its movement should be only sufficient to push a starting handle out of its notch. The traverse of this lever is regulated by moving its fulcrum pin nearer to or farther from the fabric. Lateral movement in the slay may cause a fork to tilt when a weft is broken, and permit a loom to continue running.

In order to stop a loom expeditiously, a weft fork has been placed near the entrance to each shuttle box. Also where two wefts are separately drawn from one shuttle, two contiguous forks are employed, but the prongs of one are longer than those of the other, and the wefts are so separated that the short-pronged fork acts upon the upper, and the long-pronged one upon the lower thread.

The Brake

The brake has largely contributed to render the present high speeds possible. Previous to its introduction, from 100 to 120 picks per minute represented the maximum velocity. In some cases a brake is merely an appendage to a weft fork; in others it acts whenever a starting handle is moved; for many purposes the latter type is to be preferred. As ordinarily made, a brake lever, A, Fig. 249, has an adjustable weight B hung upon one arm; the other arm, called the brake clog, is curved and covered on the inside with leather for the purpose of increasing its holding power. This clog is placed immediately below a fly-wheel C, and so governed that both may be instantly brought into contact when a weft breaks, or when a loom is stopped by other means. The weighted end of A is connected by a link D to a tumbler lever E, which rests upon either a bowl, or a curved bracket F affixed to a starting handle. When a loom is put in motion, E is raised by the pressure of F

against its full side, and the link D lifts the heavy end of A sufficiently to move the brake clog out of contact with C. If the weft fork acts, E falls, the brake A bears upon the fly-wheel C, and brings a loom to a stand. A hook on the top of E renders this brake inoperative except when the weft fork lever is drawn forward.

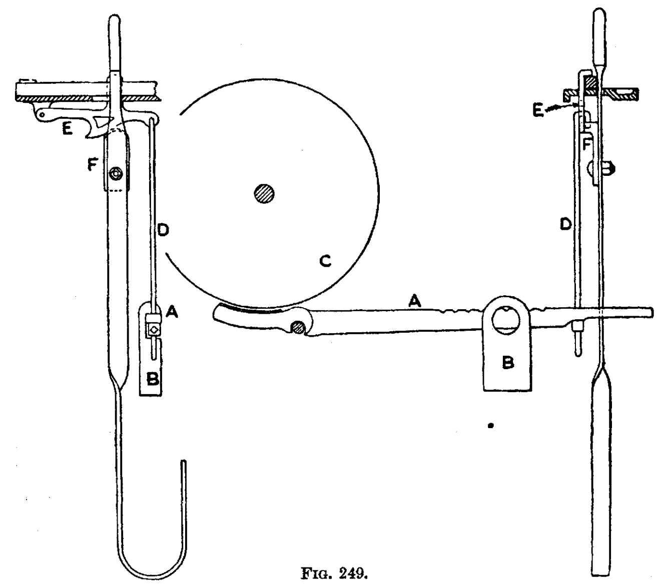

Fig. 249.

An ideal brake has not yet been invented, for, simple as its function appears, its construction is attended with difficulties. A brake when brought into operation should not impart a shock or strain to any part of a loom. It should not reduce the impetus of a slay when the last pick is driven home, but should allow free movement until the driving strap has been moved upon the loose pulley, and then bring a loom to a stand in the following half pick. If a weft is broken, a loom should always stop with the cranks at the back centres and with a shuttle at the fork side. If stopped by a weaver for piecing broken threads, the top centre is the most convenient place. A brake should not be an encumbrance, or add to the labour of a weaver. In check and other looms, where a pattern must not be broken, means should be provided for holding the brake off while a weaver turns a loom manually to find the proper starting-place.

An ordinary brake puts considerable strain upon the moving parts by acting before the driving strap is upon the loose pulley, and since it takes about one pick to move the strap, the crank shaft is forced against its bearings, the momentum of the slay is checked, and the last pick is not properly beaten home. A brake constantly acts in the same spot, and wears the shaft, bearings, and wheels, and becomes worn itself. When worn a brake permits a loom to stop in different places. The brake shown in Fig. 249 is thus seen to be unsatisfactory in many respects, and attempts have been made to construct a more perfect one. One inventor passes a steel band over a fly-wheel and attaches one end to the brake lever; the other end is made fast to a back brake which swings upon a pin. The band is in contact with about one-third of the wheel's periphery. As this brake lever rises the clogs are removed, as it falls both brakes are applied without a weight, for the moving wheel pulls the brake into action at two places, namely, from the top to the front centres, and about the back centre. In order to obtain a larger braking surface, T. Pickles, in 1894, employed a wheel with a Λ-shaped surface. He also suspended a V-shaped back brake from a pin at the top, and furnished it with a pin near the base

for a slotted arm to pass through. This brake is put in action by the weft fork in the usual manner, but gravitation carries it away from the wheel.

Haythornewaite's brake is constructed on original lines, and contains several good features. The curved arm M

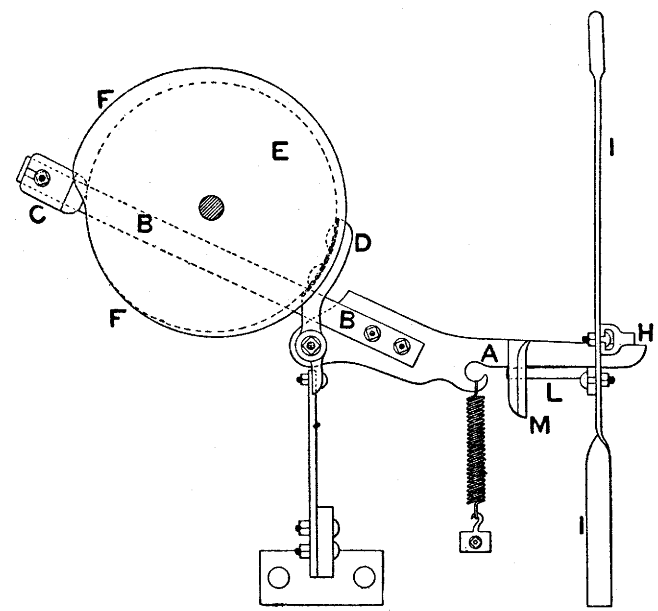

FIG. 250.

of a lever A, Figs. 250 and 251, is pushed up by a finger L on the starting handle I. A piece B is bolted upon A to support a back brake clog C, and a second clog D is also attached to A, to brake in front of the fly-wheel E. A spiral surface F forms part of E, but a groove G runs up the centre, except at one place where it passes diagonally to the outside. When a loom is working, the clogs C, D are out of contact, but a neb at the extremity of C is in line with the groove G. If a weft fails, the fork lever begins to be drawn back as the cranks leave the cloth fell. The starting handle I is pushed from its detent as the bottom centres are reached. The lever A immediately drops, and the neb of C enters the groove G, but the brake remains inoperative until the front centres are again reached. At this point the diagonal junction between E, F draws the neb of C upon the enlarging periphery of the brake wheel, and a loom is stopped with its slay a little beyond the back centre, and with a shuttle at the fork side.

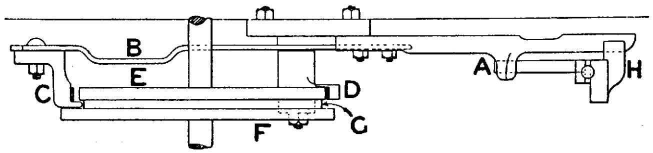

FIG. 251.

As the clog C is pushed back by F it pulls D into contact with the fly-wheel E, and lifts A until its forward end rests against a wedge-shaped fixing H on the starting handle I, where further upward movement in A is checked. Both faces of the fly-wheel are then held as in a clip, without putting unnecessary strain upon the working parts or checking the momentum of a slay in beating up the last pick. A spiral spring steadies A when a loom is working.

For another brake a fly-wheel has its rim broadened at one place. A socket is formed in a brake lever to receive the ball bearing of a clog with a lug at each end. When a starting handle is moved from its detent, the brake clog falls against the narrow part of the wheel; as the latter

continues to turn, the broad part of the rim comes into contact with two clog lugs, and a loom is stopped.

Friction-driving pulleys are being reintroduced to replace fast and loose ones, especially for heavy looms. It is claimed that by their instantaneous action less power is required to brake and pick a loom than with fast and loose pulleys. With the former the driving power ceases as soon as the connections are severed, and immediately the parts are connected, the full force is available to deliver the first pick. But an appreciable time is required to transfer a belt from one pulley to another. In stopping a loom, the belt and brake are opposing each other. In starting it, only a portion of the belt is upon the fast pulley when the first pick is delivered.

The Centre Weft Fork

A side fork is unsuitable for pick-at-will looms, because several shuttles may be driven in succession to the fork side, and if only one weft is intact the loom may continue to run. This defect increases with the number of shuttles in use. With a view to its removal, a fork has been placed in the centre of the reed space and made to feel for each pick. But at a high speed excessive vibration renders its action unreliable.

As made by Messrs. Hutchinson and Hollingworth, a centre fork has a transverse groove A, Fig. 252, cut in the slay B, to permit the prongs of a fork C to sink below the race board. A plate D, screwed upon the slay front, supports both C and a cranked lever H. The fork C consists of two prongs and a holder E, F. Its prongs are made from reed wire, are placed edgewise in two parallel saw slits in the holder, and fixed in position by a screw. A conical centre is sunk into each extremity of the holder, so that two adjusting screws G may support it. On the lower side two downward curves E, F put the fork under more or less positive control; the former enables it to be

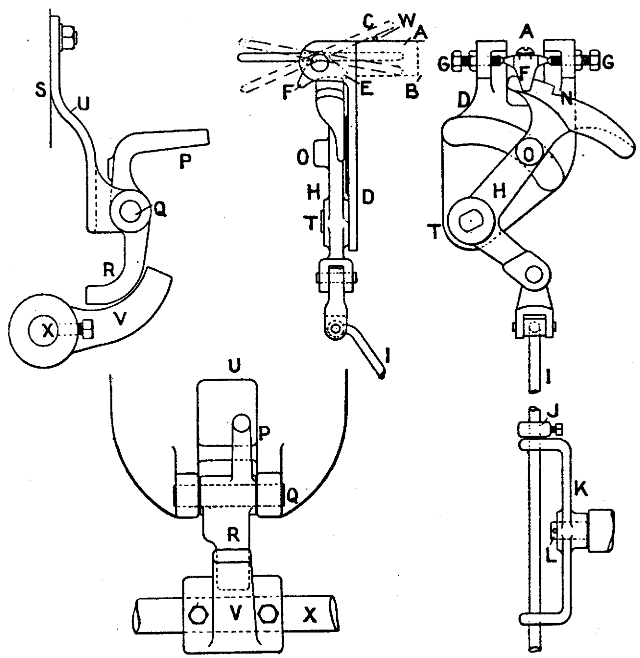

FIG. 252.

lifted and the latter causes it to be partially drawn down. The curves E, F are acted upon by a cam-shaped head on a cranked lever H, which is centred at T upon the plate D. The curved upper edge of H lifts E, and an outward swell on the front edge of H draws F down. The lever H has a thin rod I hinged upon it. I passes freely through holes

in the upper and lower flanges of a forked guide K, and K is free to swing upon a stud L, in a bracket attached to one of the cross rails. When a slay is moving into picking position an adjustable stop hoop J, set-screwed upon I, rests upon the upper flange of K. Continued backward movement in a slay carries the lever H closer to the forked guide K, and therefore the rod I assumes a position which approximates to the vertical. On contact being made between K and the hoop J, the rod I swings the lever H until its cam surface bears upon the fork holder, and lifts the prongs high enough to permit a shuttle to pass beneath them. Immediately a slay begins to move forward the rod I falls through the holes in K by gravitation, and draws H with it. If weft is absent as the prongs descend, the piece E remains in contact with the upper edge of H until a notch N is reached, when further movement in H is stopped. A projection O, on the lever H, is then opposite a dagger P, which is centred at Q upon a bracket U on the breast beam S. A slay moves O into contact with P, turns the latter upon its centre Q, and a lower arm R depresses a curved arm V upon the starting handle shaft X. By this means the shaft X oscillates, and the driving belt is transferred to the loose pulley in the usual manner. If, on the other hand, the prongs of C are arrested by weft W lying across the gap A, the fork is prevented from falling farther until the notch N has passed far enough beyond E, for the tips of the prongs to be drawn from the weft by an advancing slay. C then drops to the bottom of the groove A. But meanwhile the stop O has passed beyond the dagger P and the loom continues in motion. Centre forks are met with under various modifications; for instance, a fork may be rocked by a connecting rod fastened to the breast beam and to the fork. Then as a slay falls back the fork is lifted; as it moves forward the fork falls. A centre fork requires careful setting, and formerly, if the warp and weft were thin and open, the weft was liable to be looped beneath a fabric by the prongs. This defect has been considerably reduced by placing the fork under more positive control, and, in silk looms, by inserting a grid in the gap made in a slay.

PART XX

MECHANISM FOR GOVERNING THE WARP

SINCE the year 1786 the question of controlling a warp efficiently has received its full share of attention, but failure has followed the efforts of hundreds of inventors who have essayed the problem. The causes of failure are various, for the problem is a many-sided one. A warp-delivering motion should so act upon the threads that an equal strain will be maintained whether a shed be open or closed, and irrespective of the length of warp upon a beam. There should be no necessity for manual adjustment from start to finish of a warp. The warp should be positively supplied in lengths that exactly correspond with those drawn away by the taking-up roller. The mechanism employed should neither be unduly complicated nor liable to become deranged.

From the latter half of the eighteenth century two conditional methods have obtained, namely, rigid and vibrating warp beams. A rigid beam had a ratchet wheel

secured upon one end, and a pawl, hinged to the loom framing, rested in the teeth of the ratchet to hold the beam securely. After weaving 2″ to 3″ of cloth, the weaver pulled a cord attached to the pawl to liberate the wheel. He then proceeded to draw a length of warp forward without leaving his seat. The defect of this plan consisted in putting an increasing strain upon a warp, for every weft thread inserted, so long as a pawl occupied a fixed position.

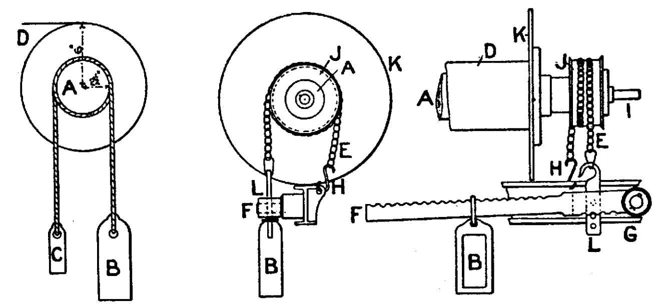

FIG. 253.

About the year 1788 a weaver named Clarke introduced a contrivance that increased the productiveness of a loom, and, in some respects, governed the warp more effectively than heretofore. He coiled two ropes several times round opposite ends of a beam A, Fig. 253, and fastened heavy weights B to the outer, and light balance weights C to the inner ends of the ropes. This allowed warp to be drawn from a beam whenever a taking-up roller was actuated. The control is superior to rigid appliances, because ropes and weights reciprocate with the shedding motion, for when a shed opens, warp is drawn from a beam, and when it closes, any surplus length is wound on again. But ropes and weights do not keep an equal tension upon a warp in all its varying positions. A change occurs at every revolution of a beam, caused by the withdrawal of a layer of yarn from its periphery, without altering its circumference where the ropes act. To rectify this would necessitate a reduction of weight in proportion to the decreased diameter of the coiled warp. Thus: if the radius of the beam A, Fig. 253, is $2\frac{1}{2}''$; that of the warp D is 6″; and B weighs 100 lbs., then if warp is drawn from D until its radius becomes 5″, a weight of 83·3 lbs. must be used to maintain an equal tension $\therefore$ 6 : 5 : : 100 : 83·3. Clarke's appliance in a slightly modified form is found on nine-tenths of the cotton looms now in use.

One alteration has been made to prevent the weights B from settling upon the floor. For stout fabrics it consists in removing the balance weights C, and fastening ropes or chains E upon hooks on the framing as at H. For light goods, ropes or chains are attached to flat springs similarly situated. Instead of causing the weights B to act direct, their efficiency is increased by suspending them from simple or compounded levers as at F, and uniting the ropes, or chains and levers, as at L. But this renders a beam less sensitive to movement in the shedding harness, and less capable of taking back any excess of warp than where balance weights are used.

In order to cause a letting-off motion to work satisfactorily, many points must receive careful attention. Of these the beam is one. Beams A are principally made of wood, of which there are two varieties, viz. solid and built; in both dry sound timber should be used. An iron hoop is inserted into each end of a solid beam; holes are drilled, filled with liquid glue, and bearded gudgeons,

about 1″ square in section, are driven in. The beam and its gudgeons are then turned to a uniform diameter; the former varying, according to the material used in its construction, from 4″ to 6″, and increasing by $\frac{1}{4}''$; the latter is from $\frac{7}{8}''$ to $1\frac{1}{4}''$. A built beam consists of a series of pulleys mounted upon a square shaft; these are covered with wooden lags, and turned. It is considered superior to a solid one, because the shaft renders twisting a rare occurrence. Beams are also made of cast or wrought iron and seamless steel tubes. The latter are light, and metal beams of all kinds are liable neither to twist nor split. They may be made with open ends and supported in cup brackets, or solid iron plugs may be cast with the gudgeons I, and the tubes shrunk on the plugs and riveted.

Cast-iron ruffles J prevent ropes and chains from channelling a beam; they must have sufficiently smooth surfaces to allow ropes or chains E to slip regularly. Smooth or corrugated iron or steel flanges K, from 12″ to 21″ in diameter, are fixed upon all beams intended for use in power-looms. They permit warps of great length to be wound on without risk of entangling the outside threads. Flanges are secured upon beams in various ways: A steel one may have a malleable iron boss bolted upon it, and be fastened to the beam by means of a clamp. Other flanges are cast in two sections, and clamped together upon a beam. But many are cast-iron, and simply screwed upon a beam.

A warp beam is supported in brackets bolted to the loom framing, and must be parallel with the back rest, the breast beam, and the taking-up roller. Unless a warp is wound upon a beam with an even tension, faulty cloth will be made. No definite rule can be given for weighting, nor for the length of warp exposed between a beam and a harness; both vary with circumstances. Generally a warp is held as tight as its strength will allow without giving the fabric a harsh feel or breaking the threads. If the strain is excessive, great force will be needed to open a shed, and the picks will not be driven close together. If the strain is insufficient, slack warp will permit one weft thread to ride upon another and form ridges in a cloth. Too much or too little warp may be subjected to the pulling action of healds; in either case unnecessary wear and tear results; in the former, because it is pulled too frequently before being woven; in the latter, because too great a tax is put upon its elasticity. From 20″ to 24″ is enough for looms making light fabrics, but 36″ to 56″ may be required in heavy looms.

Chains E are often superior to ropes for weighting warps, as the tension is more regular, and the cost of keeping them in good condition is less. The amount of friction produced by coiling ropes round beam ruffles depends largely upon their condition. New ropes possess greater holding powers than old ones; and ropes made from different fibrous materials give varying results. The condition of a ruffle also affects the tension put upon a warp; but if a given rope is coiled round a beam A, Fig. 253, and has a weight B and a counter-weight C attached to opposite ends, by doubling the weight of C twice as much weight will be needed at B to maintain an equal pull; for friction is in proportion to load.

An alteration made in the number of coils of rope upon a ruffle will produce marked changes. If a rope is twisted once round a beam and weighted, theoretically 1 lb. at C will be slowly pulled up by 3 lbs. at B. If the rope is lapped twice round, 9 lbs. will be required at B to lift 1 lb. at C. With three laps 27 lbs. will be needed at B to lift C,

and with four laps 81 lbs. will be necessary to perform the work. This is equal to the first, second, third, and fourth powers of the coils, or $1 = 3^1$, $2 = 3^2$, $3 = 3^3$, $4 = 3^4$.

Perry, in his *Practical Mechanics*, gives the following results of actual tests with a 1 lb. counter-weight :—

Laps of Rope on Ruffle.	Weight in lbs. required to slowly raise the Counter.
½	1·6
¾	2·1
1	3·0
1¼	4·0
1½	5·1
1¾	6·6
2	8·0
2¼	10·0
2½	14·0
2¾	20·0
3	23·0
3¼	30·0

The table shows a divergence from theory, but it demonstrates the utility of the rule given above.

There is a point beyond which additional laps will not be beneficial, and it is reached when regular slipping ceases, for the weights B are then wound up and the counters C sink to the floor. If, when the inner end of a rope is fixed to the loom framing as at H, a weight B is lifted, that end will slacken, and slipping will occur, but of so irregular a nature as to be useless to a weaver. It often happens that more than three coils are ineffective. Instead of increasing the coils it is desirable to increase the weights of the leverage.

The rope and lever tension device is simple but unmechanical. When tested by the conditions stated on p. 500, it is found to be incapable of maintaining an equal tension, either as sheds open and close or at different parts of a warp. An attempt is, however, made to approximate to a uniform tension during shedding by employing a vibrator, which moves in to slacken a warp as a shed opens, and out to tighten it as a shed closes. But the regulatión of friction from one end of a warp to the other is left to the weaver, who reduces the weight on F as the diameter of the warp beam diminishes. Vibrators are not equally useful for all classes of fabrics, or for all shedding motions. They may be especially useful where all the warp is moved for every pick, as in plain and centre shedding. They are often essential in looms furnished with a positive warp-delivering motion. But for stationary bottom and open shedding a vibrator is of less use, since it must slacken or tighten all the warp threads simultaneously, whereas only those that move require easing. When plain and centre shed looms are without vibrators, the rear ends of the weight-ropes or chains are attached to springs, which to some extent reciprocate with the shedding movement. Otherwise the weight-ropes are connected to fixed hooks H. A vibrator will then give satisfactory results, provided the shape and throw of its cam are derived from the shedding lift.

Ropes and weights do not fulfil the second condition, for instead of a warp being delivered positively, it is pulled from a beam as required by the shedding, beating-up, and taking-up motions. The third requirement is admirably met, because nothing capable of doing the work can be simpler or, when once adjusted, less liable to become deranged.

The so-called positive let-off motions include automatic tensioning appliances; also mechanisms which deliver a warp positively, but require weights or springs to

maintain a fixed tension upon the threads after they leave a beam. In most of these, positive and conditional parts work in unison, but without direct connection with the taking-up motion. Other let-off motions not only deliver the warp but draw away the cloth positively.

From a multitude of devices it is only possible to select typical examples from each class. Yet from these a general knowledge may be obtained of the directions in which inventors have worked. Charles Schilling of New York claims to be the inventor of a motion belonging to the first-named class. He uses weights B and smooth levers A, Fig. 254, but fastens the weights to an endless rope C that passes over guide pulleys D, E and round a rope wheel F. A pinion G is compounded with F, and its teeth gear with those of a rack H suspended from a presser lever I. The fulcrum of I is at J, and a movable weight is placed upon J at K. Above the rack H a presser bears against the under side of a warp, and as the latter is drawn away H ascends, moves the pinion G, the wheel F, the rope C, and the weights B. Since the rope C is crossed, any movement imparted to it will carry each weight B towards the fulcrum pin of its lever, and diminish the pull upon a warp beam in proportion to the reduced diameter of the warp. This motion is neither unduly complicated nor difficult to adjust. When a full warp is put in, the presser is forced down and the weights move to their proper places. If necessary, the weights can be removed during weaving, but they must be put back in the same places. Its defects are: that a warp is not delivered, but pulled off; that the presser prevents a beam from taking back any excess of warp drawn away; that it does not maintain an even tension during shedding; that the form of the presser is liable to cause the surface of a beam to become irregular. But a roller extending from flange to flange would remedy the last-named defect.

In 1875 Messrs. Hanson and Crabtree patented an automatic tension motion, in which a beam A, Figs. 255 and 256, rests in leather-covered cup brackets B, B. A cap is held upon the top of an iron hoop on A by means of a flat spring C, and is pressed down by a screw K. The pressure is reduced at every revolution of a beam by a peg D in a beam hoop. D engages a star wheel E, and

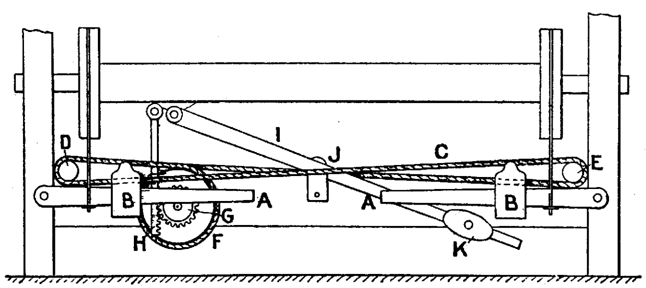

Fig. 254.

by moving it one tooth, sets in motion the wheels F, G, H, the worm I, the wheel J, and the screw K, thus slightly reducing the compressing force of C upon B. Different wheels F, or H, are used for different warps and fabrics.

A motion belonging to the second class is made by Smith Brothers. It consists in fixing a worm wheel A, Figs. 257 and 258, upon one end of a warp beam to gear with a worm B. The latter is secured to the bottom of a short vertical shaft, and a ratchet wheel C is secured to the top. Upon this shaft a bent letting-off lever D, F is loosely mounted. On the arm D a pawl E is hinged, to take into the teeth of C. A spiral spring, hooked into D, and also

into a bracket on the framing, keeps the lever in one position when not otherwise controlled. A rod G is hinged upon a slay sword, its rear is slotted, bent at right angles, and furnished with an adjusting screw. A screwed stud in the arm F passes through the slot in, and its head supports, G. Each forward stroke of a slay imparts sufficient movement to G, F to cause the pawl E to drive

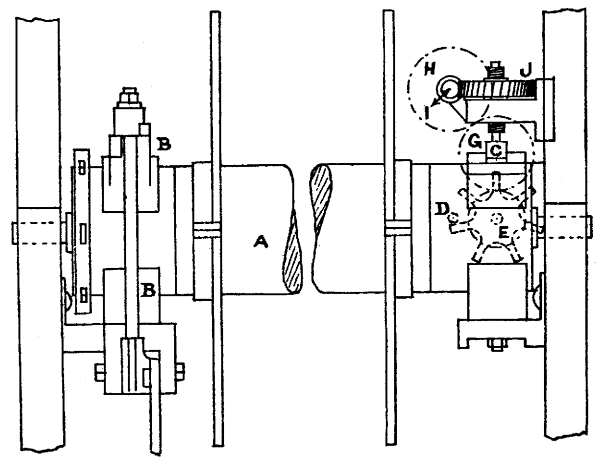

Fig. 255.

C one tooth and move the warp beam. But a tooth taken when a beam is full will deliver a greater length of warp than when a beam is nearly empty. For this reason conditional parts are added to regulate the supply. These are: a shaft H, which carries a three-armed lever I, J, K near one extremity, and a two-armed lever, I, J, near the other. I, I support a warp roller L, and J, J two weighted stalks M, M, while K is united to the lever D, F by a slotted rod N and a stud.

A warp passes inside the shaft H, and over the vibrator

L to the harness and fabric; but the weights upon the stalks M keep it under a constant tension. The ratchet C, if moved one tooth for each revolution of the cranks, would deliver more warp than the taking-up roller requires. Should this occur, the roller L is pulled back by the weights on M, and the rod N is pushed forward by the arm K until a stud in F impinges upon the inner end of the slot in N. The spiral spring is then unable to draw the pawl E far enough back to take a tooth in C, and letting-off is suspended until L regains its normal position. For heavy work, a brake band is drawn by an advancing slay against a ruffle on the shaft H, to prevent L from vibrating during beating up. A greater strain is put upon the yarn in an open than in a closed shed.

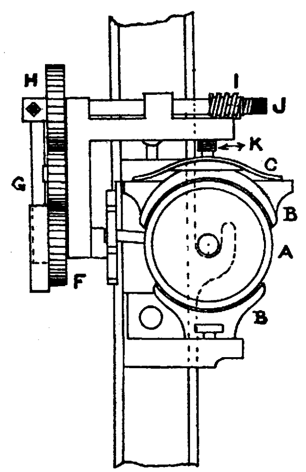

Fig. 256.

In 1892 R. Wilby removed the stalks and weights M, and in their stead employed the upward thrust of springs to regulate the inward movement of the vibrator L. He also altered the positions of the parts, but left them essentially as above named.

Messrs. Hutchinson and Hollingworth have developed a letting-off motion which also belongs to the second class. It is constructed as follows: Upon the slay sword a link B, Fig. 259, forms a connection with a three-armed ⊥-shaped lever C, whose fulcrum is at D. Each horizontal arm of C terminates in the segment of a bevel wheel,

and the teeth of C engage corresponding segments on two cranked levers E, F. These levers are loosely mounted upon a letting-off shaft G, and are situated on opposite sides of a ratchet wheel H, secured upon G. In the upper arms of E and F two pawls I, J are respectively

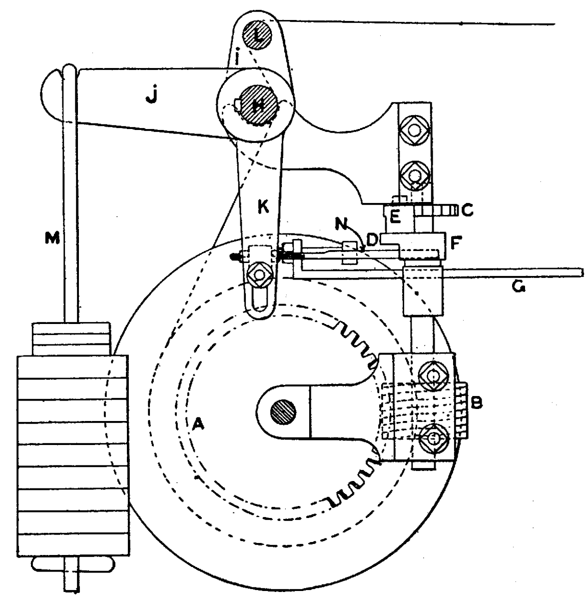

Fig. 257.

mounted. As a slay moves the segments on C to and fro an alternate movement is imparted to the pawls I, J, and this causes one to drive H at each forward, and the other at each backward, swing of a slay.

At the rear of the letting-off shaft G a worm K engages a wheel L on one end of a warp beam M. At the front of G a flanged wheel N has a brake band upon its surface to prevent overrunning. The warp from M is led over a vibrating roller O, thence through the shedding harness and reed to the taking-up roller. The ends of O are supported in the cup-shaped terminals of two cranked levers P, only one of which is shown. One lever P moves upon a stud Q; its straight arm supports an adjustable rod R, and R is attached to a weighted lever S, whose fulcrum is at T, and whose action is to draw O outward; but the extent of such movement is limited by an adjusting

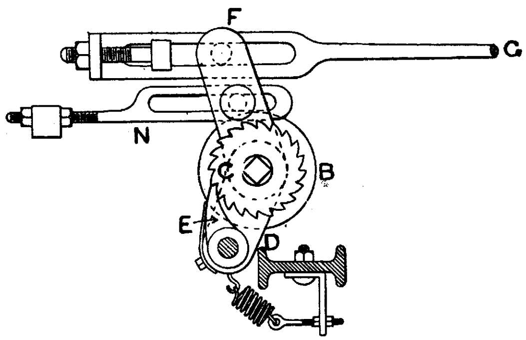

Fig. 258.

screw 2 placed beneath the straight arm of P. The second lever P is furnished with corresponding parts Q, R, and 2, but a link connects P, P in order to render the weighted lever S equally efficient at both ends of a loom. At U one lever P is provided with a regulating screw that impinges upon a lever V; the latter moves upon a pin W; at X it is connected to a cranked lever Z by a rod Y, and Z is loosely mounted upon the letting-off shaft G. To the lower arm of Z a shield 1 is affixed for the purpose of regulating the supply of warp. In case of excessive delivery the shield is interposed between the

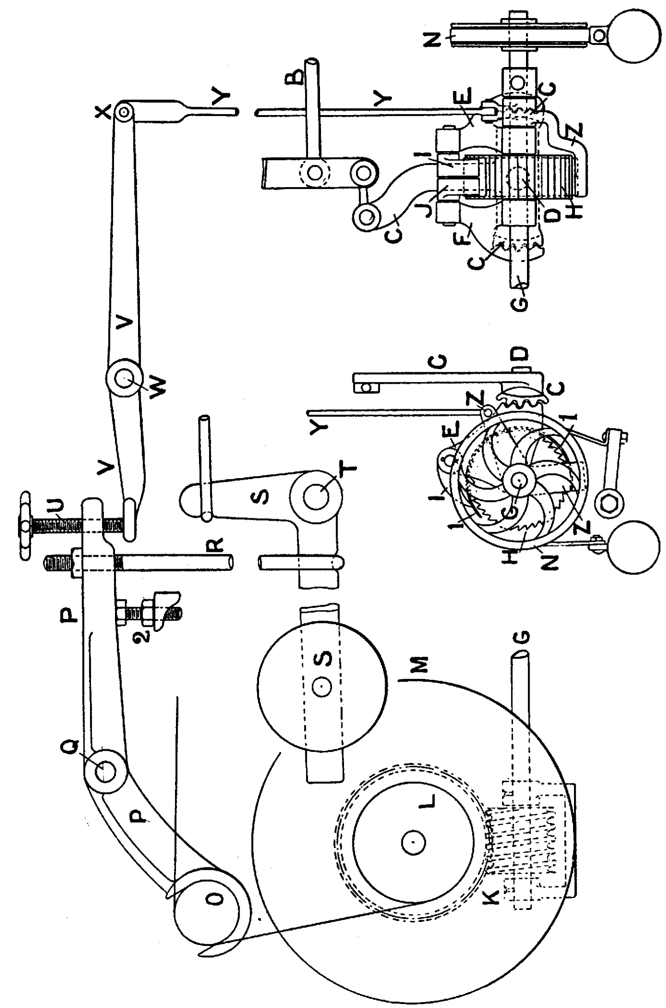

Fig. 259

pawls I, J and the ratchet H. When this occurs, I, J merely vibrate upon the shield, and all delivery ceases. But 1 also permits warp to be given off in the following manner: The forces exerted in shedding, beating-up, and taking-up tend to draw the vibrating bar O inward, a tendency which is resisted by the weighted lever S acting through the rod R. Immediately the force of S is overcome, the adjusting screw U rises with the horizontal arm of P, and permits the lever V to vibrate. In falling, the long arm of V imparts movement to the rod Y and rocks Z, thereby withdrawing the shield from between the ratchet and pawls; the latter then give motion to H and deliver warp.

If the pawls I, J are set to deliver sufficient warp from an almost empty beam, they will be nearly inoperative when a beam is full, but will automatically increase in effectiveness as a warp is uncoiled. By this means the conditional parts limit the action of the positive ones, and form a reliable combination. If two warp beams are necessary, the above-mentioned parts are duplicated.

A letting-off roller may be mounted in two arms of a weighted lever and set to bear against a warp. A cam on the bottom shaft then depresses another arm of the same lever, and from this arm a connecting rod operates a pawl in a similar manner to that shown at E, Figs. 257, 258. The nearer such a pressing roller approaches the axis of a warp beam, the more the tappet depresses the lever, and the farther the ratchet is driven.

In 1882 George Keighley devised a self-contained let-off motion, in which the beam is only weighted to prevent a warp from overrunning. After a warp leaves a beam it passes over a heavy, cloth-covered pressing roller A, Fig. 260, under a measuring roller B, having the same circumference as the taking-up roller Q, viz. 15″, and over

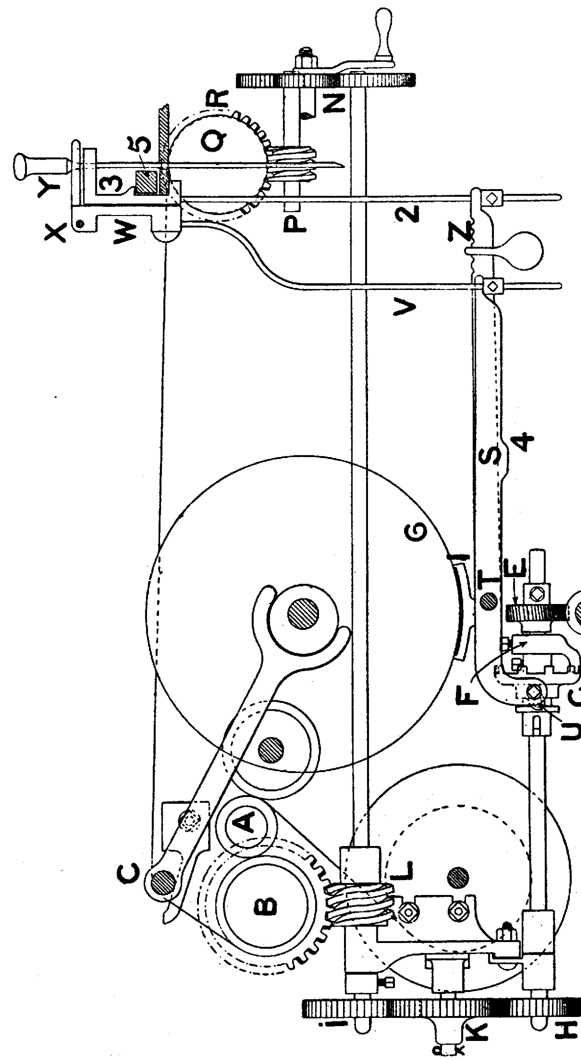

FIG. 260.

a vibrating bar C, to the cloth roller. The roller A is placed between B and two supporting pulleys that allow A to gravitate towards B, and thus hold the warp threads securely.

The parts are driven by a worm D, on one end of the bottom shaft, for D engages a wheel E upon a clutch shaft. Slightly in advance of E, a bracket F carries a flattened projection into contact with one of ten teeth on the side of a disc clutch G. When a loom stops, G slides backward upon a key-way, to disengage the letting-off and taking-up parts. G is traversed laterally upon its shaft by a pin U in lever S, which enters a ring groove in the clutch G. A rod V connects S with a three-armed lever W; its horizontal arm touches the starting handle Y, and is hinged at X, so that by turning it up to the perpendicular, a loom may be set in motion without delivering warp or drawing cloth forward. If this arm is left horizontal, when Y is shifted to its detent, W rocks, lifts V and S, and by sliding G into contact with F, all parts of the letting-off motion begin to act. Should the weft fork stop a loom, the disc G immediately moves away from the single tooth F, but F continues to move until a loom becomes stationary. After starting a loom, and before more cloth is drawn forward, the single tooth F must travel until it again makes contact with G. Cracks are thus prevented, for it takes on an average from two to three picks for F to move from tooth to tooth in G. A piece 4 on the lever S passes beneath a weighted brake lever Z to lift Z with S. But Z is free to rise alone; it carries a brake clog 1 at its inner end, and is connected by a rod 2 to a tumbler lever 3, which rests upon the weft fork lever 5, hence, when Y is moved outward, Z rises with 2, and the clog 1 leaves the periphery

of a fly-wheel 6; the opposite movement of Y causes the brake to act. The measuring roller B is driven from the clutch shaft by a wheel H, that contains 15 teeth if the teeth in a wheel I equal the number of picks per $\frac{1}{4}$ inch in a fabric. If H has 30 teeth, they equal picks per $\frac{1}{2}$ inch. If 45 teeth, they equal picks per $\frac{3}{4}$ inch; and 60 teeth give the picks per inch. The wheel I is changed when alterations have to be made in the number of picks; it is attached to the rear end of a side shaft and is rotated by a carrier K. A worm L drives the measuring roller B, and another wheel on the forward end of the same shaft drives, through a carrier N, the taking-up roller wheel, which contains 100 teeth. The latter is fixed upon a short shaft P, whose axis is at right angles to the taking-up roller Q, and is compounded with a worm which takes into the teeth of a worm wheel R, on Q.

More than one yard of warp is required to weave one yard of cloth, but the exact amount varies with the weave and with the thickness and closeness of the warp and weft. It is almost impossible to ascertain by calculation the allowance for contraction; in practice this is determined by experience. Assuming the percentage of warp-contraction has been obtained, the wheel on the forward end of the side shaft must have one tooth less for every per cent of contraction than the wheel on P.

The parts described above secure a regular delivery of warp, and a constant tension results from making the outlines of the shedding and vibrator tappets similar in curve but dissimilar in throw. The following experiment was made in order to ascertain to what extent the inventor had succeeded. A thread was passed between the rollers A, B, over the vibrator C, through the healds and reed, and over the taking-up roller Q. This thread terminated in a light weight, and was permitted to hang loosely. On moving the healds up and down the weight remained stationary, hence it was concluded that the tension was constant. This device contains many costly parts, and more time is required to gait a new warp than when a tension motion is used.

An increase of moisture in the atmosphere causes warp thread to contract in length, and when under positive control they are held rigidly by the cloth and warp beams. If under such conditions a loom is left stationary for a considerable time, the tensile strain upon the threads as they contract is often sufficient to cause fibre to slip upon fibre, and a large number of breakages to occur before the warp thus exposed can be woven up.

PART XXI

AUTOMATIC WEFT-SUPPLY MECHANISM

FROM the time when steam and water replaced manual power for weaving, efforts have been almost ceaselessly directed towards the attainment of increased productiveness in power-looms. For many years inventors endeavoured so to improve loom mechanisms that higher speeds might be possible, or more looms be allotted to each weaver. But a time arrived when the limits in both directions appeared to be within sight. Other schemes were then resorted to. Existing methods of supplying looms with weft were known to be unsatisfactory in proportion to the coarseness of the material to be used. Enlarging the storage capacity of a shuttle offered a partial

solution, but it was recognised that large shuttles required sheds of corresponding dimensions, and this entailed a higher percentage of warp breakages. Radical changes were inevitable if production was to be considerably increased, or if one weaver was to attend to a larger number of looms. Once such ideas became fixed, the problem was attacked from many sides. Some attempted to convert a shuttle from a storer of weft to a carrier of sufficient weft for one or two journeys only, and to draw from an external supply. Since a carrier could be considerably smaller than a shuttle, small sheds, and a reduced strain upon the warp would follow. Others attempted to give shuttles a continuous instead of an intermittent motion, and to cause several of them to move through a warp simultaneously, at fixed distances from each other in a circular path. These inventions require a warp to be divided in advance of, and closed behind, each shuttle, also that the weft deposited amongst the warp shall be beaten home before the arrival of another shuttle. But their details have not been sufficiently perfected to render the looms practicable.

Two principles are involved in the mechanisms now prominently under the notice of manufacturers. One consists in retaining shuttles of the usual type, and means are devised for ejecting a shuttle containing an exhausted spool or cop, and automatically inserting a fully charged shuttle. The other scheme consists in ejecting a spent spool or cop from a shuttle and replacing it with a full one. Neither principle is new, for in 1840 Charles Parker patented a method by which a spent shuttle was automatically ejected and a loaded one inserted. This was followed in 1852 by a patent granted to William Newton for a communication describing a different method of compassing the same end. Automatically changing a cop or pirn dates from 1857, in which year Patrick M'Farlane patented a device for placing a cop in a case and inserting and ejecting the cases when necessary. In 1860 Thomas Ingram patented another method, and in 1861 John Leeming modified Ingram's invention.

Since 1894 many shuttle-changing devices have been exhibited, some of which embodied the ideas of older inventors, others were developed upon original lines. Original shuttles have been inserted and ejected in front, behind, above, and beneath single shuttle boxes; they have been fed in at one end of a loom and ejected at the other end. Drop and revolving boxes have also been employed to assist in moving an empty shuttle away from a picker and a full one into working position. Subsequently the empty shuttle was ejected from its box and replaced by a full one. While effecting changes in shuttles, looms have been worked at their normal speed, at a reduced speed, and have been automatically stopped and started before, and after, a change. Changes have been controlled from a weft fork; from a feeler that acts when the weft supply is almost exhausted; also from a pick counter which effects the change after a predetermined number of picks have been drawn from a shuttle. The parts that effect the changes have been mechanically and electrically controlled.

Spool-changing devices are less numerous than shuttle changers, but they are more extensively used, probably because it is easier to change the contents of a shuttle than to change a shuttle, for shuttles are specially liable to injury during the changing operation; it is also more difficult to adjust shuttle boxes to many shuttles than to one.

The Northrop Weft-Changing Mechanism

The cop changer invented by J. H. Northrop, and patented in the United States of America in 1894, marked the beginning of far-reaching changes, which include the reorganisation of the preparation and weaving departments of textile works, and possibly that of spinning mills also. So successful has this invention proved that approximately 350,000 of these looms are now in operation.

This device has as its central and most original feature a self-threading shuttle, without which other parts of the loom would be of little value. Instead of a tongue, the shuttle is furnished with a series of movable skewers A, Figs. 261 and 262, whose metal heads are severally covered with a sheath of wood secured by three annular rings B. A forked clip C, with separable spring arms, is fixed at the rear of the weft space in a shuttle; in each of its prongs four vertical grooves are formed to receive the rings B. The diameter of a head of A is greater than the space between the prongs of C, therefore, if a skewer is pressed into C, its prongs will open, B will enter the grooves in C, and the prongs will hold A securely. An inclined directing plate D embraces C, and assists in guiding a skewer into position. After a loaded skewer has been inserted the weft must be automatically drawn into the shuttle eye. This is effected by a brass threader E, which is sunk into the shuttle near the front tip. Along the top of E a diagonal slit communicates with the shuttle eye. For the first pick, the weft enters the slit and goes beneath a downward curved lip at the entrance to the slit; and also beneath the front edge of the threader. For the second pick, the weft is sharply deflected and travels downward through a clearance space between E and

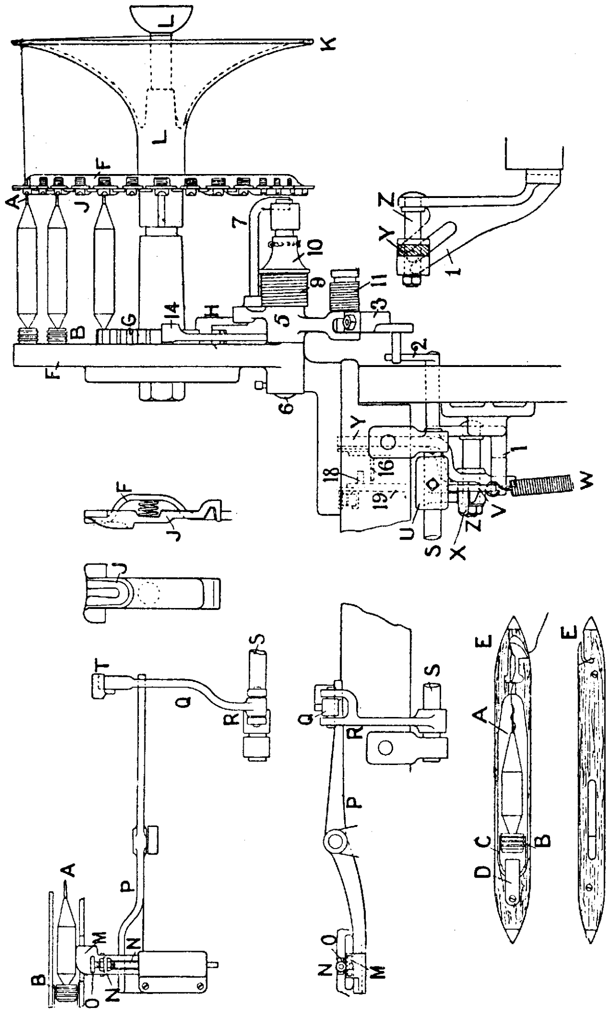

Fig. 261.

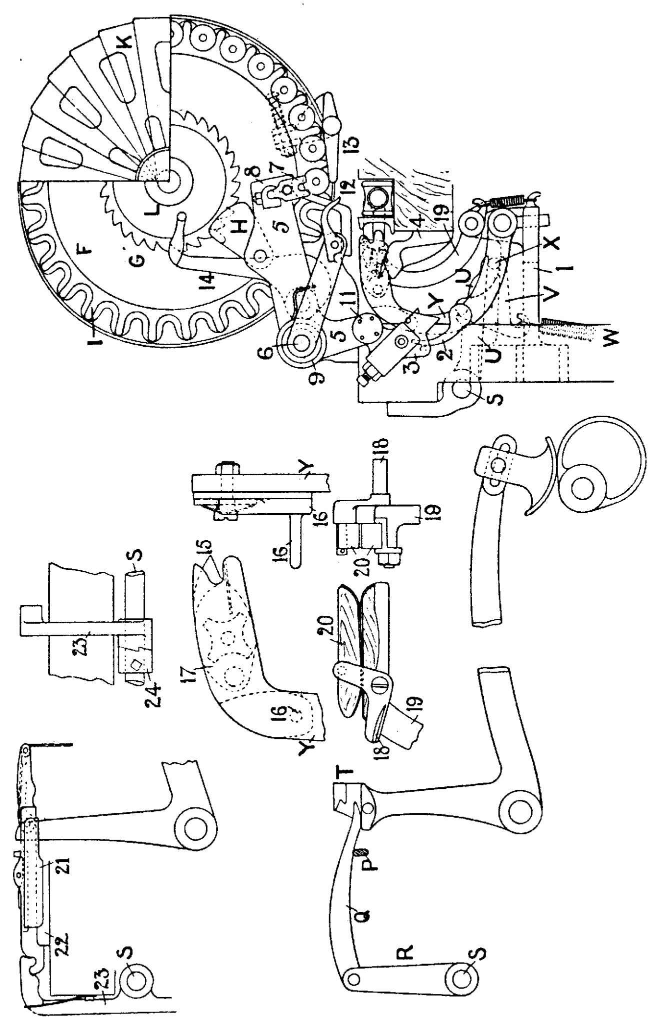

Fig. 262.

the wood, where a horn guides it to and through the shuttle eye. When once the weft is threaded the metal is shaped to prevent it from being drawn out again. Beyond the spring C a slot is cut in the shuttle face to permit a feeler to make contact with the weft, and set the change mechanism in action shortly before the supply is exhausted.

Cops or pirns when pressed upon the skewers A are placed in an intermittently rotating hopper F capable of accommodating twenty-eight skewers. F is situated over that shuttle box farthest from the driving gear. It is freely mounted upon a spindle and rotated by a ratchet wheel G and a pawl H, the latter being operated by the change mechanism. The head of each skewer A enters a semicircular recess formed in the face of a disc I, but the tips of A impinge upon recessed plates J, each being held forward by a spiral spring, as shown detached in Fig. 261. Weft is drawn from the nose of each cop over a notched disc K, and made fast at L to the hopper boss. One skewer is always immediately below the hopper axis, and, when weft fails, this skewer is forced down into the shuttle, simultaneously a spent skewer is ejected from the base of the shuttle without reducing the speed of a loom.

There are two methods of setting change mechanism in operation, namely—(*a*) by a feeler action; (*b*) by a weft fork. At the weft fork end of a slay, a feeler is mounted in sliding bearings upon the framework to face the shuttle slot. It consists of a thin brass plate M that terminates in a cylindrical shank. A spiral spring threaded upon the shank thrusts M forward, but permits it to yield to end-long pressure. A pin in M carries a cranked trip lever N, one of whose arms is furnished with an adjusting screw O, the other is free to move in a slot

in M, and rests upon a lever P. The inner arm of P is beneath a dagger Q, which is fulcrumed upon an arm R, and R is secured upon a shaft S that traverses a loom beneath the breast roller. As a slay advances to beat up, the feeler M enters the shuttle slot, impinges upon the weft, and, so long as a sufficient quantity remains, M is thrust back before the head of the screw O touches the shuttle front. As the diameter of a cop is reduced, M passes far enough through the slot to permit the shuttle to engage the head of O, tilt the levers N and P, and thus lift the free end of Q until it faces a notched bracket T, bolted upon the weft-fork hammer. As this hammer moves forward, T thrusts back the dagger Q, also the arm R, and a shaft S makes a partial revolution.

The opposite end of S controls a shuttle positioner and a weft cutter combined, by which all weft changes are effected. Thus: An arm U is screwed upon and vibrates with S. A triangular casting V is suspended from U, and a spring W is so attached to V and to the framework that its pull tends to lift the inner end of V. The inner ends of U and V being respectively above and beneath a pin X, they provide a groove for X to work in. The spring W is normally strong enough to carry a weft cutter lever Y forward, but if Y is stopped by a shuttle, the spring gives way and permits U to ascend without moving the cutter. Pin X is cast upon one arm of the cutter Y, and Y is freely mounted upon a stud Z. The lower arm of Y moves in a diagonally slotted bracket 1, shown detached in plan view, Fig. 261. When the shaft S vibrates, the pin X tilts Y towards the reed, and the slot causes Y to slide outward upon Z. The upper arm of Y serves three purposes—(*a*) it prevents a change when a shuttle is incorrectly boxed; (*b*) it effects a change when a shuttle is suitably placed; and (*c*) it cuts the weft left between the hopper boss and the entrance to a shuttle box.

It prevents a change as follows: The lever Y slides diagonally forward and outward until the mouth of a shuttle box is reached. If, as a slay advances, a shuttle is only partially driven home, that shuttle blocks the path of Y and arrests further movement, before other parts governed by Y are brought into operation. If, when the weft fails, a shuttle is properly boxed, the head of Y crosses the race board, in a straight line, without obstruction. In doing which a bent arm 2, on the cutter lever, is moved away from a notched piece 3, fulcrumed between the prongs of a forked lever 5. A coiled spring 11 is employed to lift 3 immediately 2 is moved. Normally the arm 2 holds the notched terminal of 3 down, but as Y approaches the reed, the spring 11 lifts the notch of 3 until it faces a stop 4 upon a slay front. As the driving cranks near their front centres, stop 4 engages the notch in 3, and partially rotates the lever 5, whose centre is a stud 6 in the hopper frame. Upon one extremity of 5 a horizontal rod 7, with a notched wooden finger, is fixed above the thin end of the lowest skewer A, in the hopper F. Upon the other extremity of 5 a piece of metal 8 is situated over the head of the above-named skewer. As the lever 5 vibrates, 7 and 8 press a skewer from the hopper into a shuttle, and force an empty skewer out of a shuttle. The boss of 5 passes through a coiled spring 9; one end of 9 enters the lever and the other end enters a collar 10 fixed upon the supporting stud 6. It is the office of 9 to hold 7, 8 slightly above a skewer until the shaft S is put into action, and then to yield as 7, 8 descend.

A spring guiding finger 12 is mounted upon a stud in the hopper frame; its nose is held by a spring beneath

the thin end of the lowest skewer in the hopper. As this skewer is forced out the finger guides it into the shuttle. 12 is assisted by two other parts, namely, by a fixed plate with an inclined surface, which guides the head of a skewer; also by a lever 13, so fulcrumed upon the hopper frame that its front edge is pressed by a spring against the under side of the skewer head until that skewer is ejected from the hopper when 13 yields; it also holds the skewer in position until a weft fails. The hopper F is rotated by hinging a pawl H upon the lever 5, so that as 5 ascends the ratchet G will be advanced one tooth, and so bring the next skewer into position for use. G is prevented from receding by a holding pawl 14, centred upon a stud in the hopper frame.

The weft cutter is shown detached in Fig. 262; it consists of two jaws, one made from a thin strip of steel placed in a recessed portion of the head of Y, and slightly bent forward to keep it in contact with a movable jaw 15. A cap 17 is pressed by a flat spring upon the jaw 15, and from one side of 15 a stud 16 projects. As the head of Y advances, the stud 16 engages the under surface of a wedge-shaped piece on a lever 18 which opens the jaw, but as Y crosses the race board, a casting on the slay presses against the jaw, closes it, and cuts the weft. By rotating, the hopper winds the loose ends of weft upon its boss. Another cutter is fitted in the temple, hence pieces of weft are disconnected, and a holder, situated between the two cutters, prevents these pieces from being drawn into the cloth.

An arm 19 is carried upon a stud fixed in the framing; it is held forward by a spiral spring and supports the weft holder. This holder is composed of two superposed strips of wood 20, one covered upon its upper, the other upon its lower surface with velvet. The bottom strip is secured upon a flanged bracket by a pin, but the top strip is converted into a rocking nipper by passing a horizontal pin through a slot. This pin is in the cranked lever 18, that carries the above-mentioned wedge-shaped piece. Each time the stud 16, on the cutter jaw, passes over the wedge, the lever 18 rocks, the mouth of 20 opens to receive a thread, and a spring closes the jaw upon that thread.

It is less satisfactory to control weft changes from a weft fork than from a feeler, for a fork can only act after weft has broken or run out, and hence, broken picks, broken patterns, and thick and thin places are liable to be left in a cloth. But if a fork operates the weft-changing mechanism, whenever it engages the hammer head a loaded skewer is placed in the shuttle. The fork is mounted in a casting 21, Fig. 262, which is free to slide to and fro in a flanged holder 22. A lever 23 is loosely mounted upon the shaft S, its upper arm abuts upon 21, and its lower arm lifts a holding pawl from the ratchet wheel of the taking-up motion each time the weft fork engages the hammer. 23 has one-half of a cam-shaped clutch formed on its boss, and adjacent to this boss a collar 22, containing the complementary half of the clutch, is fixed. If 23 is moved by the weft fork, both halves of the clutch engage, the shaft S is vibrated, and the change mechanism is put into operation as usual. When changes are effected by a weft fork, the parts dispensed with are the feeler M, N, O, the lever P, the dagger Q, the arm R, and the bracket T, Fig. 261.

PART XXII

TAKING-UP MOTIONS

No exceptional mechanical difficulty had to be overcome in order to supply a power-loom with an efficient taking-up motion. The principle was introduced by M. Vaucanson in 1746, more than half a century before the power-loom became a commercial success. He pressed two rollers tightly together and drove them at a constant speed. The fabric passed partly round and between these rollers, and was by this means removed as manufactured. It is the function of a taking-up motion to draw a fabric forward regularly, and to keep a texture uniform. It should therefore contain some means for accurately fixing the position of the cloth fell, but this is usually left to the weaver. Several textile machinists now make suitable provision for this; Messrs. Hutchinson and Hollingworth fix one wheel on the shaft of the cylinder M, Fig. 73, and another on the taking-up motion; and pass a chain round both. If the dobby is reversed, the taking-up roller will also be reversed, hence, after unweaving, the cloth fell will be placed in its exact position for weaving.

There are two classes of taking-up motions, namely, "positive" and "negative." The former may be subdivided into: (1) Those that act intermittently, (*a*) by taking up as a slay falls back; (*b*) by taking up as a slay moves forward; (*c*) those in which the closeness of the weft threads is varied by changing a driving wheel; and (*d*) those in which a driven wheel effects the change. (2) Continuous taking-up motions. In this case the gearing requires as much time to draw one pick away as is needed to effect the cycle of movements in weaving. Of negative taking-up motions there are—*e*, those that act in conjunction with the warp tensioner; and *f*, those that act in conjunction with a loose reed.

If a positive motion implies the use of parts where nothing is left to chance the taking-up motion in most extensive use fails in two places, for the cloth passes partly round a roller whose surface is roughened after the manner of a nutmeg grater, and the roller is pushed round by a pawl and a ratchet wheel. Hence the cloth may slip upon the roller, and the pawl may slip over the teeth in the ratchet. A taking-up roller is often made of wood, its surface being covered with a thin fillet of steel which is roughened outside by punching, is wound spirally, and fastened with tacks. If a roller consists of an iron tube the fillet may be soldered on, or holes may be bored through the tube and plugged with wood, then the fillet is fastened by driving nails into the plugs. An iron roller may be grooved longitudinally and transversely to give roughness; or pins may be driven into a leather or other foundation to enable the roller to grip a fabric firmly and draw it forward. The bearings of the beam A, Fig. 263, are in the end framing, and so placed that its axis is parallel with the breast beam, the harness, and the back rest, but its periphery projects somewhat beyond the front edge of the breast beam. Although taking-up rollers are usually placed beneath a breast beam, Smith Brothers, of Heywood, more than fifty years ago raised this beam into the position of, and employed it as a substitute for, a breast beam. This plan has been adopted by the Northrop Loom Company, and a claim is advanced that a fabric will contract less in

width than when a taking-up roller is lower down in the framework.

A beam wheel B is usually set-screwed on that end of the beam shaft farthest from the driving gear; its teeth engage those of a stud pinion C, which is compounded with

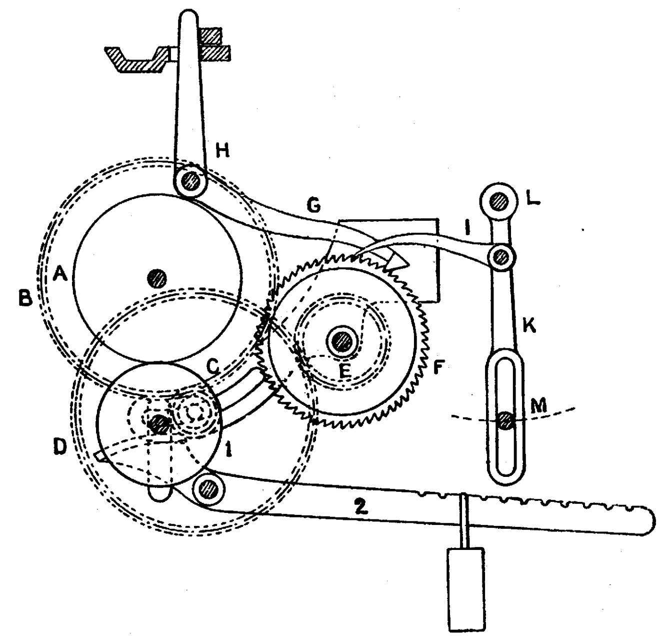

Fig. 263.

a stud wheel; both so named because they work loosely upon a stud in a slotted bracket, the slot being concentric with the beam A. Wheel D gears with a change pinion E, and E is compounded with a ratchet F. A pawl G rests freely upon the surface of F, its office being to prevent the ratchet wheel from turning backwards. A rod H extends across the loom; upon one end the pawl G is keyed, and at its opposite extremity a finger presses against the weft-fork lever. The effect of this contrivance is to lift G above the teeth of F when a weft breaks, and thus arrest taking-up. But, as G slides over the teeth of a moving ratchet wheel F, the finger on H is vibrated. In 1903 T. Pickles and B. Blakey disconnected G and H. They mounted the former upon a stud, and provided H with a horizontal arm, then fastened a connecting rod by a pin to G, and passed it through a hole in the horizontal arm. By this plan the pawl G may slide over the teeth of F without causing H to vibrate. Also, H may be placed higher in the framework and its vertical finger may be shortened. A lever K, centred at L, has a driving pawl I pivoted upon it. A stud M is adjustably bolted to a slay sword, and passed through a slot in K; it follows that a swinging motion will be given to K, and this will cause the catch I to drive the ratchet F forward and set the train of wheels in motion. The extent of such movement in I depends upon the position of M in the slot of K.

In action this device is intermittent, for it only moves the cloth when a slay swings forward. By placing the fulcrum L beneath instead of above the driving pawl a cloth will be taken up as a slay moves backward. It has been asserted that the latter plan facilitates shedding, and tends to prevent cracks in cloth by reason of the great strain upon a warp at the time of taking-up. The pawl is the weak point; it may slip over a tooth, take two teeth, or may not be strong enough to take them regularly, hence irregularities are frequent. The heavy weighting necessary for certain goods often prevents a pawl from acting correctly. In 1880 W. Clayton employed a silent feed instead of a ratchet and pawl, and others have more recently used similar contrivances.

A wooden cloth roller 1, which should be uniform in diameter and straight, is pressed against the under side of A by weighted levers 2 that act upon the gudgeons. Both levers 2 are supported on studs in the framing and loaded at their lower ends; hence A drives 1 by surface contact and winds the cloth negatively. In place of weighted levers the gudgeons of 1 may be mounted in vertical racks which engage the teeth of two pinions. Each pinion is compounded with a pulley having a belt set-screwed upon its periphery. The belts are separately weighted and press 1 against the taking-up roller A, but 1 yields as the cloth accumulates.

A taking-up motion with a lever of the second order, as at K, must be so set that the pawl I shall drop over a tooth of the ratchet F when the cranks are on their back centres, and take one tooth at each forward movement. If more than one tooth is taken the stud M must be lowered; if less than one, it must be raised. The holding pawl G should clear a tooth by about $\frac{1}{8}''$ when the cranks are on their front centres. A lever of the second order will require less power to draw a fabric forward than one of the first order, and is therefore less liable to slip, because taking-up is effected as the cranks move from their top towards their front centres; at which time a shed is either closed or only partially open. But if a pawl acts as the cranks move from their front to their bottom centres, a shed is fully open and the strain greatest. With a lever of the first order set a pawl I to drop over a tooth when the cranks are on their front centres, and to take one tooth at each backward stroke of a slay, then fix the holding pawl G to clear a tooth about $\frac{1}{8}''$, with the cranks at their back centres. If the pawl employed is shaped to pull instead of push a ratchet round, reverse the settings given above. Taking-up has been effected by moving one tooth at each forward and backward swing of a slay. Measuring motions are also attached to taking-up motions to stop a loom on the completion of any desired length of cloth.

Weft is placed closer in one fabric than in another, hence a taking-up roller must be made to rotate correspondingly slower or faster. This is done by changing the number of teeth in one wheel of a train, that wheel being frequently the change pinion E. The selection of suitable wheels is a simple matter, for whatever their form or position, all wheels and rollers are drivers, driven, or carriers. A driver is one that increases in velocity in proportion to its increased diameter or added teeth. A driven wheel is one that decreases in velocity in inverse proportion to its increased diameter or added teeth. A carrier merely conveys motion from one part of a machine to another without altering the value of a train; it also turns independently upon a stud or shaft.

To find the number of teeth required in any change pinion for a given number of picks per $\frac{1}{4}$ inch :—Multiply the teeth in all the driven wheels together, and divide by the teeth in the driving wheel when multiplied by the number of $\frac{1}{4}$ inches in the circumference of the taking-up roller, and by the required picks per $\frac{1}{4}$ inch. Thus, taking Fig. 263 as an example: $\frac{\text{B} \times \text{D} \times \text{F}}{\text{C} \times \text{A} \times \text{picks}}$ = the required pinion E. Assume change pinions are required to give 16 picks per $\frac{1}{4}$ inch with two trains of wheels. The first to consist of a beam wheel B of 75, a stud pinion C of 15, a stud wheel D of 120, and a ratchet F of 50 teeth respectively, and a roller A, of 15″ circumference. The second train to have a beam wheel of 75, a stud pinion of 12, a stud wheel of 100, and

a ratchet of 50 teeth respectively, and a beam 15″ in circumference.

$$\text{The first train} = \frac{75 \times 120 \times 50}{15 \times 60 \times 16} = 31{\cdot}25 \text{ teeth required.}$$

$$\text{The second train} = \frac{75 \times 100 \times 50}{12 \times 60 \times 16} = 32{\cdot}55 \text{ teeth required.}$$

Since only whole numbers can be used, the first requires 31, and the second either 32 or 33 teeth. But cloth contracts in length after it leaves a loom, and for this purpose it is usual to add $1\frac{1}{2}\%$ to the calculated number of teeth in a pinion. This is an arbitrary allowance and does not necessarily mean that all cloths contract $1\frac{1}{2}\%$. Thus $31{\cdot}25 + 1\frac{1}{2}\%$ = say 32 teeth, and $32{\cdot}55 + 1\frac{1}{2}\%$ = say 33 teeth in the wheels to be used.

Where similar trains of wheels are used for all the taking-up motions in one mill, calculations may be simplified by using a constant number, namely, the number of teeth required to give one pick per $\frac{1}{4}$″, which, divided by the picks required per $\frac{1}{4}$″, will give the number of teeth for a change pinion.

$$\text{The constant for the first train} = \frac{75 \times 120 \times 50}{15 \times 60} + 1\tfrac{1}{2}\% = 507.$$

$$\text{The constant for the second train} = \frac{75 \times 100 \times 50}{12 \times 60} + 1\tfrac{1}{2}\% = 528.$$

Then a pinion for 16 picks per $\frac{1}{4}$″ with the first train must have :—

$$\frac{507}{16} = 32 \text{ teeth.}$$

$$\text{One with the second train} = \frac{528}{16} = 33 \text{ teeth.}$$

Inverse proportion may also be used to find the number of teeth in a pinion; thus if a 33 pinion gives 16 picks, what wheel will give 20 picks? 20 : 16 : : 33 : 26, the teeth required. Changing a driving wheel involves the trouble of making a calculation, and the risk of employing a wrong wheel. To reduce this risk, tables of change wheels are compiled for easy reference.

Many variations from the above-described motion are to be met with. An alteration of one tooth in a pinion may make too great a change in a fabric, for in some heavily picked goods one tooth equals two or more picks per $\frac{1}{4}$ inch. In such cases a train of seven instead of five wheels is employed. A driven wheel is sometimes changed instead of a driver; when this is done calculations may be rendered unnecessary, for the wheels forming a train may be such that the number of teeth in a change wheel equals the number of picks per unit of length in a fabric. Thus, in Pickle's motion the ratchet has 24, the first pinion 36 (the first stud wheel is the change wheel), the second pinion has 24, the second stud wheel 89, the third pinion 15, and the beam wheel 90 teeth respectively; the cloth roller has a circumference of 15·05″

$$\therefore \frac{24 \times x \times 89 \times 90}{1 \times 36 \times 24 \times 15 \times 15{\cdot}05} = \frac{89}{90{\cdot}3}, \text{ but } 89 + 1\tfrac{1}{2}\% = 90{\cdot}3 \;\therefore$$

the teeth in the change wheel equals the picks per inch. If the wheel of 36 teeth is replaced by one of 27 teeth, a change wheel equals the picks per $\frac{3}{4}$ inch; if by 18 teeth, a change wheel equals the picks per $\frac{1}{2}$ inch; and if by 9 teeth, a change wheel equals the picks per $\frac{1}{4}$ inch; the latter number is, however, too small for practical purposes. The number of teeth being clearly stamped upon each change wheel, mistakes are not of frequent occurrence (see also Keighley's positive take-up motions, p. 513).

The chief difference between intermittent and continuous motions is found in the manner of driving. In the latter a side shaft A, Figs. 264 and 265, is fixed at right angles to,

and is driven from, the picking shaft B; it gives motion to a fabric by means of two bevels C, D, a worm E, a worm wheel, F, a change pinion G, a stud wheel H, a stud pinion K, a beam wheel L, and a beam M. The velocity of M depends upon the dimensions of the wheels and roller employed to drive it. The worm E has been mounted loosely upon A, and its boss made in two parts to form a clutch, one part being fast upon A, the other connected to the weft-fork finger. When the finger acts the clutch is opened and taking-up

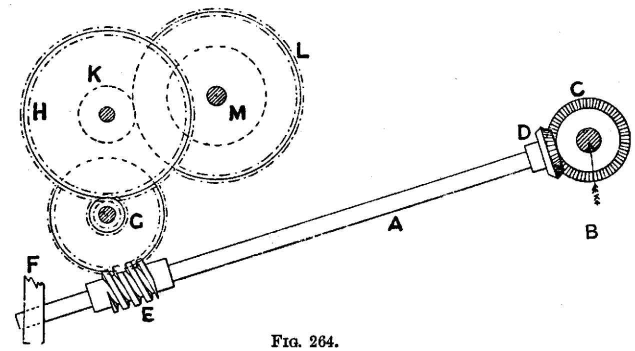

Fig. 264.

is arrested. This device is positive in action, for if M is covered with card clothing, or with pins, slipping is impossible. It also possesses the further advantage that if a loom is turned backward the cloth is also moved back. In intermittent motions, on the contrary, a pawl acts in the same manner, irrespective of the direction of movement in other parts of a loom. Hence cloth may be drawn forward when weft is absent, and unless a weaver lets back the fabric before recommencing to weave, cracks will be produced.

Cracks and thick places are therefore avoided by the weaver's skill to judge correctly the distance to reverse a cloth after unweaving, and after weft has broken. So-called crack preventers are frequently attached to taking-up motions; they let back a predetermined number of picks each time a loom is stopped by a weft fork. But since weft may break one to one and a half picks before a weft fork acts, these contrivances will either permit cracks to be made, or when a fork acts immediately

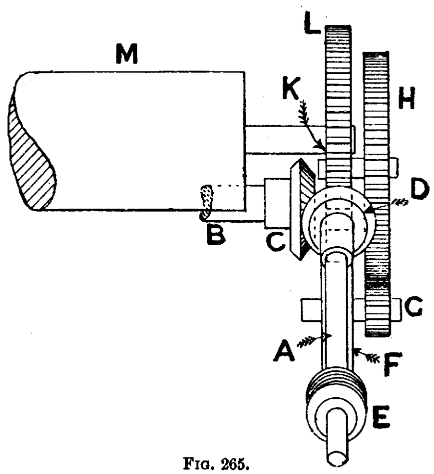

Fig. 265.

a weft breaks, they will make thick places. Such an attachment consists of two holding catches, one of which is free to slide through a space equal to two or more picks. If a weft breaks, the taking-up and the ordinary holding catches are lifted, but the sliding catch remains in contact with the ratchet and yields to the predetermined extent.

In bordered and cross-striped fabrics it is often necessary to place weft threads closer together in one portion than in another. This may be done by causing the shedding

motion to effect the change. Thus: A cord from a spare jack in a dobby is tied to one end of a spiral spring, and another cord from the opposite end of that spring is tied to a light lever secured upon the rod H, Fig 263. A spring is employed because the oscillation of H is limited by the length of slot in which its finger is placed, hence, once the finger has completed its journey, any additional movement in the jack will merely stretch the spring. When the rod H is vibrated it must carry the holding pawl G out of gear with the ratchet F, without disturbing I, and further taking-up will cease until the shedding motion permits G to fall. By lifting G on alternate picks the cloth will be drawn forward at half the speed; this is equal to doubling the number of weft threads per inch. Other proportions may be obtained by giving the pawl varying periods of inactivity, as, for example, if it is lifted twice and allowed to remain down once, the number of picks will be trebled. Or, if lifted once and left down twice, the number of picks will be increased by $\frac{1}{3}$.

Negative, or drag motions are employed for fabrics that would be injured by a roughened roller, also in cases where the weft is so irregular in thickness that a fabric, if drawn away positively, would be full of uneven places. In most negative motions change wheels are unnecessary, for in beating up, the reed slackens a fabric, and a weighted lever, a pawl, and a ratchet wind the cloth upon a smooth roller. By using such a roller the picks are not liable to be pulled out of their appointed places. Close attention must be given to the relative weighting of the warp beam and the taking-up lever, or the decreasing diameter of the warp beam and the increasing diameter of the cloth roller will cause a fabric to be drawn away irregularly. Negative motions are readily adjusted for heavy fabrics, but light ones give more trouble. In heavily weighted warps the thickness of the weft controls the taking-up, and a uniform bulk of cloth may be produced without the necessity for letting back when a weft breaks, but in lightly weighted goods it is possible to take up for a few picks after a weft has broken.

As applied to fustian and velvet looms, the parts consist of a cloth roller A, Figs. 266 and 267, with a worm wheel B fixed upon it. A worm D on a short shaft C gears with B, and two ratchet wheels E, F are provided with compounded holding catches. At E there are two and at F three catches, all slightly differing in length. The shaft C serves as a fulcrum for a slotted lever G, that carries the pulling catch H, and also a loosely jointed pendent stalk K. Near the base of K a fixed collar rests upon a slotted arm L, projecting from a slay sword M. The lower portion of K passes through L, and its collar permits of the stalk being loaded with adjustable weights N; these enable the catch H to pull the ratchet E forward. When a loom is active the slay's vibrations are transferred to the arm L, and as L lifts the stalk and the lever K, G, the catch H engages a tooth of the ratchet E. The parts G, K, and N are then suspended from E until weft accumulates sufficiently to cause a reed to slacken a fabric, and the weights N to move the ratchet E. The holding catches on E, F prevent backward movement. To increase the number of picks per inch the weights on the warp beam must be increased relatively to those at N, and to reduce the picks both sets of weights must be brought nearer to a state of equilibrium. In either case the exact alteration is made by trial. The weights upon the warp beams are adjusted once or twice daily; those at N are seldom disturbed except when a considerable alteration is made in the build of a texture.

On silk looms a taking-up motion is usually controlled by a loose reed that swivels upon two pins in the ends

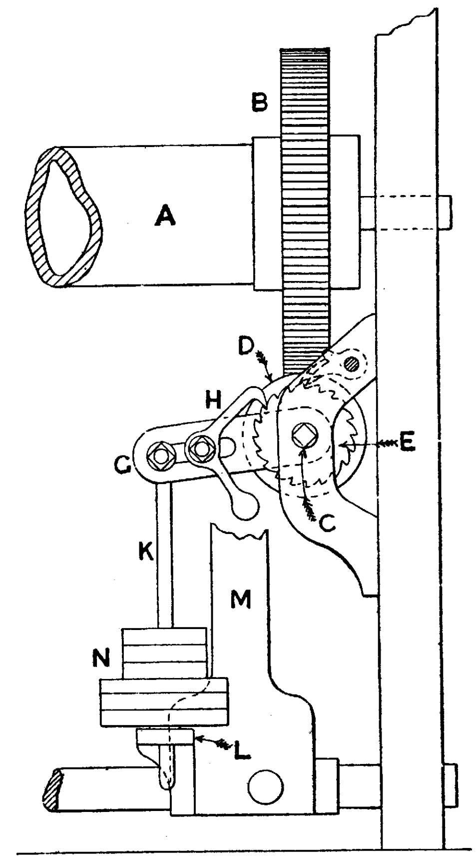

FIG. 266.

of a slay cap. This plan was patented in 1836 by C. G. Gilroy. The reed is normally kept vertical by causing a spring C, Fig. 268, to press one arm of a lever D against a case B. The lever D is fulcrumed at E, and furnished at F with an adjusting T-shaped piece. All the

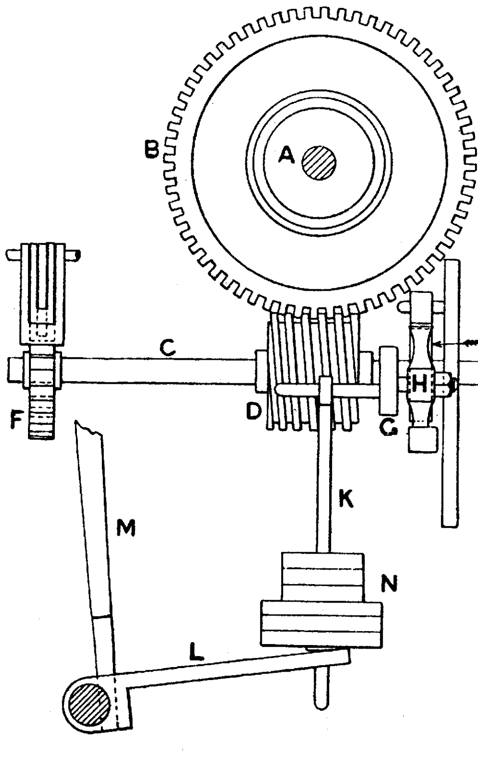

Fig. 267.

above-named parts are attached to and swing with the slay.

Immediately in front of F a lever is centred upon a pin at G′, and connected at G with a pawl H, which rests upon

a ratchet wheel 1. This ratchet is compounded with a spur-wheel 2, and 2 drives a pair of compounded wheels 3, 4; the last-named gears with a beam wheel 5, fixed

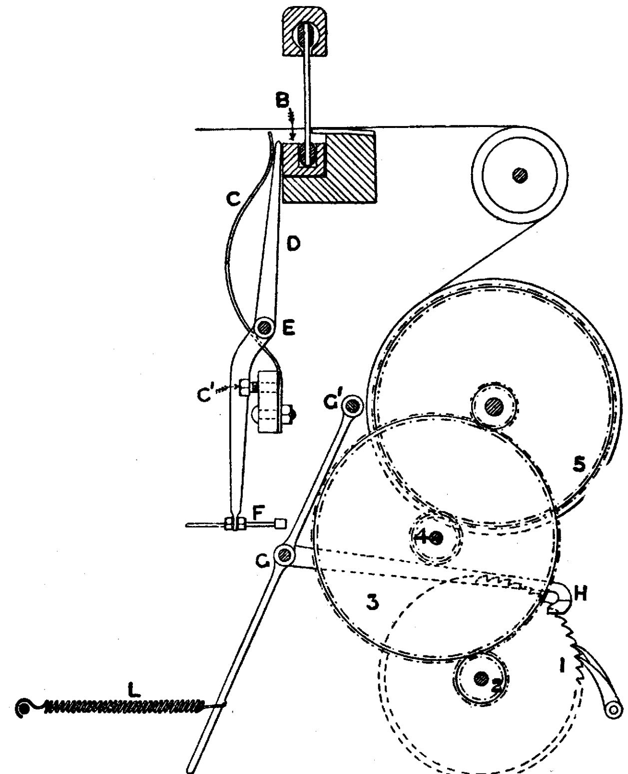

Fig. 268.

upon the shaft of a taking-up roller whose circumference is one yard. Cloth is only drawn forward when the reed is pushed back by the weft. At such times the head F thrusts the catch H forward; in doing this a helical spring L is stretched, but as F moves back the spring contracts, and sets the train of wheels in motion. To increase the number of picks the spring C must be tightened, and to reduce them C must be slackened by means of the adjusting screw C′. Greater alterations may be made by changing a wheel in the train.

J. Honegger applies a taking-up motion to silk looms which is capable of finer adjustment than Gilroy's. It is shown in Fig. 269, where the reed A is held in an upper and lower case B. Both cases are mounted in arms C, and upon a shaft D. The bearings of D are on the slay sword S, and D has two other arms E that terminate in anti-friction bowls F. As a slay swings back the reed is kept steady by reason of these bowls making contact with two bow springs G. Normally the reed pressure is regulated by hooking two spiral springs H into the arms of E, passing their ends through castings I on the swords, and providing them with thumb-screws J.

A pin K projects from the slay and impinges against the lower reed case B; it is kept forward by a collar and a light, open-coiled spiral spring. Facing K is an adjusting head on a lever L, whose fulcrum is at M. The lower arm of L has a pin from a latch N resting upon it, and so long as the reed is not pressed back by the weft, K thrusts back L and lifts N above a catch in a bar O to prevent taking-up. Should beating-up become difficult the reed falls back, the latch N remains unlifted, and taking-up proceeds. The bar O is connected by a lever P, having a fulcrum at Q and a link at R to a slay sword S. Adjacent to O a slotted slide bar T is supported by studs, and carries the latch N. When N engages the catch in O the bar T is pushed forward and takes with it a bar U, whose rear end is pinned upon a slotted lever V, and V swings upon a stud

W. This lever is made to rock a second slotted lever X upon its centre Y. Thus: a block 1, placed in the slot

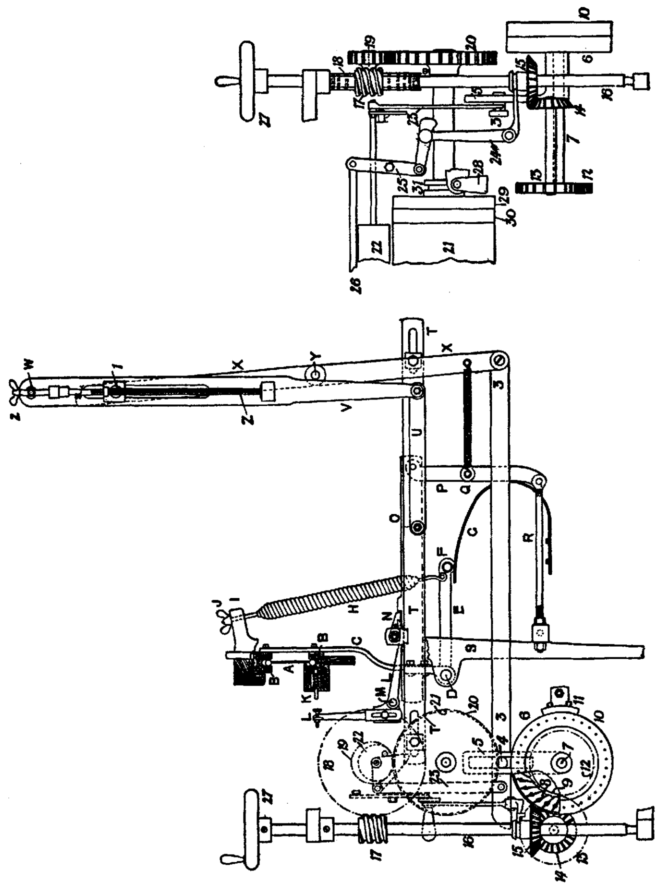

Fig. 269.

of V, unites V, X by a pin. A screw Z, having its bearings in V, passes through a nut in 1. By turning a thumb-screw

2, the block 1 will either rise or fall, and V, X will be united in different places. Since V swings through the action of N, O, T, U, the lever X imparts motion to a bar 3, but the extent of that motion depends entirely upon the position of the pin in the slots of V, X. At 4 a stud from the bar 3 passes through a slotted arm 5. The last named is fast upon the boss of a flanged disc 6, while 6 is loose upon a shaft 7. Inside the flange of 6 are thirty-one drivings pawls 8, all thrust forward by flat springs against the teeth of a broad ratchet wheel 9, having thirty teeth, and being fast upon 7. A second flanged disc 10 is bolted to the framework at 11; it carries a similar number of pawls to the disc 6; they also bear upon the teeth of 9, but merely to prevent backward movement. The flanges on 6, 10 enclose the ratchet wheel. On the inner end of the shaft 7 a spur wheel 12 is fixed to drive a wheel 13, and 13 is compounded with a bevel 14 in order to drive a second bevel 15 upon an upright shaft 16. At 17 a worm on the upright shaft engages a worm wheel 18; the latter being compounded with a wheel 19 to drive the wheel 20 and the taking-up roller 21.

The fabric passes over a breast beam, behind a roller, thence in front of a second roller 22, and to the cloth roller 21. As a piece of cloth accumulates upon 21, the roller 22 is pushed up by the cloth. In rising, 22 takes with it a bar 23, which is also fast upon 3; this lifts the pin 4, in the slot of 5, thereby reducing the movement of the taking-up roller. A clutch is formed on the boss of the wheel 15 and operated from the starting handle through the levers 24, 25 and a bar 26; so that on putting a loom in motion the clutch closes; on stopping it the clutch opens, to dislocate the taking-up and permit adjustments to be made by the hand wheel 27. A disc 29 is fast upon the

shaft of 21. From the inner face of a sliding boss 31 a pin normally passes through 29 into a hole in a metal hoop 30, on one end of 21. A ring groove in 31 receives a pin from an eccentrically mounted piece 28. By turning up 28, the pin of 31 is withdrawn from and loosens the cloth roller 21; a fabric may then be removed from the roller without interfering with other parts of the taking-up motion.

PART XXIII

TEMPLES

DURING weaving, cloth contracts in width by reason of the tension upon both warp and weft. As the warp threads separate to form top and bottom sheds they simultaneously close upon the last thread of weft, and exert sufficient force to produce a series of corrugations along its surface. If a bent thread is required to cover a given width of cloth, it must be longer than a straight one; but, since extra length cannot be provided, the cloth becomes narrower. Temples are employed to counteract contraction, and thus prevent the edge threads from being broken by the reed, and the reed from being injured by the warp.

Self-acting temples date from 1786, when Dr. Cartwright patented the application of nippers that opened as a reed advanced and closed upon the cloth as a reed retreated from the fell. At a later period cog wheels, rings, and rollers were tried, but with small advantage to inventor or manufacturer. It was not until 1839, when J. Smith patented the "penny temple," that success was achieved. Even then self-acting temples were not in great demand, for so late as 1870 many fabrics were woven by the aid of wooden temples which were moved manually. At the present time, however, self-acting temples are in general use, and are of varied types. They include the trough and roller; single, double, and three-roller side temples; inclined and horizontal rings, nipper, and other styles.

The trough and roller temple was patented by W. Kenworthy and J. Bullough in 1841, and has been extensively used for light and medium fabrics. It consists of a semicircular iron trough A, Fig. 270, that extends across the reed space. It is placed beneath a fabric with the hollow part upwards, and the ends are recessed to form bearings for a case-hardened roller B whose diameter is $1\frac{1}{8}''$ to $1\frac{1}{4}''$. Two caps C pass over the journals of B and are secured to the holder by bolts. The roller is fluted for 12″ to 18″ from each end, but a plain portion, from 4″ upwards, is left at the centre. The flutes on one side of the plain piece have a left-handed thread chased amongst them to form sharp teeth, and a right-handed thread is chased amongst those at the other side. The whole is supported upon two long spring-stands D which are bolted to the front rail of the loom. In case a shuttle is trapped in the warp, the springs give way and the temple rolls back without doing damage. If at such times the reed is a loose one the trough also assists in forcing back the reed. In fixing this temple in position the front edge of the trough is moved as near the cloth fell as possible without touching the reed, and the roller should turn freely in the trough. As a fabric passes over the edge of A it is deflected by the roller B, and the maximum bite is obtained by raising the front of A until a fabric forms a sharp angle. This temple

is not adapted for heavy work, and is seldom used for cloth more than 60″ wide. Its ability to prevent contraction is not great, for a cloth is only held by frictional contact

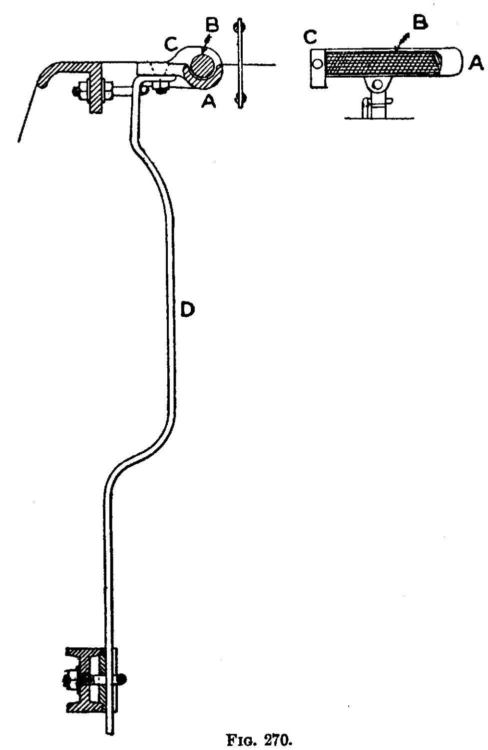

FIG. 270.

with B; and the roller wears comparatively smooth. It cannot distend a fabric; still, by making the outer ends of a roller conical for about 12″, the selvages will be firmly held. If a cloth does not approximate to the reed space, the thick ends of a conical roller will not permit its centre to be pushed far enough forward. This temple covers about 2″ of the newly woven piece, and thus prevents the ready detection of defects; the race board must also be lower than is necessary for most temples, but a claim is made that it gives a better cover to cloth than side temples. Should any hard substance be accidentally interwoven, the cloth will be torn by the trough.

Side-Roller Temples

Single-roller side temples were patented in 1824 by J. C. Daniell. They are specially adapted to hold out light fabrics: but are also fitted on medium and moderately heavy looms, in which the slay moves too near the breast beam to leave room for more than one roller. They are fitted in a cast-iron case, and mounted at each side of a fabric upon a rod A, Fig. 271. The rod may be provided with holes for two studs B to pass through, in which event B, B are bolted on the breast beam; each has a spiral spring pushed over it to hold the temple forward, and a nut C to secure A upon B. Or flat S-shaped springs may take the place of spiral springs. Where space is of less importance, a flat rod is often fastened to long springs similar to those shown at D, Fig. 270.

For light goods the rollers D are box-wood, with steel journals, and steel hooped at one end. But solid brass and steel and brass shirted rollers are often used. In each case finely pointed steel pins are driven into the rollers spirally. Soft steel, from 3″ to 6″ long by $\frac{1}{2}$″ in diameter, is also employed. The body of each roller then contains a large number of short, sharp points which lean towards the edges of a cloth. Some rollers are slightly conical in form, the taper being from $\frac{3}{4}$″ to $\frac{5}{8}$″ in

diameter on a 4″ roller. A temple case is open below to allow size and dirt to fall out. A movable cap is screwed down tight, but a space is left facing the roller axis for a fabric to enter; as the latter is drawn forward, it is bent over the roller points and held by them with sufficient tenacity to ensure good weaving and still leave the piece fairly free from marks.

Many temples are capable of preventing a fabric from contracting unduly, but are unable to distend it. Since cloth contracts between a reed and the bite of a temple, it is often desirable to stretch it slightly while in contact

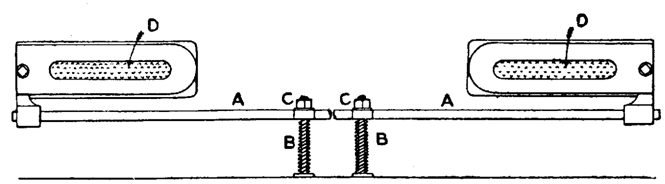

Fig. 271.

with the temples. One of several similarly constructed single-roller temples was introduced by William Lancaster; it has a fixed spindle D, Fig. 272, for a boss A to turn upon. A is $\frac{13}{16}$″ in diameter, and has fourteen longitudinal grooves cut in its periphery at equal distances apart. A set of saws B, with fine teeth and smooth protruding ends, fit loosely into the grooves of A. At each end of the spindle D a hollow collar C, with an inclined edge, is secured, and all the smooth projections on the saws B enter the recesses of C, C and are thus prevented from falling out of A. As the boss A rotates, one end of each saw bears in succession against the cam-shaped edge of the inside collar and slides outward. This teeth of B carry the cloth out with them at both sides simultaneously. This temple is liable to become choked with dirt and loose threads. Another modification contains four toothed segments that enclose a boss in which a cam groove is cut for a pin from each of the segments to enter. As the boss revolves, the pins are pushed outward quickly but return slowly.

Most roller temples have greater holding power than a trough and roller, because the rollers are often fitted with

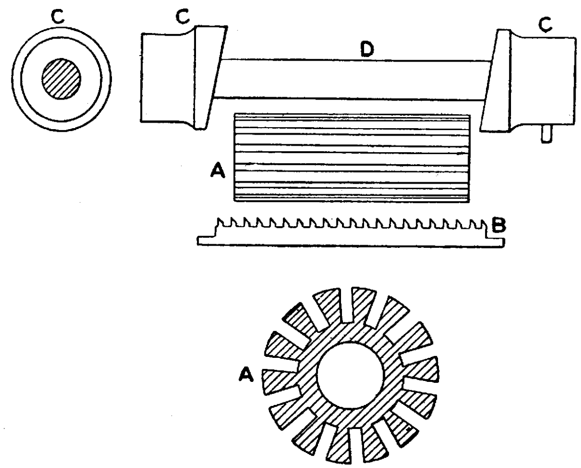

FIG. 272.

pins that pierce the cloth. They are made in different ways. In the coloured section of the cotton weaving industry double-roller temples are largely used, the rollers being from $3\frac{1}{4}''$ to $6''$ long, and from $\frac{7}{16}''$ to $\frac{11}{16}''$ in diameter; and they are placed in pairs near each edge of a fabric. Both may be of uniform thickness; or they may be conical, with a slope of from $\frac{1}{16}''$ to $\frac{1}{8}''$ on $4''$ of length. In the latter case the thick edges bear upon the selvages and hold the cloth tightest where contraction is most

harmful. The rollers may be held parallel, or they may converge towards the centre of the fabric. On the outside the centres may be $\frac{15}{16}''$ apart, and on the inside $\frac{13}{16}''$ to $\frac{14}{16}''$ apart. Both may be similar in material and in the shape of tooth, or one may be wood or brass, the other iron, and their teeth may be formed and inserted differently.

A cast-iron or other metal case is provided with bearings for the roller pivots and fitted upon brackets secured to the breast beam. A case should allow the pins of the front roller to be brought within $\frac{1}{8}''$ of the face. Thin steel appears to be best adapted for this purpose, and it should be set as near as possible to the reed without touching. Its slope should coincide with the warp line between the breast beam and the harness eye when a shed is closed, and it should be placed as low down as possible without touching the slay. Adjusting pieces are provided for the inner pivots to prevent longitudinal movement in the rollers. The fixings must provide a means for lateral adjustment, also for moving the temples forward or backward. Spiral springs, short horizontal, and long vertical flat springs are used to hold the temples forward, and to permit them to move backward when a shuttle strikes them. Of these, long vertical springs are less liable to become stiff and spoil a reed than either of the others. The cap may be brass, cast-iron, or steel; its front and back edges, together with a longitudinal central rib, divide the cab into two semicircles and press the cloth down level with the axes of the rollers. If an angle bar is attached to the front edge of each temple case, and crosses a fabric close to the fell, it not only prevents the shedding harness from lifting that fabric, but it assists to throw out a loose reed when a shuttle is trapped. If properly constructed, this temple is as simple and effective as any available, and is applicable to a very wide range of fabrics. The cap is, however, liable to glaze dark, uniformly coloured cloths.

Three-roller temples have been introduced in order to remove this defect. They may have two outer rollers in a case, and the centre one in a cap to take the place of the middle deflecting piece. Or two rollers may be fixed in a cap, and one in a case, which is equal to using the former upside down. The teeth should be as short as possible or they will not liberate the cloth without marking it.

Ring Temples

Inclined rings or segment temples were invented in Switzerland by M. Mathis, and introduced into this country about 1870. They are almost as varied as side rollers. From a single ring, with two or three lines of pins, to upwards of twenty rings, each with one row of pins, are met with. Some are made with two rings placed one behind the other on separate studs $1\frac{1}{8}''$ apart, and covered with a double semicircular cap. But the most general form of this temple consists of a series of parallel brass rings A, Fig. 273, which are $\frac{3}{16}''$ broad by $\frac{7}{8}''$ in diameter, and furnished with a single line of fine radiating steel points. Washers B hold the rings $\frac{3}{16}''$ apart. They are flat on one side, but an eccentric boss is formed on the other side, whose length equals the width of a ring, and every washer has a hole drilled obliquely through it. A stud C, about $\frac{3}{8}''$ in diameter, is securely fixed in an inner end-piece, and the rings and washers are placed upon C with the full side of each eccentric uppermost. When all are in position a second end-piece E is slipped upon C and the whole bolted into the temple-holder F. The obliquely

drilled holes in the washers hold the rings A more or less diagonally to the axis of C, and the eccentrics carry the pins above the upper surface of B and inside their lower surfaces.

For rollers $\frac{15}{16}''$ in diameter, the rings A are often $\frac{1}{4}''$ apart and slope towards the selvages at an angle approxi-

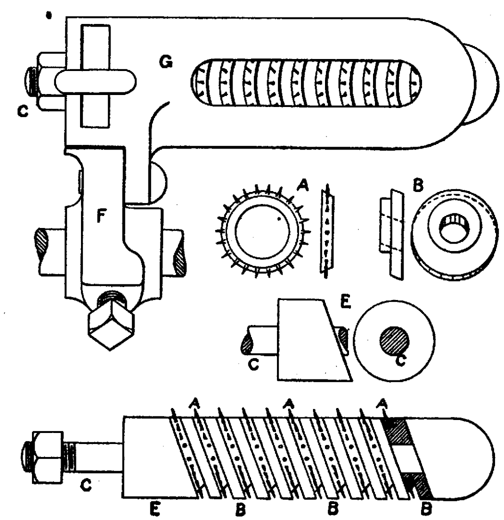

Fig. 273.

mating to 22° from the vertical. Broad looms, however, are provided with temples that vary from 6″ to 9″ in length, and contain 15 to 20 rings. In long temples the rings are seldom equidistant, nor is the angle of inclination a fixed one. A 17-ring temple, for example, may be $1\frac{1}{16}''$ in diameter, and the two outside rings $\frac{5}{16}''$ apart, while the two inside ones are $\frac{3}{4}''$ apart. As they approach a selvage, the inclination of each increases, but the parts cease to be interchangeable. To prevent these temples from becoming choked with dirt and size a notch has been cut in the bottom of each washer B, then as the rings rotate they scrape against two sharp edges and cleanse themselves. Another plan is to form a ring with a flange that overlaps the edge of B, for the purpose of preventing dirt or threads from getting between A and B.

Ring temples stretch a fabric to about the reed width and are applicable to wide and narrow looms. Those with a single ring act on the selvage only, and are mostly used for fabrics that would be injured by temple marks showing in the body, such as dress goods, velveteens, and light fustians. Provision is made in single ring temples used on velveteen looms for temporarily moving the temple inward in the event of the cloth becoming detached from the temple, so that the cloth may be replaced, and then the temple is put back to its normal position. Stout calicoes of medium width require from six to ten rings, while heavy sheetings have from twelve to fifteen rings. This temple is liable to injure the edges of delicate fabrics, and if a ring becomes clogged it tears the cloth.

Horizontal ring temples were invented in 1839 by J. Smith, and are the oldest now in use. They consist in bolting upon the inside of a breast beam a slotted bracket A, Fig. 274. In the slot of A a thin plate B with two overlapping edges is secured, and B has a flat spring riveted at its centre. A thumb-screw C traverses A and passes through a tongue in B. By turning C to the right or left, a temple can be adjusted laterally. A plate D is pushed between the overlapping edges of B and above its flat spring, so that the combined pressure of the spring and the bent edges may hold D tight. A brass roller E, $1\frac{3}{8}''$ in diameter, has three lines of radiating steel pins all $\frac{1}{8}''$ long.

E is laid horizontally upon the holder D and a screw is passed freely through its centre; it is encircled by an oblique rim F, in which a diagonal slit G is cut for the edge of a fabric to enter, and by which it is bent over the pins H. A wider slit at the rear permits a fabric to leave the temple. In action a selvage is gripped by the

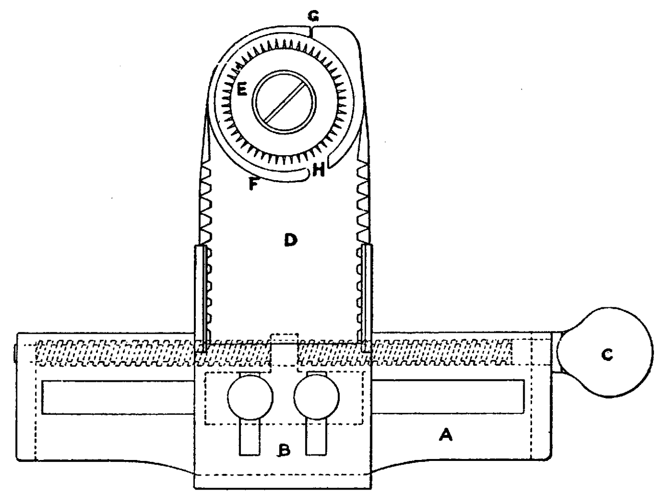

FIG. 274.

pins and stretched from the point of contact round the outer extremity of E; but, after passing that point, a fabric contracts again until it passes out by the wide slit.

In case a shuttle is trapped, the plate D is forcibly driven back and requires to be adjusted manually before restarting a loom. This temple holds a cloth firmly, but is troublesome to manipulate after unweaving, as the holder is not sufficiently flexible. It is also dangerous to use, for if loose weft is broken off while a loom is in motion, there is a risk of crushing a weaver's fingers.

Other things being equal, the best temple is that which will grip and stretch a cloth nearest to the fell; stretching a piece half an inch or more from that point is less efficient. The Dutcher temple enables cloth to be stretched nearer the fell than most others. Its case has a shank cast upon it which is partly oblong, partly cylindrical. The cylindrical portion carries an open coiled spiral spring, so that one end impinges upon the oblong shoulder, the other upon the end of a slotted box in which the shank is placed; the box being adjustably secured upon the breast beam. A heel, cast upon the under side of the temple case, is engaged by an advancing slay and the temple is pressed back. As a slay recedes from the fell the spring pushes the temple forward. By this means a temple case can be set in advance of the fell without risk of injury to the reed. In practice it has been found that thin goods are marked by temple teeth and stout goods are not properly held. In this roller the teeth are longest near the outer end and taper down to the inner end. For fine goods they are uniformly distributed over the roller, as then they do not pierce a cloth, but release it freely. For stout cloth half the pins are removed from six outside rows in order that those remaining may more readily pierce a cloth, and hold it longer. The roller is $2\frac{1}{2}''$ long by $\frac{9}{16}''$ diameter, and bored axially to receive and turn freely upon stud journals. Each stud has a thread cut near its head, but the smooth portions enter the roller. The cap is tapped at each end to receive the studs, and in order to make one bearing dust-proof, the inner end of a roller is turned down to fit inside a recessed cap.

PART XXIV

INTERNAL AND EXTERNAL SELVAGES

When two or more pieces are woven side by side in a loom and subsequently cut asunder, internal selvages hold the inner edge threads in position. Such selvages are inferior to true ones, but are serviceable where strength is of minor importance. Adjacent threads of the inner edges may be twisted half or wholly round stationary threads, or twisting threads may cross other threads that work in plain order. The simplest apparatus consists of a doup of worsted heald twine, which terminates in a pendent ring. This doup is tied to the front shaft; the crossing thread is passed through an eye in a back shaft, it is next bent under one or more straight threads, drawn through the pendent ring, and with the straight threads passes into one dent of a reed. The crossed thread is lifted each pick; first by a back shaft to form an open shed, and next by the doup to form a crossed shed. From two to four dents are left empty between each pair of selvages according to the fineness of a reed. The objections to the above plan are, that the crossing threads cannot be lifted by a doup more than half the depth of a shed, that a doup chafes as it is pulled round the stationary threads, and breaks frequently. Fabrics may be split while in a loom by drawing the gaps over fixed knives, but they are usually cut after leaving a loom.

In 1889, Briggs Bury introduced a pair of flexible chains with a small ring at each end. By means of heald twine he attaches the upper rings to the back and front shafts respectively. The chains hang free at their lower ends, and the crossing threads are drawn through both pendent rings. When the front shaft is raised, a cross shed is formed and the chain on the back shaft hangs in a loose loop. Also, when the back shaft is raised the same edge thread is lifted in an open shed, but the chain on the front shaft loops round the other side of the stationary thread. When both shafts are level, both chains hang slack and form loops below the warp. By their superior strength chains resist friction for a much longer period than twine, and their flexibility, cheapness, and weight well adapt them for the purpose.

In 1886, J. W. Shorrock and T. B. Taylor patented the split motion shown in front and side elevations in Figs. 275 and 276. It consists in bolting a framing A to a cross rail above the warp. From A a wire B descends below the bottom shed line, and is there coiled to form two eyes C that take the crossing threads 1 for adjacent selvages. At D two small flanged rollers turn freely upon studs in A. Two straps E, E are bent round D, led through guides F, and, on plain looms, one end of each is made fast to the periphery of a pulley G, set-screwed upon the heald-roller shaft H. A piece of elastic 1 is hooked into the bend of wire support J, and the opposite ends of E, E are secured to it. At L two brass eyelets are fixed in E to take the crossing threads 1, and the stationary threads 2 are drawn through separate eyes K in the frame A.

The oscillating motion of H causes G alternately to unwind the straps from, and wind them upon, its surface. As they unwind, the elastic I draws E up, and the eyelets L carry the crossing threads 1 beneath the flanged rollers D, and up on one side of the stationary threads 2. The reverse vibration of H moves all the parts back to their

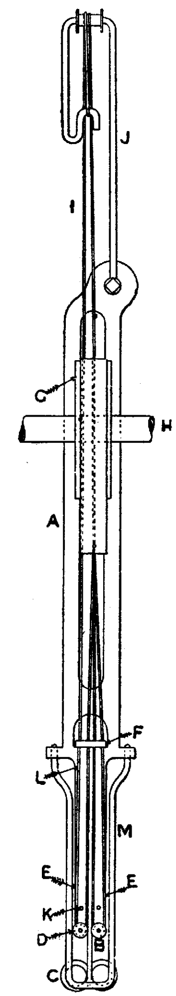

Fig. 275.

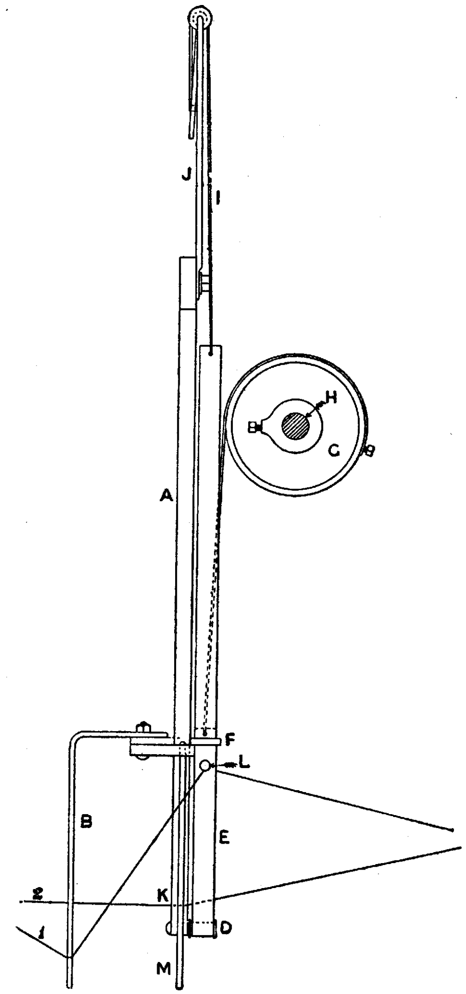

Fig. 276.

initial positions, and places the threads 1 on the opposite sides of 2. The wires M merely hold the ordinary warp threads away from the moving straps E. This split motion is comparatively inexpensive, and may be controlled by tappets, dobbies, or Jacquards. In case either of the last named is used, a jack of one and a harness thread of the other are connected to a light lever that multiplies the lift of the straps E, for E must move through approximately twice as much space as either healds or harness.

A motion of French construction differs from Shorrock and Taylor's; chiefly in causing the threads that do not cross to weave in plain order instead of remaining stationary. The mechanism serves two functions, namely, to weave gauze and to weave plain.

Figs. 277 and 278 are respectively front and side elevations. Three compounded pulleys A, B, C are suspended from a loom rail; D, D′ is a strap which is screwed upon A; its ends are connected to two treadles that are moved alternately by cams to vibrate the pulleys A, B, C. Or a spring may be attached to D, or D′, in which case one treadle and cam will serve the purpose. The thick line E is an endless piece formed partly of strapping, partly of twine, and is fixed to the surface of C. It carries two mails F—one for each selvage, and is led round grooved pulleys G, H, G′. If A, B, C turn in either direction, both mails F, and the warp threads they contain, will pass under the pulleys G, G′, and ascend on the other side. In doing this, each mail carries its warp round two threads that are drawn into the same dent as a crossing thread. The plain threads are moved by a third strap secured to a pulley B. Opposite ends of this strap are attached to cords I, I′. The cord I is bent round a pulley K, from whence it passes diagonally up to, and is tied upon the cord I′, and I′ is

taken round a pulley K′ and up to I. Each cord carries

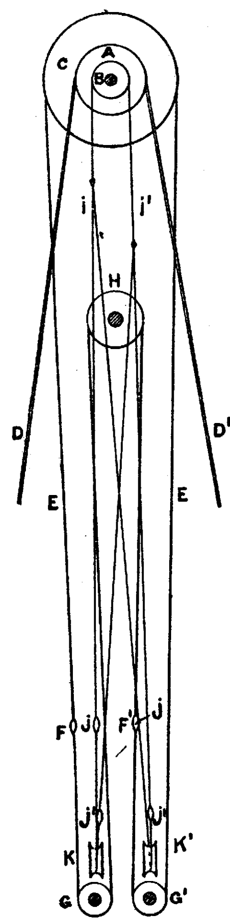

FIG. 277.

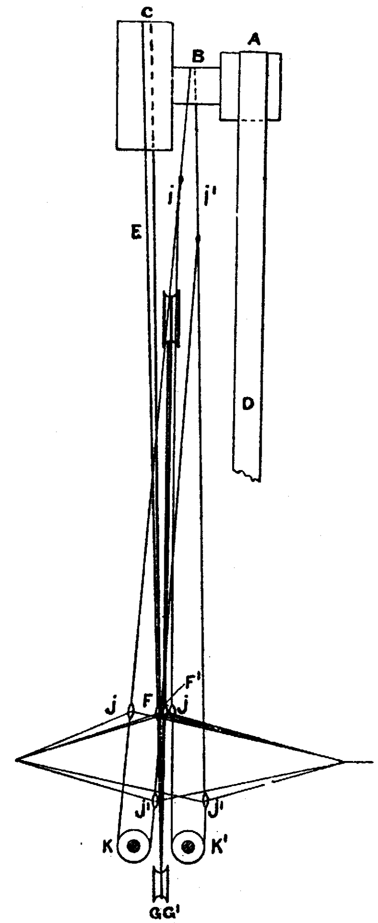

FIG. 278.

two mails J, J′ that operate parts of separate selvages.

Hence if an oscillation of B causes the mails J, J to ascend, J′, J′ will descend, and the motion of B when reversed will lift J′, J′ and sink J, J. Taking both actions together, the cords appear to be complex, but if a moving thread merely twisted half round a stationary one, the device would be as simple as that invented by Shorrock and Taylor.

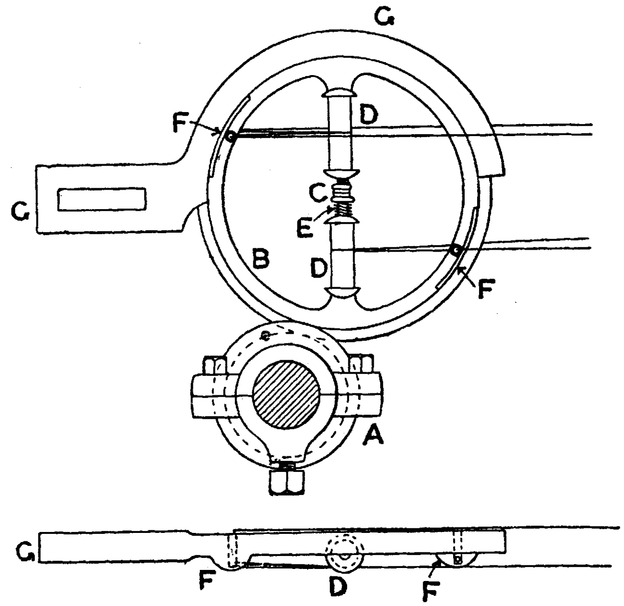

Fig. 279.

Two pairs of needles have been fitted in frames: one pair to point downward and move in a vertical plane; the other pair to point upward and move in a horizontal plane (see Fig. 139). Each needle carries a thread; those that rise and fall pass alternately to the right and the left of those that move to and fro. By another plan a crank on

the bottom-shaft-wheel, and a connecting rod, rock a three-armed lever, the two remaining arms of which move selvage healds in opposite directions.

Some selvage motions twist one thread spirally round another; probably two of the best known of these were introduced by Sir Titus Salt and by J. Boyd respectively. The first named has a split-pinion A, Fig. 279, bolted on the crank shaft; it has sunken teeth and smooth flanges on either side. The rim of a wheel or ring B has two smooth outer edges, but teeth project from the centre; they are in the ratio of two to one in A, and the latter drives the former. The inner diameter of B is crossed by a spindle whose terminals are pressed into holes drilled in the ring. This spindle has a key fitted near one end, a pin hole drilled near the other, and a thread cut somewhat beyond its centre to carry two lock-nuts C, having milled heads. Two thread spools D are mounted upon the spindle, and a coiled spring E abuts against the end of one of them. The other spool has a key bed to receive a key in the spindle. The first spool would turn freely if the spring E was not compressed by the nuts C to thrust the spool against the holding pin—and thus retard rotation. Each spool has two threads wound upon it, and both spools are fixed upon the spindle, so that rotation will tend to wind the threads upon one as the others unwind.

On one face of the ring B two curved flanges F face each other. Inside each flange a tube passes through the ring B and protrudes on the flanged side; each tube has an eye drilled in the side that faces the spools. Both threads from a spool are passed through an eye, then one is led to the right and the other to the left. The wheel B is situated above A, with its front edge immediately behind the healds, and its centre midway between the top and bottom lines of an open shed. B is kept in contact with A by a semicircular grooved cap G, which receives the teeth of B, and is bolted to any convenient bracket on a loom; hence the smooth edges of A, B and B, G touch.

Continuous twisting is obtained as follows: As B rotates, the flanges F are moved successively to face the centre of a shed; at this point the two threads nearest the healds are separated by a flange and tube, while the other pair, being farther from the healds, are nearer each other at that place; therefore the separated threads pass on the outside. But after a half-revolution of B the second pair are separated to assume the outer positions, and the first pair converge and move between them. Spinning twist in the spool threads must be in such a direction that rotation in B will not untwist and break them. To avoid trouble from this cause, two pairs of untwisted strands may be wound upon each spool; every revolution of the ring will then put a twist into both pairs. When this motion is properly adjusted it forms a neat and strong edge.

In 1863 J. Boyd fitted two circular spools loosely inside brass holders, and placed the holders in recesses on opposite sides of a central plate. The spools and their holders are retained in position by pressure from two external flexible plates. The top of each holder is bevelled to slope outward, and the under side to slope inward. A back plate holds what would in ordinary splits be the stationary threads; but here they move up and down in opposition to the spools. Thus, if for one pick these threads form a bottom shed, and the spool yarn a top shed, on the following pick they change places, in doing which they slide between the spool-holders and the middle plate. But as the threads move down again to assume their original positions, the upper bevels on the holders guide them between the holders and the outer plates, therefore they twist round the spool yarn, forming one-half twist between every pair of weft threads. A tappet and spring give the vibrating motion. Boyd's device forms a good strong selvage, but both the last-named inventions are too costly for general adoption.

Fast or woven-in internal selvages appear to date from the invention of E. Riley in 1857. Since which time W. Simpson, in 1890, J. H. Clibran and G. Browning, also in 1890, E. Ashworth and A. H. Oldham, in 1891, and more recently others have turned their attention to the subject. In most cases an interval of $\frac{1}{2}''$ to $\frac{3}{4}''$ is left between the warp threads intended to form separate fabrics. The weft that crosses these intervals is cut in the centre of the gap, and turned back into the warps. Inside selvages are thus made of double weft, while the outer ones are of double warp. Much of the mechanism for this purpose is elaborate and costly, although some of it is comparatively simple. Irrespective of the quality of the work turned out by them, it is not economical to sever in the loom cloth that has to be printed or otherwise finished, for the cost of the processes subsequent to weaving is thereby increased.

Plain Side Selvages

Without increasing the number of heald shafts, plain selvages, or such as closely approximate to plain weaving, may be made on sateens, twills, and other weaves. This is done by means of a contrivance known as a boat.

A boat is shown in front and side elevations in Fig. 280. It consists of a piece of wood A, about 2″ long, straight beneath, but curved above. A hole D is drilled through A to receive a fulcrum pin. Two pieces of leather B, B′ are nailed to the under side of A and turned round opposite ends; they are each about $1\frac{1}{2}''$ long, and wide enough to reach across the wood. A series of reed wires C, C′ are riveted in the leather, half-twisted, and bent over at the top. If a semi-plain selvage is to be made on a five-shaft sateen, one up and four down, two such boats will be re-

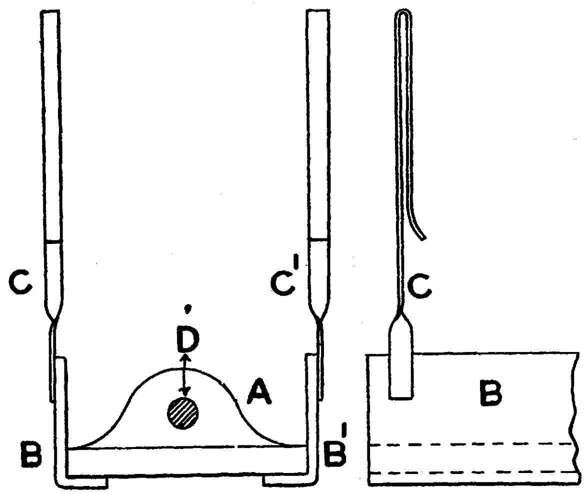

FIG. 280.

quired. Both are situated behind the healds at opposite edges of a piece, and below the warp line; they are supported upon pins bolted to the loom frame. Instead of drawing selvage threads into heald eyes, those intended for shafts 3, 4, 5 are passed through the loops of C′, and those for shafts 1, 2 go through the loops of C. Every thread from C goes over an eye in shaft 1 or 2, and every thread from C′ goes over an eye in shaft 3, 4, or 5. As a sequence, selvage threads in a rising shaft pull up one end of a boat

and depress the other end. The threads in the lifted end of A rise to a top shed, but those in the depressed end of A are pulled down to the race board. Since plain cloth cannot be made with five shafts, either two picks in each

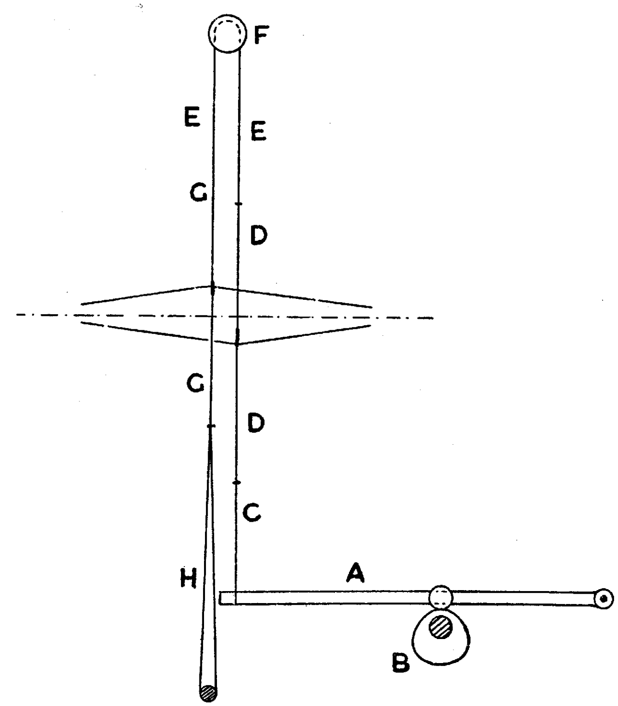

FIG. 281.

repeat of the sateen must be put into one selvage shed, or one pick in every five will be drawn up to the edge threads of the body, and therefore be lost to a selvage. By drawing the outside set of five threads in each selvage through the healds in the ordinary manner, the loss of a pick in a selvage can be prevented. Also by suitably drawing the warp through the boat loops and over the heald eyes, twills and other satins than that taken as an example may be woven with perfect plain edges in some cases, and in others with only slight modifications. A boat may also be made from a single piece of wire bent to the requisite shape. Instead of a boat, two sets of 16 mailed healds may be strung upon four wires, two above and two below, and severally connected to webbing. One web is passed over a flanged roller which is freely mounted upon a pin, and each end is attached to a separate wire. A second web is passed beneath a second roller and similarly united to one of the lower wires. These extra healds are placed behind the ordinary shafts. Warp threads are then drawn into all as for boats, and as the shafts rise and fall the threads that pass over eyes on the shafts, as for boats, impart movement to the selvage healds.

Another method of weaving plain selvages is illustrated in Fig. 281, where A is a light lever resting by gravity upon a cam B. From A a cord C ascends to a group of healds D that are threaded upon a wire. A second cord E is bent round a grooved pulley F and connected to the top loops of D. The opposite end of E is similarly connected to a second group of healds G, and the bottom loops of G are made fast upon a coiled spring, or a piece of stout elastic cord H. When the small face of B is uppermost, the lever A must be heavy enough to distend the elastic H and thus draw D down and G up. But when the cam B lifts A, the elastic H exerts sufficient force to restore the healds to their former positions. Hence if the group D contains odd threads, and G even ones, plain cloth will be woven. A single heald may be similarly employed to

manipulate a catch thread, for fabrics in which two or more picks are driven through the same shed, and where the weft would otherwise be withdrawn on the return of a shuttle.

PART XXV

ADJUSTMENTS IN POWER-LOOMS

SHORTLY after the power-loom became a commercial weaving machine an iron frame was substituted for a wooden one on account of greater compactness, strength, and cheapness. Compactness economises floor space, and strength is needed to resist shocks and vibrations that result from several pieces of mechanism acting intermittently. Although the parts of a loom work in harmony, and derive motion from a common source, they act and react upon each other to a considerable extent. A loom frame consists of two ends which are united by longitudinal and transverse rails. Where two pieces join, the framing should be planed; shaft bearings should also be bushed. The design of a loom frame determines the positions of the parts and their relations to each other; it affects the cost of production, by rendering it an easy or difficult matter to adjust, to repair, and to manipulate the machine. The cost of running a loom is influenced by the distribution of strength throughout the framing. If a frame is not strong enough to withstand the recurring shocks at the points where impact occurs, other parts will vibrate and break.

In height a frame should be such that a weaver may readily reach any part requiring attention. From 33″ in narrow looms to 40″ in wide ones is the usual height of a breast beam above the floor, and a back rest is frequently from $1\frac{1}{2}''$ to 3″ higher than a breast beam.

The stretch, or distance from front to back, varies with the nature of the material to be woven and the mounting of a loom. For calicoes it is from 35″ to 38″,

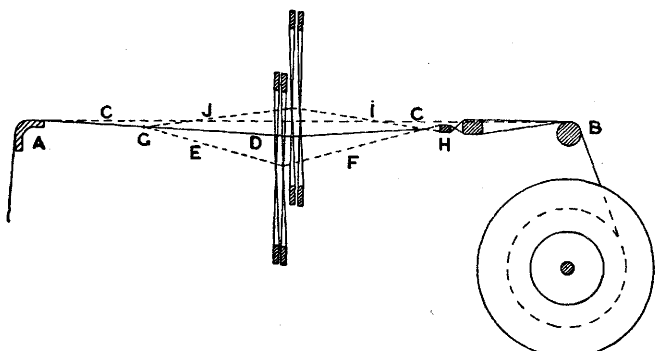

FIG. 282.

but narrow looms designed for heavy work are from 40″ to 45″, and broad looms from 52″ to 56″ deep.

The warp line is determined by the relative positions of the back rest B, Fig. 282, the breast beam A, the harness eyes, and the lease rods H. In practice the above-named parts are placed in different positions. Some overlookers fix A and B in one horizontal plane, and, with a lease in which two threads are over and two under each rod H, the distance between the first rod and the centre heald shaft equals that from the centre heald shaft to the cloth fell G. The heald eyes are then sunk below a straight line C, C, as shown at the closed shed line D. An upward movement

given to some warp, and an equal downward movement given to the remainder, will form in the bottom shed E, F equal angles before and behind the healds, and equal but smaller angles will be formed in the top shed I, J.

The angles being similar, equal strain will be put upon the warp on both sides of the healds, but more on the bottom than on the top shed. As a sequence, all threads in the lower line will be tight, while those in the upper one will be slack. This to some extent prevents the threads that pass in pairs through a reed, from running together in a fabric. But partially or wholly opening a shed intended for one pick before a reed drives the last one into position will assist in giving cover to a piece. For, during the operation of beating up, loose warp threads are separated from tight ones, and when in a cloth all threads will be equidistant. In Lancashire it is customary to fix the back rest $1\frac{1}{2}''$ higher than the breast beam, and to sink the heald eyes as before. But cover in cloth may be regulated by moving the lease rods. If they are set closer to the back shaft, a warp will be tightened, and if nearer the back rest, it will be slackened. This plan gives different angles behind and before the healds, and puts more strain upon a warp in one part of a shed than in another. When fabrics are woven face down, the bottom shed is made slack by dropping the back rest and raising the heald eyes. If inequality of tension be taken too far, corded cloth and broken warp will be frequent.

The correct bevel of a slay depends upon the length of the swords, the positions of the rocking shaft and connecting pins, the throw of the cranks, and the warp line. The warp line of an open shed determines the length of the swords, and if the latter are perpendicular when both reed and fabric touch, the position of the rocking shaft is also determined. Cranks for narrow and medium looms move a reed $4\frac{1}{2}''$ to $6''$, and for wide looms from $6''$ to $12''$. When the requisite size of a crank and the length of a connecting arm have been obtained, the former's position is fixed in the frame by the rule given on pp. 456 to 458. The arms are connected to the swords, the cranks are placed on their bottom centres, and the slope of the race board is made similar to that of the bottom warp line. But the backs of the shuttle boxes must coincide with the reed.

After fixing the position of the crank shaft, that of the bottom shaft is proceeded with. It should be placed so that picking and shedding tappets may be readily adjusted. In looms designed to weave stout fabrics, the driving wheels are necessarily large, and heavy fly-wheels are fixed upon the main shaft, in order to accumulate sufficient energy to ensure steady turning as the cranks approach their bottom centres. But driving wheels must not be heavier than necessary, or as they revolve the energy stored up by them will be expended upon the frogs of a fast reed, and the brakes of a loose reed, whenever those parts are brought into action. All wheels should be well made and balanced, and as the teeth wear rapidly at the picking point, it is advisable to move the wheels periodically $\frac{1}{4}$ of a revolution, and again key them upon their respective shafts.

Since a crank shaft receives the motive power direct, and transmits it to other parts of a loom, all movements are regulated by this shaft. When the cranks are on their fore centres, beating up takes place, and as movement continues, other pieces of mechanism are brought into operation. In order to ascertain whether everything is working correctly, new looms are run for some hours before any attempt is made to weave with them. For this reason the

picking motion is adjusted first. If a cone pick is to be used, the tappets and cones should be in contact all the way round, the force should be properly directed, and the parts at both sides of a loom should be equal. A long shuttle box is also an advantage, as by guiding a shuttle it reduces any tendency to fly out. It is usual to set the mouth of a box at least $\frac{1}{8}''$ wider than the rear end. Unless picking arms and straps are carefully prepared and fixed, the arms will put a twisting strain upon the spindles as the pickers approach the forward ends of their traverse. A long arm will give too much leverage, but a short one will strain the strap, spindle, and picker. If in narrow looms an arm moves through an angle of 40 degrees, it will generally pass through about 30 degrees before it becomes parallel with a loom end; the remaining 10 degrees will cause it to slant inward. To find its proper length, the cranks are turned to their fore centres, the arm is drawn over the spindle centre longitudinally, and that part of the arm where the picking strap leaves it should be over the spindle axis. The length of a picking strap is obtained by turning the cranks on their back centres and moving an arm backward and forward; a picker should then slide freely from end to end of its spindle without the strap being unduly slack. If, however, it is necessary to lengthen or shorten a strap, this can be done by adjusting the strap itself, or by loosening the upper ring upon the upright shaft and moving the arm in or out; in either case the time of picking will be slightly altered.

Slow-running looms should begin to pick when the cranks are on, or a little past their bottom centres, but in fast-running looms it is usual to pick 10 degrees to 15 degrees before these points are reached. To time a pick, a picker is held against a box end, and the crank shaft is turned until the picker begins to move. If the cranks do not occupy their proper positions, the bolts that pass through the picket-tappet slots are loosened, the shell and nose are moved in the required direction, and screwed tight. When a tappet nose faces the cone axis, the inner edge of the nose should be from $\frac{1}{8}''$ to $\frac{3}{16}''$ from the thick end of a cone. If more force is required, a tappet is moved nearer the upright shaft; but excessive force should be avoided.

Shedding and picking tappets may be correctly timed to each other, but not to the slay, in which event any alteration in the time of picking should be accompanied by a corresponding alteration in the time of shedding. This is done by loosening the crank-shaft bearings, lifting one wheel out of gear with the other, moving the tappet shaft in the required direction, and again making the bearings secure. Shuttles should be equal in weight and sufficiently heavy to overcome any side-pull from the weft. They should not be too large, or their increased bulk will necessitate a deeper shed. This will strain and break the warp. A large shuttle will hold a greater length of weft than a small one, but more time is needed to repair warp than to replace weft.

If a shuttle strikes a box end it will rebound, a cop will be thrown off, or a spool pin will be broken. If when the cranks are on their bottom centres a check strap holds a picker about 1″ from a box end, the foregoing defects will be avoided (see p. 377). Shedding tappets are set to act at different times to suit the fabric to be produced. If cover is unimportant, a tappet may be used on which less than $\frac{1}{3}$ of a pick is allowed for dwell. A shed should then be almost closed when the reed and cloth are in contact, but it must be fully open as a shuttle enters the

warp. Such a tappet is set by placing the cranks in their picking position, turning the tappet in its working direction until a treadle is fully depressed, and fixing it securely upon the shaft. Where cover is required, the cranks are placed on their top centres, the tappet is turned until both treadles are level and then screwed tight. In practice healds are level in all positions while the cranks move from their top centres until a reed is within $\frac{2}{5}''$ of the cloth fell. In case one tappet plate has a larger diameter than another, the treadle actuated by the largest plate is connected to the back shaft. If springs are used to reverse movement in heald shafts, they should all be equal in strength. Before attaching them, place each in turn upon a hook, and suspend a weight of from 4 to 7 lbs. from it; only those springs should be selected that stretch to the same extent—when supporting the same weight.

If a dobby of the Hattersley type is used, the bottom and top knives are set to move about $\frac{1}{4}''$ after liberating the hooks. When a peg is not acting, a hook is lifted $\frac{1}{4}''$ above a knife, and the driving crank is timed as for tappet shedding. For the adjustment of an oscillating tappet, see pp. 57, 58, and for that of single and double acting Jacquards, see pp. 207-209.

The back rest, the breast, and warp beams should be parallel with each other. A warp should be wound with an even tension, and be level all across. It is customary to set the beam flanges from 1″ to 2″ wider than the warp in the reed, but selvage threads should not be unduly oblique or they will be liable to break. Ropes or chains must be so coiled round the ruffles that regular slipping will occur, and the weights must receive frequent attention.

With a taking-up lever of the type illustrated in Fig.

LOOM ADJUSTMENTS.

Maker of Loom.	Warp Line.			Shedding.			Jacquard Cylinder.			Picking.			Weft Fork.		Box Motions.		Loose Reed.		Fast Reed.	Style of Loom.[2]
	Height of Breast Beam	Height of Back Rest.	Height of Warp Line when Shed is Closed.	Movement Begins.	Duration of Movement.	Pause.	Card Touches Needles.	Cylinder Full In.	Card Leaves Needles.	Movement of Picker Begins.	Movement of Picker Ends.	Movement of Picker.	Movement Begins.	Duration of Movement.	Movement Begins.	Movement Ends.	Distance between the Finger and Heater at 0°	~~The Distance the Finger~~ Passes the Heater.	Fell to Reed when Blades and Frogs are in Contact.	
Atherton Bros.	33·4″	33·4″	33·0″	270°	280°	80°	..	..	..	180°	237°	9·2″	270°	332°	..	..	..	..	3·0″	Twill, 2×2.
J. Dugdale and Sons	33·4″	33·1″	32·0″	273°	204°	156°	..	..	..	156°	214°	7·0″	97°	156°	..	..	1·7″	0·6″	..	Plain.
W. Dickinson	33·9″	33·3″	32·8″	264°	220°	140°	..	..	..	150°	210°	8·5″	100°	180°	..	..	1·7″	0·5″	..	Plain.
T. Pickles	35·1″	34·1″	33·9″	264°	274°	86°	..	..	..	184°	248°	11·0″	90°	136°	..	..	1·5″	0·5″	..	Plain.
George Keighley	33·9″	34·3″	32·5″	288°	239°	121°	..	..	..	180°	234°	7·0″	90°	136°	..	..	1·6″	0·9″	..	Plain, with Positive Let- f.
Butterworth and Dickinson	33·3″	31·5″	31·9″	243°	252°	108°	..	..	..	180°	252°	11·0″	270°	288°	..	..	..	..	2·2″	Sateen, with Outside Tappets.
Atherton Bros.	33·5″	33·5″	31·8″	256°	256°	104°	..	..	..	171°	227°	8·0″	270°	284°	..	..	..	..	3·2″	Shirting, with Plate Tappets.
H. Livesey	33·0″	31·6″	32·0″	288°	288°	72°	..	..	..	185°	268°	12·0″	113°	154°	..	..	..	..	2·9″	Satin, with Barrel Tappet.
R. Hall and Sons	34·2″	34·7″	33·0″	202°	317°	43°	..	..	..	180°	216°	6·5″	115°	158°	..	..	..	..	2·9″	Fustian, with Oscillating Tappet, and Yates Pick.
Platt Bros. and Co.	34·6″	35·0″	32·5″	234°	288°	72°	..	..	..	180°	216°	4·0″	72°	144°	..	..	..	..	2·5″	Fustian, with Woodcroft Tappet, and Latch Pick.
Lancaster and Co.	33·7″	34·2″	32·6″	263°	240°	120°	..	..	..	165°	225°	9·0″	75°	120°	300°	91°	1·5″	0·4″	..	Plain, with Eccentric Box Motion.
Butterworth and Dickinson	33·3″	32·6″	32·4″	243°	252°	108°	..	..	..	162°	225°	11·0″	72°	162°	333°	135°	..	..	2·0″	Plain, with Eccles Box Motion.
Northrop Co.[1]	33·6″	35·0″	32·9″	207°	171°	189°	..	..	..	207°	252°	7·5″	45°	270°	..	..	..	..	2·4″	Twill, with Cop Changer, and Cone Under Pick.
Butterworth and Dickinson	33·5″	32·6″	32·2″	223°	270°	90°	..	..	..	176°	234°	9·5″	90°	144°	..	..	..	..	2·4″	Sateen, with Cowburn's Shuttle Changer.
Hansen	34·6″	33·9″	34·0″	247°	237°	123°	..	..	..	142°	196°	9·0″	76°	142°	..	..	..	..	2·9″	Plain, with Hansen's Shuttle Changer, and Cone Under Pick.
Hacking and Co.	33·0″	31·1″	32·3″	245°	300°	60°	..	..	..	180°	260°	11·0″	60°	180°	0°	140°	..	..	3·4″	Terry, with L. and Y. Dobby, and Eccentric Box Motion.
R. Hall and Sons	34·0″	33·3″	32·2″	206°	310°	50°	..	..	..	154°	206°	8·5″	90°	129°	..	..	..	..	2·7″	Serviette, with Terfloth Dobby, and Lever Pick.
J. Dugdale and Sons	33·2″	31·0″	31·5″	258°	302°	58°	..	..	..	180°	243°	10·0″	92°	151°	..	..	..	..	3·2″	Lappet, with Ward's Dobby.
J. Dugdale and Sons	33·2″	31·9″	32·1″	258°	302°	58°	..	..	..	165°	221°	10·0″	78°	135°	0°	109°	..	..	2·7″	Shirting, with Ward's Dobby, and Wright Shaw's Box Motion.
H. Livesey	32·8″	31·8″	32·1″	261° 261°	230° 288°	130° 72°	..	..	..	176°	234°	8·0″	85°	144°	..	..	1·2″	0·4″	..	Dhooty, with Tappets and Blackburn Dobby.
Pemberton and Co.	33·6″	32·5″	32·5″	224°	300°	60°	..	..	..	165°	195°	9·0″	90°	131°	..	..	..	..	2·2″	Fancy, with Ward's Dobby.
Crompton and Knowles[1]	34·1″	34·2″	33·2″	200°	308°	52°	..	..	..	200°	240°	8·0″	90°	160°	0°	160°	..	..	2·4″	Dress Goods, with Stafford Dobby, Crompton and Knowles Box Motion, and Cone Under Pick.
G. Hattersley and Sons	35·4″	32·5″	32·5″	220°	307°	53°	..	..	..	187°	240°	7·5″	67°	160°	40°	180°	1·5″	0·4″	..	Shirting, with Hattersley Card Dobby, and Skip Revolving Boxes.
Wright Shaw	34·1″	33·4″	32·6″	218°	313°	47°	..	..	..	152°	218°	9·5″	85°	183°	341°	114°	..	..	2·7″	Shirting, with Schelling and Staübli Dobby, and Wright Shaw's Box Motion.
Harling and Todd	34·1″	32·0″	33·3″	220°	306°	54°	..	..	..	167°	229°	11·0″	90°	126°	..	..	1·7″	0·5″	..	Leno, with Cross Border Dobby.
Anderston Foundry Co.	35·0″	32·9″	32·5″	266°	313°	47°	..	..	..	188°	227°	10·0″	94°	172°	..	..	..	..	4·7″	Lappet, with Centre Shed Dobby, and Under Pick.
G. Hodgson	34·9″	34·6″	33·5″	240°	332°	28°	221°	258°	359°	185°	221°	12·5″	64°	180°	19°	167°	..	..	2·4″	Double Plain, with Double-lift Twin Jacquard, Eccentric Box Motion, Centre Weft Fork, and Cone Under Pick.
Butterworth and Dickinson	33·4″	31·7″	32·1″	213°	315°	45°	202°	240°	330°	169°	218°	8·5″	83°	202°	..	..	1·6″	0·2″	..	Brocade, with Cross Border Jacquard.
R. Hall and Sons	34·8″	33·0″	33·8″	288°	300°	60°	192°	252°	360°	168°	210°	8·0″	96°	216°	342°	102°	..	..	3·0″	Tapestry, with Double-lift Double Cylinder Jacquard, Diggle's Box Motion and Lever Pick.
Hacking and Co.	33·7″	32·1″	33·5″	240°	305°	55°	176°	242°	353°	175°	207°	8·0″	87°	174°	327°	109°	..	..	2·5″	Tapestry, with Double-lift Double Cylinder Jacquard, Eccentric Box Motion, and Latch Pick.
D. Sowden and Sons	35·6″	34·9″	35·0″	200°	307°	53°	162°	212°	274°	187°	207°	8·5″	80°	173°	0°	160°	..	..	3·5″	Tapestry, with Double-lift Single Cylinder Jacquard, Eccentric Box Motion, and Centre Weft Fork.
Atherton Bros.	33·4″	32·3″	31·6″	218°	313°	47°	218°	256°	313°	180°	227°	9·5″	28°	218°	..	..	1·7″	0·5″	..	Brocade, with Double-lift Single Cylinder Jacquard.

1 0° = Bottom Centre. In all other cases 0° = Top Centre.

2 Where not otherwise stated, the loom is fitted with a Cone Over Pick.

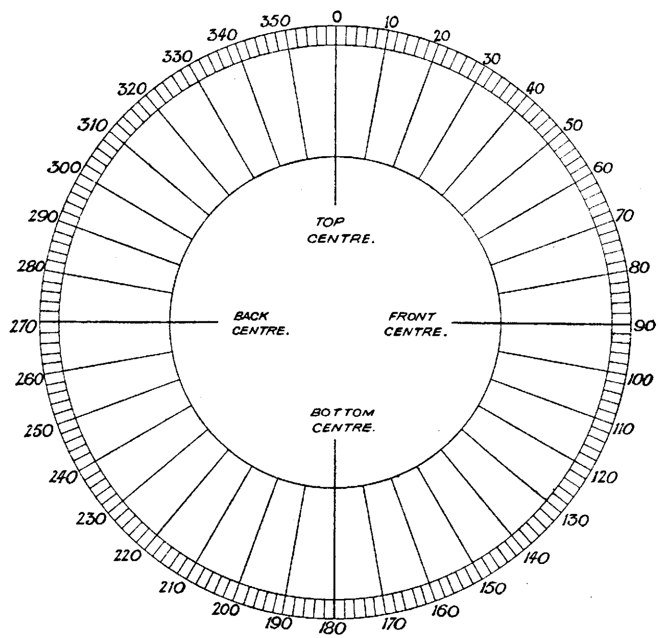

FIG. 283. *Face page* 579.

263, a pushing pawl is set to drop into the hollow of a tooth in the ratchet wheel when the cranks are upon their back centres. The driving stud is then raised or lowered until a pawl takes one tooth as the slay moves forward. The cranks are turned to their fore centres, and a holding pawl is fixed about $\frac{1}{8}''$ past the bottom of a tooth (see p. 533).

In fast-reed looms the blades must clear the frogs by $\frac{1}{8}''$ to $\frac{1}{4}''$ when a shuttle is in its box, and they should be long enough to stop a slay when a reed is $2\frac{1}{2}''$ or more from the cloth fell. In practice the distance varies from $2''$ to $4\frac{1}{2}''$. The broader and deeper the shuttle, the greater the distance (see pp. 382, 383).

The steadying springs should be strong enough to prevent a loose reed from vibrating as a shuttle moves across. When the cranks are on their top centres, there should be a space of about $2''$ between the fingers and heaters, so that, in case of accident, sufficient room will be provided for the fingers to rise and slide along the upper inclines. In order that the fingers may hold a reed firm when in contact with a fabric, their tips must pass the front edges of the heaters about $\frac{7}{16}''$ (see p. 385).

When a shuttle is boxed at the driving side, and the cranks are upon their fore centres, a weft fork tappet should move the hammer lever. So long as weft is intact, the fork must clear the hammer head by $\frac{1}{4}''$, and pass through the grid without touching (see p. 491).

Multiple shuttle boxes should begin to move as the cranks reach their top centres, for then half a revolution is available for effecting a change and steadying the boxes before a shuttle is driven across. In one-sided box motions the pick following a change must be delivered from the multiple box side, and in all multiple box motions the bottom of each box must coincide with the race board (see also pp. 416, 417).

The accompanying sheet, Fig. 283, shows that considerable variations from the foregoing adjustments are to be met with. The figures have been obtained from 32 looms made by 21 different firms.

When a warp is placed in a plain loom, cords are attached to the heald staves, and the healds are coupled to the roller motion to bring the shafts parallel with the slay. The reed is then mounted in the slay so that it shall not move vertically, but shall be free to move longitudinally, for this will permit the reed dents to face the heald eyes. Yarn is tied in bunches upon a rod, and cords or cloth connect this rod with the taking-up roller. The centre bunch is attached first, that is followed by the two outside bunches, and after them intervening ones are knotted upon the rod, care being taken to keep the threads equally tense. At half the lift both treadles should be in contact with the tappet, and in this position the healds are attached to them at a uniform height. The slay is moved to ascertain whether or no, in a fully open shed, the yarn touches the race board and misses the reed top; if it does not, the healds are adjusted vertically by means of the cords and straps.

Risk of shuttles being ejected may be minimised by attention to the following points: Fibrous yarn, knots with long ends, slack warp, uneven race board, small sheds, the bottom line too high, worn pickers, swells that give a twist to the shuttle as it leaves a box, and a rocking shaft that allows the slay to lift. All are fruitful causes of trouble.

Temples are fixed nearer to or farther from a reed, as the piece to be woven is light or heavy. Their inclination

varies, but as a rule they are set as near a reed as possible without touching, and with their front edge from $\frac{3}{16}''$ to $\frac{5}{16}''$ lower than the breast beam (see pp. 547-557).

Much wear and friction is caused by neglecting to lubricate the moving parts of a loom. But if lubricants are used too freely, grease is thrown upon the material being woven and about a weaving room.

PART XXVI

WEAVING SHEDS

In England looms are usually placed in a shed, because this type of building ensures good light, especially where Jacquards are used, solidity of foundation, freedom from vibration, better ventilation, and more uniformity in the humidity and temperature of the atmosphere than buildings of several stories. Ventilation and humidification are now regulated by law, and it is part of a factory inspector's duty to see that legal conditions are strictly complied with. A shed also admits of the most convenient arrangement of machinery and of easy supervision. The cost of building and gearing is small, and the carriage of material from place to place is facilitated. A shed may be built any width or length, and may adjoin other and more lofty buildings. The situation is of importance; it should be open to moist winds but protected from dry ones, and the subsoil should be clay. In making a selection consideration should be given to the cost of land, the cost of construction and equipment, and the scale of local taxation; the close proximity to a good and cheap supply of water and fuel, ready access to the markets for raw material and finished products; but especially to a locality in which experienced operatives are plentiful.

In many cases the machinery employed for all processes between spinning and weaving is placed in a contiguous building of two or more stories, for by this means floor space is economised. In other cases a shed contains all the plant necessary to keep a concern in operation. Whatever the nature of the building, the machinery should be arranged to give the maximum of convenience with the minimum of supervision. Both will be appreciably affected if the material to be used can be prevented from travelling over the same ground twice. The complete scheme should be such as will keep down the cost of insurance.

Where Jacquards are used, sufficient height must be provided for suitably placing these machines over the looms, also because harnesses interfere with the free distribution of light. Shed walls A, Figs. 284 and 285, are 12′ 0″ to 16′ 0″ from the floor line to the base of the girders, and usually 14″ thick, unless one wall has to carry the gearing shaft C, in which event the thickness of that wall is increased to 18″ or 24″. If all the walls are of equal thickness, the shaft C rests upon columns built in one wall B. For the sake of cleanliness, it is desirable to isolate the shaft C from the shed by a thin wall.

The roof is supported partly by the walls, but principally by a series of cast- or wrought-iron columns D, erected upon a concrete and stone foundation. In sheds constructed with narrow bays, to weave plain cloth, cast-iron columns have a diameter of 5″ at the base and $4\frac{1}{2}$″ at the top, with a metal thickness of $\frac{5}{8}$″ at the former and $\frac{1}{2}$″ at the latter places. Since they only support a light roof and the shafting, this strength is ample. But for

Jacquard weaving the columns should be stronger, and have lips cast upon them from 7′ 0″ to 11′ 0″ above the floor line in order that they may support a network of light girders on which the Jacquards are to rest. An

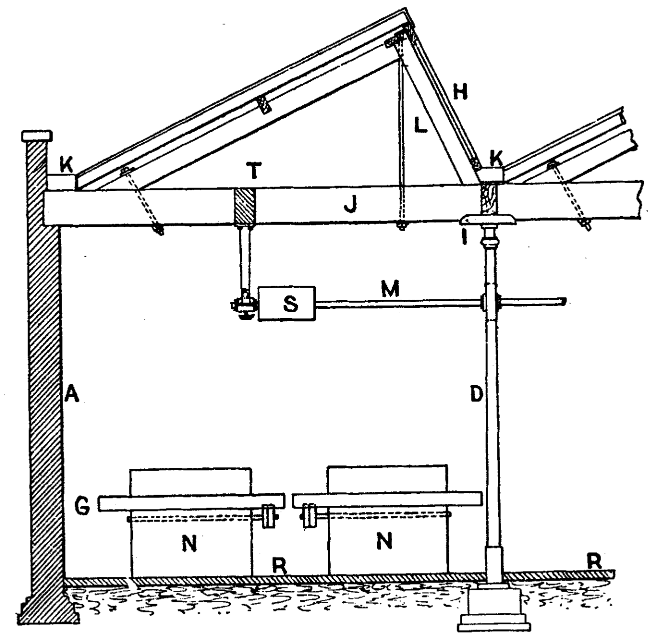

FIG. 284.

additional 1″ in diameter and $\frac{1}{8}$″ in metal thickness will in most cases suffice. The arrangement of columns depends largely upon the class of loom to be used; they are generally distributed to take four looms—two in length and two in width, and leave walking space between and round the looms. Narrow looms are from 3′ 6″ to 4′ $4\frac{1}{2}$″

wide, averaging 4′ 0″ or 4′ 1″; and broad looms are from 4′ $7\frac{1}{2}$″ to 5′ 8″ wide, but many are 5′ 2″ wide. A working alley E should be 20″ to 22″, a back one F not less than 16″ to 18″, and an end passage G 24″ wide; therefore taking the narrowest looms, we have $3' 6'' \times 2 = 7' 0'' + 20'' + 16'' = 10' 0''$ from centre to centre of the columns that run from east to west. For a loom 4′ 0″ wide, at least 11′ 4″ should be allowed; in some new sheds filled with narrow looms 12′ 9″ is provided. Broad looms with two or three warp beams require a space of 14′ 4″ to 15′ 0″ between column and column. When planning a shed, extra space must be provided if two or more warp beams are to be used with each loom, also for tappets and dobbies when placed outside a loom framing, and for multiple shuttle boxes, or the work of the operatives will be unnecessarily difficult to perform. The looms in one shed may be of such varied lengths as to make it impossible to place them in a fixed position relatively to the columns. In old sheds, and in lines from north to south, the columns are from 15′ 0″ to 20′ 0″ apart, but in new sheds columns are greatly reduced in number. Thus, instead of arranging them, say 11′ 0″ by 16′ 9″ apart, as in the old plan, they are 22′ 0″ by 33′ 6″ apart. This provides for four narrow looms lengthwise and two end passages, between any pair of columns that run from north to south; also for four lines of looms with front and back alleys, between columns running from east to west. But alternate lines of shafting must be supported from the roof, and the roof beams and columns strengthened to guard against vibration. In a shed of the new type it is much easier to arrange looms of different lengths than in one of the old type, and the transit of warps is facilitated. Columns have a uniform arrangement, except where main passages traverse a shed.

At all such places at least 4′ 0″ should be allowed; they may be against the walls, or in the middle of a shed.

Weaving sheds are top-lighted, and the roofs are saw-toothed. Windows H run from east to west to give a northern light, which is the most uniform, and to prevent the direct rays of the sun from entering the building the roof also forms a protection from east winds. Roof are made of wood or metal, and each column is cast in the form of a shoe I, to take the horizontal wood, iron, or steel beams J that run from north to south. If the driving is overhead, cross beams T are placed at, and midway between, the columns. But if the driving is below the floor line they are fixed at the columns only. The beams J, T bind the columns and walls together; they support the roof, and from T and the columns D the shafting is suspended. Cast-iron gutters K rest immediately over the columns, but are at right angles to the beams J. They are connected to parts L, that make an angle approximating to 65 degrees with the water-level. These parts carry the upper portions of the roof, the gable of which forms a right angle. The steepness of each glazed portion H prevents the snow from collecting upon it in winter, and the sun from shining in too freely in summer. If in large sheds the only outlets were at the walls, it would be difficult to remove storm water fast enough, therefore the hollow columns are utilised as discharge pipes, and drain-pipes beneath the floor carry the water away. With this system difficulty is experienced in cleaning out the drains, and water is liable to find its way to the shafting and bearings. Much leakage may, however, be prevented by attention to the construction of the gutters, and the flashing under the windows. Another plan for removing rain water from shed roofs consists in fixing pipes beneath the gutters and parallel with the beams J. Where water is first received, they are small in diameter but increase in area at each succeeding bay in proportion to the volume of water. Small manholes are provided at intervals, which allow the pipes to be readily cleaned out. In sheds of moderate size the roof may be pitched to slope from the centre to each outside wall at the rate of $\frac{3}{8}''$ to 1 foot. Each down spout is then large enough to remove half the water from one gutter.

Where a main driving shaft C is used, it is fixed against the gearing wall, and should be placed 9′ 0″ to 11′ 0″ above the floor line. It turns, by bevel wheels Q, all the line shafts M, that run parallel with and between alternate rows of looms N. In most cases line shafting is fixed transversely to the windows in order that the loom slays shall not throw shadows on the warps. Still there are sheds in which the shafting and gutters are parallel. If a shed is arranged for a given number of double rows of looms, an extra shaft is required. Some manufacturers prefer to have one or even two single lines of looms set apart for their least skilled weavers.

Main shafts are driven by steam engines, steam turbines, gas and oil engines, and electro-motors. On the continent of Europe looms have, for several years, been separately driven by motors and water turbines. In this country a shed is now being erected for separate driving by motors. Motion is conveyed from an engine through wheel gearing, ropes, and belts. Where wheels are used it is often advisable to place an engine at or near the centre of the gearing wall, and to elevate its bed so that the power may be passed direct to a wheel P on the shaft C. Or if the velocity is unsuitable, a second motion shaft is employed. In which event an engine wheel drives a pinion on the second motion shaft, and another wheel O

on that shaft transmits the power to P. The crank shaft of an engine and the main shaft C are then parallel, and equal power will be distributed on both sides of the wheel P. Instead of tooth gearing, ropes may be led from an engine wheel round a rope pulley on the shaft C. Every length of main shafting diminishes in diameter in proportion as the power to be transmitted is reduced; its dimensions are influenced by the nature of the looms to be driven and the distance from support to support. Generally speaking, loom shafting is stouter than that necessary for ordinary driving because of the unsteady action of these machines. Power is distributed to line shafts through bevel wheels Q, whose diameters should be such as will impart the required velocity, and cause each tooth of one to work by degrees in all the teeth of the other; a difference of one tooth is sufficient to ensure the latter. The line shafts M may be driven direct if the crank shaft of an engine is parallel to M, for half the ropes will be taken to pulleys on line shafts at one side, and half to those at the other side of the rope wheel. By means of similar ropes and similar wheels every shaft in a shed can be driven.

Looms are driven in various ways from shafting placed below the floor line. By one plan trenches, about 7 ft. deep by from 4 ft. to 6 ft. wide, are cut in the earth to contain shafts, driving drums, and supporting brackets, also to permit oilers and greasers to pass to and fro with a minimum risk of injury. Belts pass through holes in the floor to the loom pulleys, but the distance from centre to centre of the pulleys is several feet less than for overhead driving. This is a defect, as a belt must be tight in proportion as its length is reduced. On the other hand, it is claimed that less frictional electricity is generated, that moisture from the trenches is continually carried through the belt holes, and that an under-driven shed is cleaner than an over-driven one. Another plan consists in excavating a basement under the entire shed. The shed floor then rests upon beams 8 ft. apart, beneath which an ample number of columns is provided to prevent vibration. The cost of building such a shed is much greater than for over-driving or under-driving by the trench system. The space thus provided is, however, utilised as a storeroom for warp and weft, and as a general store.

In order to give the machinery a firm base, a shed floor R is covered with heavy slabs of stone. Looms are made right and left handed, to bring the driving pulleys together, and are placed back to back. They are formed into groups of four, and two rows are driven from one line shaft; the latter is fixed to the columns D, and further supported by hangers from the roof beams T. Each group is driven by a drum S, 20″ to 24″ wide by 15″ to 20″ in diameter, which is capable of carrying four driving straps. Or two narrower drums are fixed on opposite sides of the shaft bearings, and as close together as possible. Each then drives a pair of looms by means of pulleys that vary from 8″ to upwards of 18″ in diameter, according to the required speed of a loom. In order that the loom ends may give straight lines of machinery, the crank shaft of one is made longer than that of its fellow by at least the width of two driving pulleys. Loom shafts are set parallel with the line shafts in the following manner: A plummet is dropped from different points along the first line shaft, and where it touches the floor a permanent mark is made with a chisel. A chalked cord is stretched over two such marks, lifted at the centre, and suddenly liberated, when a straight white line is left on the floor, and it must be extended from

wall to wall. Similar lines may be made below alternate shafts, after which two marks are made, 10′ 0″ to 12′ 0″ apart, upon one of the lines; each is used as a centre from which two intersecting arcs are described on both sides of the line. A chalked cord is stretched over the points where the arcs intersect to make a line at right angles to those already traced. From these lines the positions of the loom feet can be obtained, care being taken to fix them so that the pillars will not unnecessarily obstruct the back alleys. A long straight-edge, with a spirit-level on the top of it, is laid upon a loom in various positions, to ascertain if packing is required beneath the feet; if so, pieces of wood are cut to the required size, the positions of the foot holes are marked, the loom is removed, holes are drilled in the flags, and dry wooden pegs are tightly driven into them. The loom is then put back into position, and long nails are driven through the feet into the wooden plugs; the latter swell with the moisture of the floor and hold the loom securely. By another plan, after the positions of the loom feet have been defined, and holes drilled in the flags, projecting studs from loose feet are dropped into them, and the loom is placed upon the recessed loose feet.

In addition to the calculations given for healds on pp. 12 to 19, for shedding on pp. 31, 32, 61 to 64, 82, 309, 310, 317 to 319, for picking on pp. 338, 339, for beating up on pp. 460 to 466, for reeds on pp. 469-470, and for taking-up motions on pp. 534 to 536, two velocity examples are added. Namely: If a line shaft makes 130 revolutions per minute and is to drive a loom at the rate of 200 revolutions per minute, by means of a loom pulley 9″ in diameter, what must be the diameter of the driving drum?—

130 : 200 : : 9″ : 13·9″, the diameter required.

Also, if a line shaft makes 140 revolutions per minute, and is furnished with a drum 15″ in diameter, what must be the diameter of the loom pulley to give 220 picks per minute?—

220 : 140 : : 15″ : 9·55″, the diameter required.

So many small matters connected with a loom require close attention, that successful weaving depends upon strict attention to details. But most of these can only be dealt with as they arise in practice.

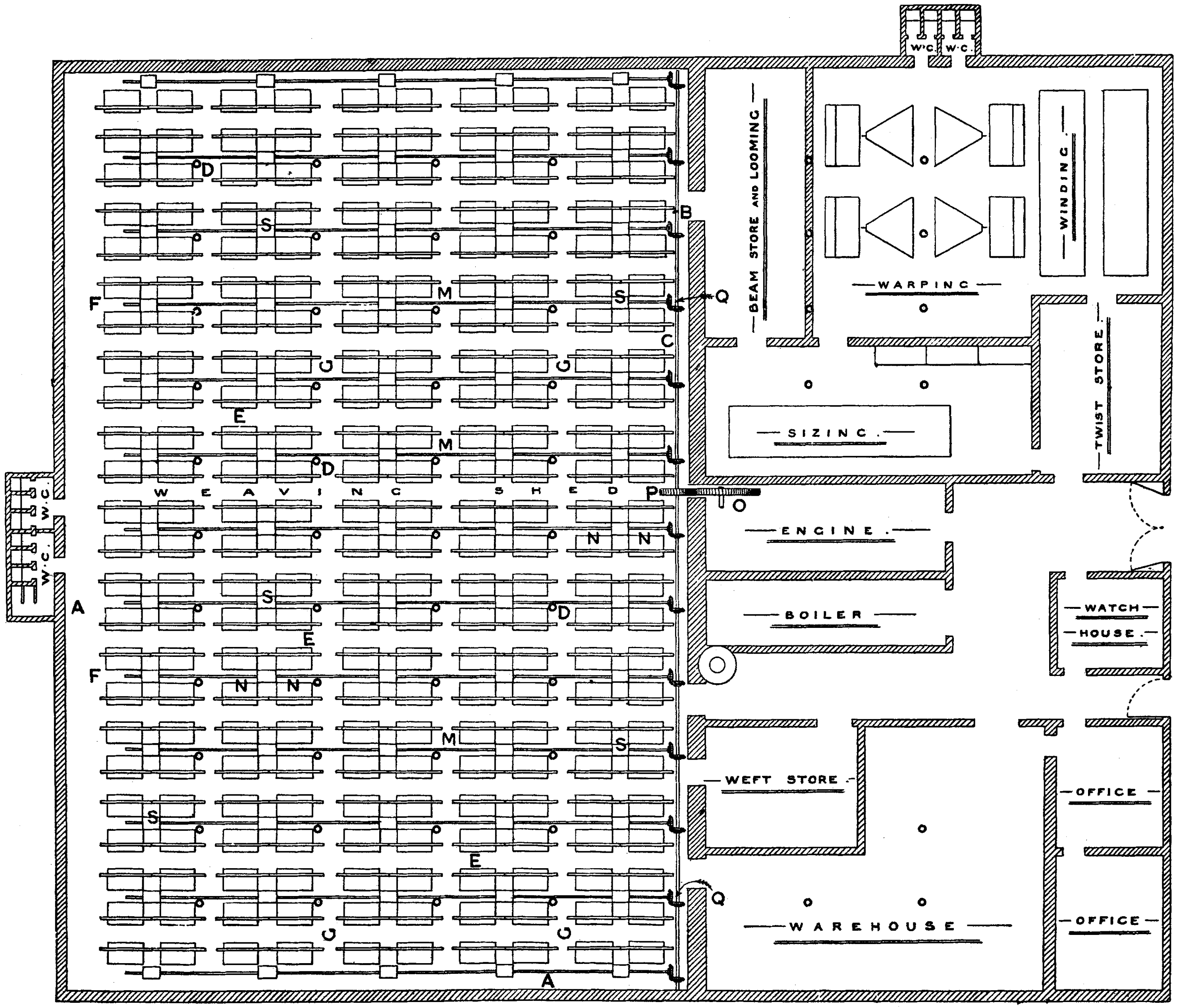

FIG. 285.

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