

The Dewsbury reed has 19 dents to a group, or beer, on 90″; the Holmfirth reed has 5 dents to a group, or beer, on 12″.

In some silk reeds, the pitch, the warp threads per dent, and the width go together, as a 2000 reed, 8 thread, 24″; or an 1800 reed, 4 thread, 18″.

Of the foregoing the Stockport reed is in most extensive use, and bids fair to supersede others in Lancashire.

The most useful comparison is the number of dents per inch in a number 1 reed of each system. To find which use the following rule:

$$\frac{\text{Count} \times \text{dents per beer}}{\text{Inches in the basis}}.$$

Thus Stockport, $\frac{1}{2} = 0{\cdot}5$ of a dent per inch.

Bolton, $\frac{1 \times 20}{24{\cdot}25''} = 0{\cdot}8247$ of a dent per inch.

Radcliffe	No. 1 reed	= 1	dent	per inch.
Huddersfield	”	= 1	”	”
American	”	= 1	”	”
Stockport	”	= 0·5	”	”
Scotch	”	= 0·02702	”	”
Macclesfield	”	= 0·02778	”	”
Bolton	”	= 0·8247	”	”
Bradford	”	= 0·5556	”	”
Dundee	”	= 0·5405	”	”
Worsted	”	= 0·3704	”	”
Dewsbury	”	= 0·2112	”	”
Holmfirth	”	= 0·4167	”	”

The count of one reed may be converted to its equivalent count in another reed, as follows:—

$$\frac{\text{Given count} \times \text{dents per beer} \times \text{inches in the basis of the required count}}{\text{Inches in the basis of given count} \times \text{dents per beer of the required count}}.$$

Example.—What does a 40 reed Bolton count equal in the Dundee and Stockport systems?

$$\frac{40 \times 20 \times 37''}{24{\cdot}25'' \times 20} = \text{a } 61{\cdot}03 \text{ Dundee reed, and}$$

$$\frac{40 \times 20 \times 2''}{24{\cdot}25''} = \text{a } 66 \text{ Stockport reed.}$$

PART XVIII

TERRY MOTIONS

THE so-called "Terry" or Turkish towelling textures form a branch of the pile industry, and require special mechanism for their production. The features that distinguish these fabrics from others are: That two warps are needed, one for ground, the other for pile; and that weft is only partially beaten up at the time of insertion. A ground warp is, during weaving, held as tense as the strength of the material will admit of, but a pile warp can be readily drawn from its beam. Both warps may be controlled by heald harnesses, or the ground warp may be controlled by healds, and the pile by a Jacquard. In either event both are interlaced with the weft threads. Three, four, or five picks are inserted to each transverse line of loops, but two of them are not at once driven into the positions they are intended to occupy in a fabric,

then similar groups are similarly treated. Between the last pick of the first group and the first of the second one, a gap is left, whose width is varied to suit the length of pile to be manufactured. In beating home a group of three picks this gap must be closed, by making the weft slide along the tense ground warp, and so draw the pile warp forward with the weft, thus forming loops upon the upper or the lower surface. By using a suitable shedding harness each warp thread may be looped above or below at pleasure, but all must loop either in one direction or the other. Hence a Turkish towelling fabric differs from true terry, because in the latter the same number of loops need not be formed in every line.

Two systems have been introduced for forming gaps: one requires a fast reed and a variable swing in the slay; the other a loose reed and a uniform swing in the slay. Mechanisms of the most varied description have been devised for both systems. One inventor mounts a crank shaft in movable bearings, and, by means of levers and links, unites the bearings with a latched cam. By lifting or dropping the latches a bowl will be moved from one cam groove to another. When in one groove, the crank shaft is pushed forward to beat up; when in the other groove, the shaft bearings are drawn back and the reed is no longer able to reach the cloth fell. The number of revolutions made by a crank shaft when in each position is determined by the shedding motion. Another plan consists in mounting a driving shaft in the vertical arms of two cranked levers, the horizontal arms of which are adjustably weighted and rest upon cam surfaces. As the cams rotate, the cranked levers push forward and draw back a crank shaft, to beat up and to leave a gap respectively.

Crank shaft bearings have been fixed and a variable traverse given to the slay by other means. Thus both connecting pins on the swords have supported pendent levers that terminated in curved slots, and the connecting arms were attached to the pendents. Two levers mounted upon studs in the frame each held a bowl in a slotted pendent. These bowls formed the fulcra upon which the pendents swung. By raising or lowering the bowls leverage was altered, and consequently the traverse of a slay varied. A cam decided when, and how far, the bowls should move in the slots. Eccentric pins have been used to unite the swords and connecting arms; the eccentrics were turned half a revolution, by wheel-gearing, for each change in the throw of a slay. When the full sides of the eccentrics faced the reed a slay moved its minimum distance, but when their full sides faced the cranks a group of picks was beaten home. A reed may be fast and a slay swing uniformly, if the breast beam and back rest of a loom are connected and made to slide to and fro. In moving forward they carry the cloth fell beyond the reed stroke; in moving backward the cloth fell is placed in its normal position, and a group of picks beaten up.

Swivelling, or loose reed terry motions are numerous, and more extensively used than fast reeds. One of the oldest of these contrivances consists in placing the lower rib of a reed in a case, to each end of which a latch is attached. Beneath the latches a bar receives a vertical reciprocating motion from a cam. In rising, this bar lifts the latches against the slay sole to lock a reed; in falling, the latches face fixed pins and, as the slay advances, contact is made between them, and both case and reed are thrust back to form a gap. Two recent devices will indicate the nature of loose reed terry motions.

Hacking's Terry Motion

This piece of mechanism permits a slay to move uniformly, but imparts to a reed a variable traverse. It consists in allowing a reed A, Fig. 243, to swing freely in the slay cap B, but the base of A is placed in a case C, which extends across the warp space. Two arms D unite C with a shaft E whose bearings are on the swords. C may be pressed against a slay back and moved out of contact

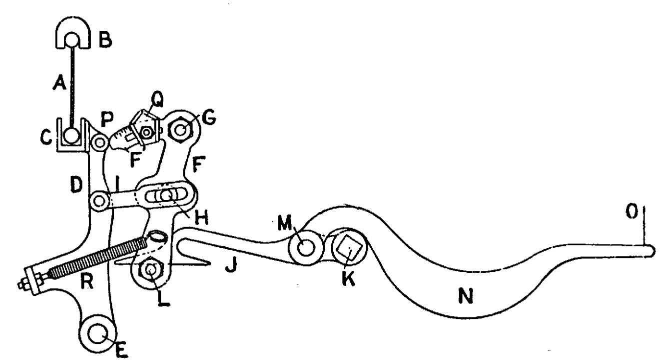


Fig. 243.

with it at pleasure. Thus: A lever F is fulcrumed at G upon one ear of a sword; its upper curved arm F′ is graduated to facilitate the adjustment of a stop Q, that regulates the length of pile. F is moved about its centre G by hinging a hook J upon a stud K in the loom frame, so that J may engage with, or be detached from, a stud L in the lever F. An arm N is free to move upon a pin M in J, and is sufficiently heavy normally to hold J above L. From the rear of N a wire O is led to a jack in a dobby, or a hook in a Jacquard. By lifting N the hook J falls, and as a slay advances with D, F, to beat up, L is arrested, this depresses F′, and permits a bowl P, mounted upon a pin in D, to roll along the upper face of F′ until a stop Q is reached. As P traverses F′, a coiled spring R draws D, C, and A away from a slay sole; the distance they move being regulated by the position Q occupies on F′. An adjustable stud H is fixed in F, to receive a slotted link I which is centred upon D. When the bowl P impinges upon Q, the stud H is at the end of the slot in I, and prevents a reed from jumping forward. By allowing N to fall, J disengages itself from L, the spring R draws the concave nose of F′ to face the centre of P, in which position L impinges upon the sword, and a reed case is securely locked.

In this loom a dobby automatically effects every change required to weave Turkish towels, namely: It causes the warps to be drawn forward to form fringes. It inserts more picks per inch in the headings than in the body of a towel. It places, where required, differently coloured wefts in a fabric, and forms terry. It changes from one weave to another, measures the length of each, slackens the pile warp for weaving terry, and tightens it for the headings.

Hattersley's Terry Motion

Messrs. Hattersley also make a terry motion for a swivelling reed. It is constructed and operated as follows: A, Fig. 244, is a reed whose upper rib is held in a slay cap, C is a reed case, D one of several supporting arms for C, and E a shaft mounted upon the swords,—all of which are similar in construction and action to those in the pre-

ceding figure. Upon E a collar, provided with a projecting lip M, is fixed; a lever, F, G, is also loosely mounted upon E. Two lugs K, on the under side of F, G, have

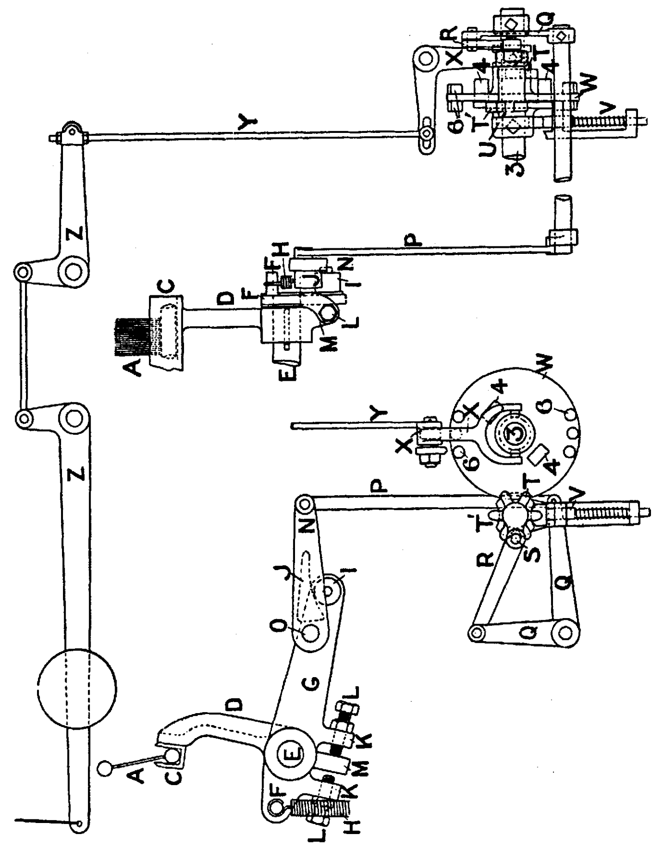


Fig. 244.

adjusting screws L fitted in them for the purpose of regulating the length of pile. A spring H on arm F draws the front screw L against M and holds a reed in position for beating up. The rear screw L is thus normally out of contact with M; it determines how far a downward movement in G shall draw back a reed A. Arm G terminates in a bowl I, and, as a slay moves to and fro, I rolls upon the upper or the lower slope of a wedge J, formed on one face of a lever N, whose fulcrum is at O. A link P unites N with a cranked lever Q, and a rod R connects Q with a crank S which is loose upon a stud. The boss of S is compounded with a double-notched locking plate U for a hammer V to act upon; also with two sets of teeth T, T′. Each set consists of three teeth that cover half the circumference of the boss. Those forming one set are on the opposite half of the boss to those of the other set, but are not in one line, yet, taken together, they equal a wheel of six teeth. Crank S is moved by mounting a sliding peg disc W upon the picking shaft 3, and rotating it by two prongs 4 of a forked boss fixed upon 3. Disc W has on each face two sets of three pegs 6; the outer sets engage the teeth T intermittently, and move the crank S from its front to its back centre. In doing this the wedge lever N is lowered and the bowl I mounts the upper surface of J to lock a reed. But when the inner sets of peg 6 engage the teeth T′, the crank S moves from its back to its front centre, lifts the wedge lever N until bowl I rolls along the under surface of J, and withdraws a reed from a slay sole. In the boss of W a ring groove receives the prongs of a forked cranked lever X, whose other arm is attached to a rod Y for the purpose of coupling it with a cranked lever Z. From the upper arm of Z a rod passes to a second cranked lever Z, which is flexibly connected with the shedding harness, and sufficiently weighted normally to thrust the forks X and the pegged disc W inward upon the picking shaft. But when Z, Z are moved, the outer pegs

in W engage the teeth T; when Z, Z are undisturbed, the inner pegs in W engage with teeth T′ until a smooth part of the boss of S faces the pegs, when the latter are free to rotate without disturbing S.

Terry fabrics are known as three, four, five, and six picked; these terms refer to the schemes of weaving. In a three-picked weave a reed is loose for two beats of the slay and locked for the third, hence three picks form a group which must be beaten home simultaneously. In four and five picked weaves a reed is loose for two beats, and locked for the remaining beats to form groups of four and five picks respectively. But a six-picked terry has its weft beaten up in groups of three picks, with a different scheme of interlacing warps with weft for the second group from that adopted for the first one.

It is customary to put terry pile warps under tension as for ordinary goods, but it is difficult to form pile of uniform length. On the latter account many patents have been procured for automatic mechanisms that deliver fixed lengths of warp each time a reed is locked. By most of these devices a pile beam is either placed upon an intermittently driven drum, and the warp is unrolled by frictional contact; or the warp is nipped between intermittently driven rollers. But cost of upkeep, or lack of efficiency, has prevented their general adoption.

During recent years looms have been introduced which have made it possible for one weaver to attend four looms where formerly two were the maximum number. This has been accomplished by controlling the various changes from a dobby. Thus in the case of the making of an ordinary terry towel with coloured headings and fringes the following changes have to be made. The body of the towel being taken as normal, when the terry-making device is at work and the terry warp is slack; when this is completed the terry motion must be put out of action, an increase in the number of picks must be made, and "plain," *i.e.* terry weave with both warps tight must be produced for a specified length; then extra white and coloured wefts of a coarse count must be introduced for cord headings. During this period the weave is changed, picks being put in with the first, fifth, and first ends raised on three succeeding picks, followed by picks with the first, fifth, and first ends left down on three succeeding picks. This produces a very thick cord heading, and is continued as long as may be required; this may be followed by another portion of "plain," after which the fringe is drawn down mechanically. All these operations and changes are automatically controlled, thus taking from the weaver what was previously the main portion of her work. The looms have proved highly satisfactory.

In the weaving of large Jacquard terry patterns, many attempts have been made to simplify the designing and reduce the number of cards. In some cases two hooks have been controlled by one needle, and one card has been presented to the needles for three or more picks, instead of one needle for each hook and one card for each pick, thus effecting a considerable saving in both designing and cards.

Some years ago W. Myers invented a machine in which four hooks were controlled by one needle, and one card was used for three or more picks according to the loop to be made, thus reducing the number of cards from six to one for a three-pick terry.

The essential parts of the machine are shown at Fig. 245. Each card is presented to the needles for three or more picks, during which time the griffes are worked to produce the weaves shown at L, M or N, O.

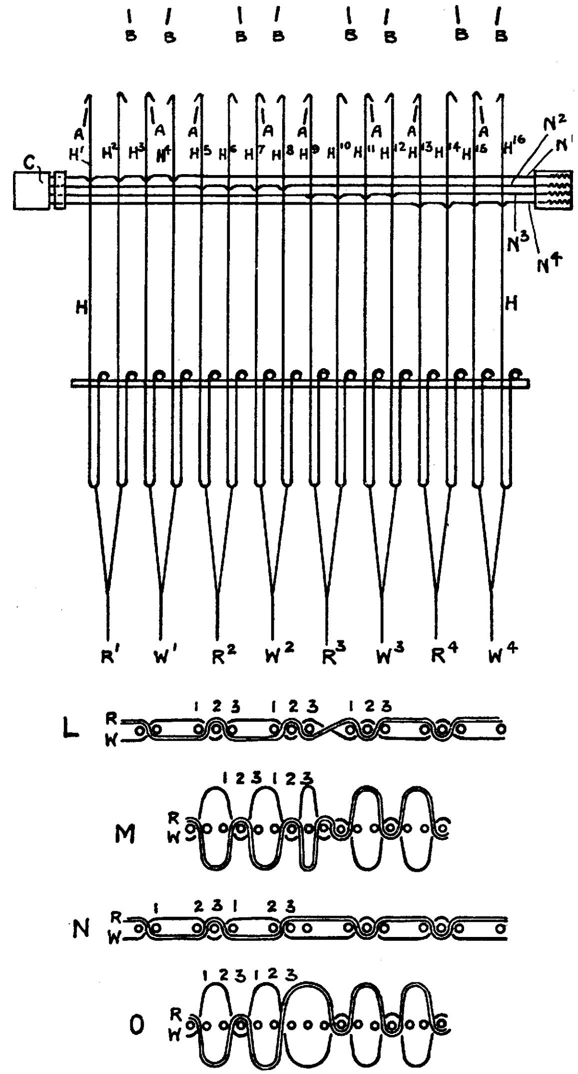


FIG. 245.

The machine is designed to weave figure and ground in solid terry, such as is commonly met with in lettered towels and figured bath mats.

For a three-pick terry griffe A is raised on picks 1 and 3, and griffe B is raised on pick 2. Therefore if it is desired to weave a red figure on a white ground, the design will be painted up in red and the ground left blank for the white portion.

Holes in the card will allow hooks H^1, H^5, etc., to be lifted on picks 1 and 3, thus making red figure, whilst blanks in the card will allow hooks H^3, H^7, etc., to be lifted to form white ground. To make terry in the opposite colours at the back of the cloth, the blanks in the card will cause hooks H^2, H^6, etc., to lift red ends on pick 2, to bind the red ends under the white ground, and holes on the card will cause hooks H^4, H^8, etc., to lift white ends on pick 2 to bind the white under the red figure.

Specially designed cams are used to operate the griffes in the desired manner, and to control the cylinder.

The most desirable weave is shown at L and M, but this requires that the griffe A shall be up on pick 3, then sink and be up again on pick 1. This practically converts the machine into a single lift so far as speed is concerned. For ordinary goods, such as towels, this is a distinct disadvantage, and has prevented the development of the machine. For wider goods, where the speed of the loom is much slower, the machine could be used to advantage. Another plan of weaving is shown at N, O, but here it will be observed that a long loop is made at the change, and this is considered objectionable, as all these long loops appear at the edge of the figure; therefore, although a higher speed may be obtained, it is at the expense of the appearance of the figure.

PART XIX

WARP AND WEFT STOP MOTIONS

Warp Stop Motions

In the year 1786 Dr. Cartwright patented a device for stopping a loom on the failure of a warp thread, and numerous inventors have since endeavoured to improve upon his scheme. Most of these inventions, however, were ignored until the problem of automatically supplying a loom with weft was forced into notice. It then became apparent that the number of looms which could be allotted to one weaver was limited by the attention to be given to warp breakages, and that only a warp stop would enable a radical change to be effected.

The following distinct types of warp stop motions are in use :—(*a*) Dr. Cartwright's plan, where detectors are independent of the shedding mechanism and severally suspended from the warp threads. In these, so soon as a fracture occurs, one detector falls into contact with a vibrating bar connected with the starting gear, and the loom is brought to a stand. (*b*) Those in which metal healds form detectors: —Here, at one point in the movement of a shaft, each heald is supported by a warp thread until a fracture occurs, when a heald falls by gravitation into the path of a vibrator, and the loom stops. The Boyne and one of the Northrop stop motions are of this type. In all motions included in groups *a*, *b*, connection between the detectors and the starting gear may be made either mechanically or electrically.

(*c*) Those in which steel wires are passed between pairs of crossed warp threads and, during weaving, are bent towards the shedding harness, but on the failure of a thread a liberated wire moves back into contact with a metal plate and electro-mechanical connections stop the loom.

Efficiency depends to some extent upon the positions detectors occupy in a loom. If they are on the shedding harness, the necessity for twice drawing in a warp, for dropping detectors over warp threads, or for threading wires amongst a warp is obviated. Further, since threads break most frequently in or before the healds, when detectors are placed between the lease rods, or in the positions usually occupied by lease rods, there is a risk of broken threads wrapping round unbroken ones and preventing those detectors from acting quickly. An efficient stop motion must have a wide range of application; it must be readily adaptable to different types and different widths of looms, to different materials, to varied counts of yarns, and to fabrics requiring two or more warp beams. Such a device improves the quality of cloth by causing weaving to cease when threads are broken; it reduces the number of floats, and prevents broken threads from breaking others. But heavy detectors are liable to break threads which would otherwise remain intact. The accompanying figures show different types of detectors and different methods of operating them.

The Northrop Warp Stop Motion

The Northrop warp stop motion consists in suspending a drop detector from each warp thread, so that its basal end shall be above a vibrating comb, until, through the

breaking or slackening of a thread, a detector descends into the path of the comb; when the driving handle is moved to stop a loom. Each drop A, Fig. 246, is made from a thin strip of smooth metal, approximately 5″ long by $\frac{7}{16}$″ broad. The upper portion is slotted, and at one place its breadth is reduced to facilitate the locating of a broken thread. Beneath the slot an eye is punched for a thread, but below that the metal is solid. The slots in A enable them to be threaded upon two bars B, which are placed about $1\frac{1}{4}$″ apart. These bars are held in the ends of a frame C, consisting of two sides and two ends. Upon the lower edge of each side piece a strip of finely serrated metal is screwed with its serrations inside. The end pieces of C are attached to the framework, and provide bearings for a shaft D. This shaft is furnished with a series of arms for the support of a thin plate E, finely serrated along both edges. All the above-named parts are fixed from 6″ to 7″ behind a harness, and extend across the warp space. A collar F is recessed to take a spiral spring and is fixed upon D. One end of this spring is made fast to the collar, the other end is similarly united to the loose half G of a claw clutch. The second half G′ of the clutch is fast upon D, and D is vibrated in the following manner: A cam H is fixed upon the picking shaft, and one arm of a cranked lever I rests against its face. The rear arm of I carries an adjustable rod J, whose upper end is fast upon the loose half of G. As H rotates, a rocking movement is conveyed from I, J to G. The coiled spring attached to G and to the fast collar F transmits sufficient energy to rock the shaft D. If by the descent of a dropper A the vibrations of the comb E are arrested, a loom must be instantly stopped. This is accomplished by mounting the driving handle V upon a pin and passing its base through a slot in a lever L, N, whose fulcrum is a shaft M situated in front of the rocking rail. The arm N is pinned upon a hooked bar O, and O has its

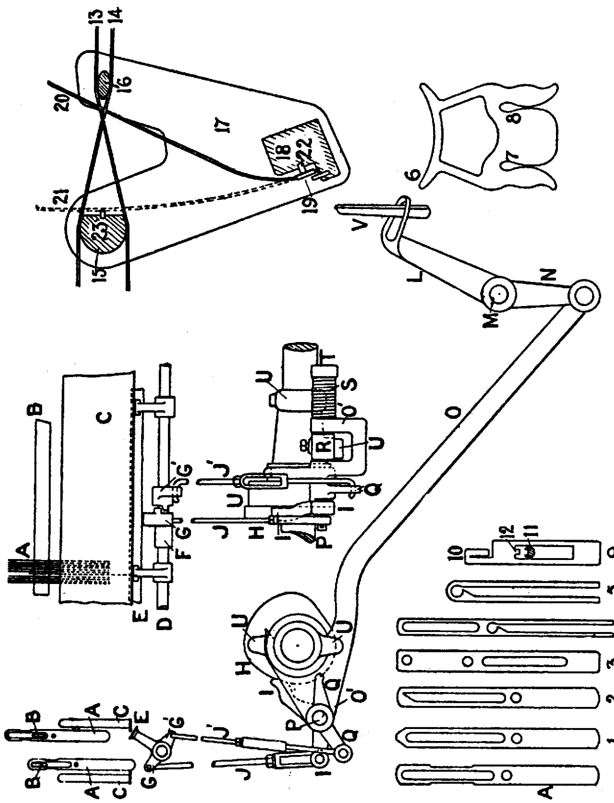


Fig. 246.

hook passed behind, and half round, a ring groove in the boss of H. Beyond the hook, O has a projecting piece O′ in which are bearings for a shaft P. Upon this shaft the cranked lever I is fixed, and a straight

lever Q is loosely mounted. A rod J′ unites the rear arm of Q with the fixed half G′ of the clutch. A short arm R is set-screwed upon P, and beyond R a coiled spring S has its outer end secured in a collar T, which is also fast upon P, but the inner end of S is fixed in the projection O′ of the lever O.

As the cam H rocks the dropper shaft D, an opposite vibrating movement is imparted to the straight lever Q by the rod J′, and the inner ends of Q and R are thereby raised and lowered alternately. So long as the comb E vibrates its full distance, the forward ends of Q, R are carried out of reach of two pieces U, that project from opposite sides of the boss of cam H, and the loom continues in motion. But if a dropper A, from the front line, falls into the path of E, the spring in F yields to the action of the cam H, and R, by engaging one piece U, is pushed back. In receding R takes with it the hooked bar O, thereby causing the lever N, L to free the starting handle V from its retaining notch. In the event of a dropper A, from the back line, falling into the path of E, the spring S yields, the inner end of Q makes contact with the second projection U, and the loom is stopped as before. Electrical connections may be employed to stop a loom in place of the mechanical device described above.

Several drop detectors are shown detached in Fig. 246. In those marked A, 1, 2, and 3, the warp is drawn through the detector eyes before entering a shedding harness and reed. But in 4, 5, and 6 provision is made for placing the detectors over warp threads. In 3, 4, 5, supporting rods are placed beneath a warp, but dirt and fluff are liable to accumulate upon the bars and impede free movement in the droppers. In 6 the detector is supported by two adjacent warp threads, one of which enters the eye

7, the other enters eye 8. In case either thread breaks, one end of 6 descends into the path of a vibrating comb and the loom is stopped. A thin piece of slotted metal has been freely hinged upon the top of a dropper A, and a light rod threaded through all the slots that fall in one line, so that, on the descent of A, the hinged piece will be lifted to locate broken warp. A detector of the type shown at 9 is suspended at 10 from a wire heald, and at 11 a vibrating grooved shaft passes through all the detectors that form one line. As a heald moves from one shed line to another each is, at one point, supported by a warp thread until a fracture occurs, when the tongue 12 falls into the groove of shaft 11 and arrests vibration. So soon as this occurs a loom is stopped.

Detectors occupy different positions in a loom; those represented by A, 1, 2, 3, 4, 5, and 6 are usually placed in a frame behind a shedding harness, but forked detectors such as 4, 5, and 6 may be suspended between lease rods; the latter are then fixed in a frame and a predetermined distance is maintained between the droppers and rods. Detectors in the back line are supported by threads that pass beneath the back rod, and those in the front line are supported by threads that pass beneath the front rod. The warp is itself supported by three round rods; two are outside the lines of droppers, and the third between them.

Breakages in warp being most frequent between the cloth fell and harness, detectors of the types A, 1, 2, 3 are occasionally placed between a harness and slay. But it is then necessary to place a harness an undesirable distance from the cloth fell. Detectors of type 9 are placed in the best position for acting instantly; they have, however, only been adapted for patterns that may be woven with a small number of shafts.

In 1902 A. P. S. Macquisten patented a warp stop motion of original design and application. It is shown in Fig. 246, where 13, 14 are two warp threads; 15, 16 are back and front lease rods respectively, which have their ends secured in two frames 17. An adjustable comb clamp 18 is also secured in 17; it is slotted longitudinally to take a series of wire combs 19, each 1″ long by $5\frac{1}{2}$″ deep. The backs of the combs rest against a metal bar 22, and two warp threads 13, 14 are crossed between 15 and 16, then one tooth is passed between them. When a loom is in operation the comb teeth are drawn forward by the crossed warp as at 20, but on the failure of one thread a tooth springs back to the position 21, where it makes contact with a strip of metal 23, let into the lease rod 15, and thus closes an electric circuit to operate the mechanism connected with the driving gear, and stop a loom. A breakage is readily located by the position of a wire.

A flexible wire is passed under a screw at one end of the control plate 23, and another wire is similarly placed against plate 22 in the comb clamp 18; these suffice to convey the small current necessary. The electro-mechanical motion which stops a loom is contained in a circular dust-tight casing bolted to the loom frame near the starting handle. It consists of a rod attached to a slay sword for the purpose of rocking a lever fulcrumed in the box. A projection from a slotted portion of the box is situated immediately behind the starting handle and is normally stationary. But on contact being made between a comb tooth and the plate 23, a piece of metal is moved electrically into the path of the swinging lever, and the otherwise stationary projection is pressed forward by the lever to stop a loom.

Weft Stop Motions

Dr. Cartwright quickly realised that a practical power-loom would require many new pieces of mechanism, one of which was an appliance to stop a loom immediately weft gave out, and thus prevent a fabric from being rendered unsightly by cracks. He fixed a swinging staple inside a shuttle, and caused it to be supported in a horizontal position by a thread of weft. When the weft failed, the staple assumed a vertical position, and was caught by a hook near the entrance to a shuttle box. This hook acted through a lever upon the driving belt, and brought a loom to a stand. Dr. Cartwright's plan did not succeed, nor was any striking success achieved by later inventors, until the introduction of the "fork and grid," which C. Gilroy claimed to have invented in 1831. Mr. Osbaldeston, of Blackburn, also claimed the invention, but it was patented in England by Ramsbottom and Holt in 1834. It was improved by Kenworthy and Bullough in 1841, and in 1842 James Bullough added a brake to make its action certain and expeditious.

From the last-named year this delicate and simple device has been an essential adjunct to most looms. It is usually adjacent to a starting handle, and a fork A, Figs. 247 and 248, is placed between a fabric and a shuttle box. Its three prongs are bent almost at right angles to its shank; the shank is also bent in the same direction to form a hook about $\frac{3}{8}$ of an inch long. A fork is free to swing upon a pin, but the prong end is the lightest. In 1903 T. Pickles and B. Blakey patented a fork made in two pieces; the prong section terminates slightly in front of the fulcrum pin, where it is bent at right angles. A second pin supports a shank that is bent at right angles at

both ends. The vertical portion of the fork impinges upon that of the shank, hence any pressure put upon one will tilt the other. The object of this change is to remove strain from a fork pin and thus prevent wear, for a worn pin renders the prongs liable to touch the grid bars.

A fork holder B is fixed by a set-screw to a fork lever C that occupies a horizontal position immediately behind

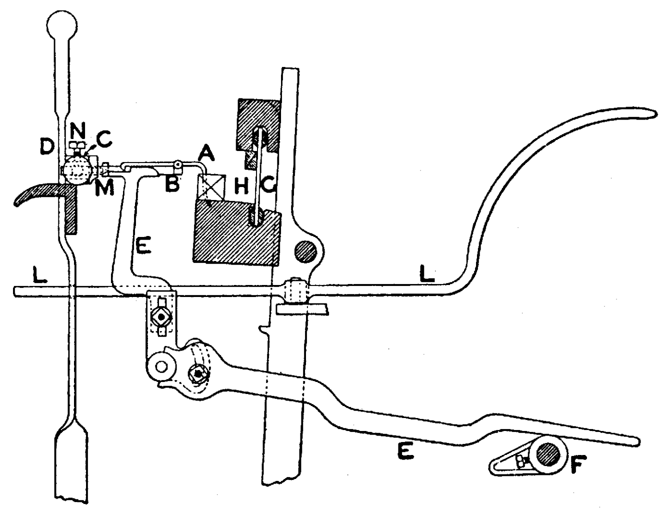


Fig. 247.

a starting handle D, and is hinged at its outer end. The short bend of A rests upon the top of a cranked hammer lever E, which is furnished with a catch capable of engaging the hook upon A, and the lower arm of E rests upon a cam F, on the bottom shaft of a loom. As F rotates, the head of E moves forward on alternate picks. In looms without a bottom shaft, a revolving scroll, see Fig. 196, may be used; in that event a rod from W is connected to the hammer lever E, Fig. 247, to impart the requisite rocking motion.

A metal grid G is fixed vertically, between a reed and shuttle box, with its spaces facing the prongs of A. In 1903 T. Pickles sheathed both the grid bars and the fork prongs with rubber; in 1904 he replaced the metal bars by catgut,—the object of the former change being to prevent the prongs passing the usual distance through

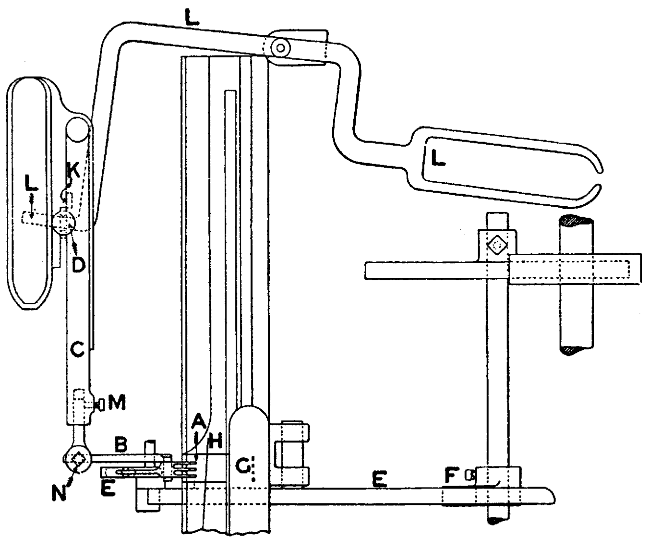


FIG. 248.

the bars, and, therefore, to draw less weft from a shuttle; the latter to render the bars flexible. A weft fork acts as follows: When a slay moves forward and a line of weft H crosses the grid G, the fork prongs are prevented by the weft from passing between the grid bars. By so doing the shank of A is tilted up as the hammer on E begins to advance, thus rendering contact between them impossible. Should a weft be absent the fork prongs pass

through the grid, and the shank remains horizontal. As the hammer moves forward it carries with it the fork, fork holder, and fork lever; the latter pushes the starting handle out of its detent K, and the spring of D, acting through a belt fork L, transfers the driving belt to a loose pulley.

Being placed at one side of a loom this mechanism only feels for alternate picks; but after weft has broken, the cranks should not revolve more than twice before a loom stops. Care is, however, required so to adjust the parts that a loom will stop when weft is absent, and continue running when it is present. To ensure the former, the fork prongs must not touch any part of the grid or race board, and they must be low enough to prevent the weft passing beneath them. Accurate setting is provided for by an adjusting screw M on the fork lever, which allows the prongs to be raised or lowered, and the fork to be moved laterally. A second setting screw N on the fork holder permits of a forward or backward adjustment. A weft thread should lift a fork hook clear of a hammer as the latter begins its forward movement. If a fork passes too far through a grid, there is a risk of cutting the weft; but if it does not pass far enough through, the hook will not clear the hammer. Also, if a shuttle rebounds, the weft is slackened, and will not tilt a fork sufficiently. Any of these things will bring a loom to a stand when it should be running. The lever E should commence to move when a reed begins its backward journey, and when a shuttle is boxed at the fork side, so that if weft is broken the hammer will engage the fork hook and transfer the belt to a loose pulley. If a weft is intact, the fork hook will be kept up until E has moved forward far enough to miss it, and the loom will continue to run. The fork lever C also requires attention;