CHAPTER VII

LET-OFF MECHANISM

THESE motions are employed for regulating the amount of warp delivered from the warp beam, and also to maintain the necessary tension on the warp during the time that shedding and beating-up take place. The let-off motion has a direct influence on the number of picks per inch put in the cloth, being subsidiary to the take-up motion. There are two common classes of let-off motions, each class containing different types, the principle involved and the construction of each type in the two classes being practically the same. These motions are classified either as negative or as positive let-offs. The former term is theoretically correct, but is practically a misnomer, since the construction of this class of motion is such that it is solely employed for the purpose of keeping the warp in tension, and it does not in any definite manner let off the warp, the latter being drawn from the warp beam as required. Motions classed as "positive" differ from the former in that the warp beam is actuated mechanically in order to let off the requisite amount of warp, the motions being automatic in their action. These motions, however, do not necessarily give off exactly the same length of warp for each pick, but are so constructed that they are sensitive to variations in the tension on the warp, which is brought about by any cause—*e.g.*, the difference in the counts of the weft yarns, as when weaving fancy vesting fabrics spotted by means of extra silk weft or other yarns of much finer counts than those used for the ground.

Various attempts have been made to construct a positive let-off the principle of which was to draw the warp off the beam by means of drawing rollers. The rollers were driven by a train of wheels in a manner similar to a positive take-up motion, suitable provision being made for regulating the let-off of the warp to the take-up of the piece in correct relation to each other, as occasioned by the variation in the shrinkage of the different weave structures, counts and quality of yarns, and in the number of picks per inch in different cloths. It is chiefly on account of these varying factors, and of the difficulty experienced in taking back the exact amount of warp after picking out, and at the same time preventing a shady place in the cloth, that this class of motion has not been adopted.

A let-off motion should possess the following features: Uniform tension should be maintained on the warp during the cycle of motions attendant on each revolution of the crankshaft. Provision should be made for regulating the motion necessitated by reason of the decreasing diameter of the warp on the beam, from the commencement to the finish of the warp. It should provide a ready means for taking back the warp on to the beam after unweaving for any defect. The motion should be sensitive, and readily respond to any variation in the tension of the warp.

Negative Let-off Motions.—These are referred to in different terms—namely, brake, friction and twitch rope let-off. The principle is the same in each, the difference being in the method of application. The warp beam is supplied with suitable ruffles, one at each end, to which a brake may be applied, usually a steel band lined with leather; or the ruffle may form part of a friction clutch, in which the requisite pressure is applied through the medium of levers and weights. The method most generally adopted is to employ stout hemp ropes or chains in combination with levers and weights. Fig. 46 shows an arrangement of this latter type. The rope A is first secured to the cross-rail B, then passed up behind the ruffle C, around which it is coiled a number of times, according to the tension required on the warp. It is finally secured to the ratchet D on the lever E, which is weighted by means of the weights F. This type of motion is generally adopted for broad looms engaged in weaving woollens, blankets, and other plain heavy fabrics. Another type of this motion adopted for narrow looms is illustrated in Fig. 47. A chain A is substituted for the rope. The position of the weight lever is as shown, but the principle in each of the motions is the same.

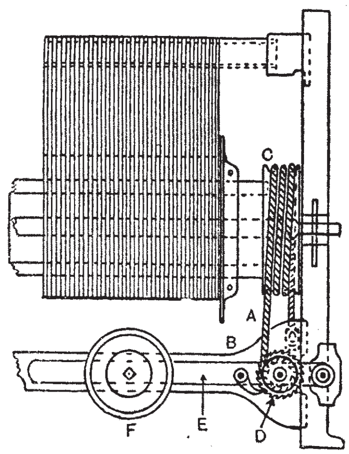

FIG. 46.

VARYING THE TENSION OF THE WARP.—Such motions afford ample scope for regulating the tension on the warp as may be required for different cloths, also for maintaining a uniform tension on the warp from a full to an empty beam. The tension may be varied by any of the following methods: By utilizing one or both ruffles on the beam; increasing the number of coils on the ruffles; adjusting the position of the weight on the lever; or by means of additional weights. In the looms employed for weaving the heavier class of fabrics, two back rails are employed at the back rest, the warp being interlaced as shown in Fig. 47. This is a very useful arrangement, as the tension due to interlacing the warp in this manner reduces very considerably the friction to be applied by means of the ropes or chains on the ruffles; this also renders the motion more sensitive to the varying strains on the warp. There is a limit, however, to which additional coils can be made effective; if the ropes are coiled too frequently around the ruffles, and excessive weight placed on the levers, the delivery of the warp will be very irregular. This is due to the ropes maintaining their grip on the ruffles without allowing the warp beam to slip forward; consequently the weight lever is gradually raised and the rope is slackened between the beam and the cross-rail, until the friction between the coils and the ruffle is no longer sufficient to keep the warp beam in check; the beam then moves quickly forward, delivering an indefinite length of warp, which allows the levers to drop and the ropes to regain their grip. This process is repeated again and again, with the result that the numbers of picks per inch are irregular, and the piece is very shady weft way. For this reason it will be found that equal friction applied on each ruffle yields better results than having excessive tension on one and the other only lightly tensioned.

Causes of Defective Working.—The above features outline the chief defect in this class of let-off motion, which is in the main the cause of dark and light places in the cloth. This defect may also be traced to the ropes becoming dirty and greasy through usage. Owing to the tension exerted on the ropes they are speedily drawn and worn into a practically solid strand, and when in this condition they are not so effective as when new. In order to overcome the irregular grip of such ropes a free use is made of powdered plumbago, but unless great care is exercised in its application, the defect it is intended to remedy will be rendered worse.

No doubt the most important factor in connection with the use of ropes is that they are adversely affected by the

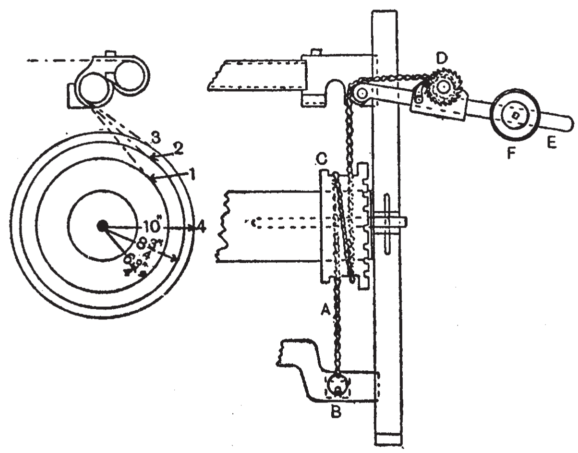

FIG. 47.

oil thrown off by the picking tappets and cones. In looms where the picking mechanism is placed inside the loom frame, as is the case in many of the plain looms fitted with the cam and cone type of picking motion, the rope when coiled around the ruffle is in close proximity to the picking mechanism. Much of the surplus oil is thus thrown off on to the ropes and ruffles, and this result has been frequently the direct cause of uneven pieces. A further defect in the use of ropes is that they are affected by changes in the temperature of the weaving shed, such changes increasing or diminishing their grip on the beam and resulting in the irregular delivery of the warp between one portion of the piece and another.

It is with the object of overcoming this defect that chains have been substituted for hemp ropes, as they are not affected by any change in the humidity. There is one feature in the use of chains which is worthy of special consideration. Some tuners prefer to use chains without applying any oil or other lubricant, as they claim that a very regular grip can be maintained between the chain and the ruffle, providing that the latter is turned up true and smooth. No doubt this practice is permissible, but the difficulty is in keeping them perfectly dry throughout. They are not only liable to receive the surplus oil thrown off by the picking or any other mechanism of the loom, but the indiscriminate weaver will often apply oil with the object of increasing the production. For this reason it is much safer to lubricate the chain and ruffle, with either tallow or vaseline, at the commencement of a new warp, and so mitigate the possibility of surplus oil falling on them during weaving. A defect more common in light wefted fabrics is due to uneven shedding by reason of one or more of the heald shafts being lifted too high or drawn too low. An irregular lift of the healds in the formation of the shed is often sufficient to cause the warp to be jerked forward, as the warp beam is only lightly tensioned, the defect being more in the nature of a crack or incision across the piece than one of shadiness.

ADVANTAGES AND DISADVANTAGES OF THIS CLASS OF MOTION.—The advantages of this class of let-off motion are to be found in the simplicity of their construction; their suitability for light and medium weighted cloths; their adaptability for weaving tender warps and those made from yarns possessing few elastic properties. This latter is made possible on account of the oscillatory movement which is imparted to the warp, simultaneously with the strain of shedding and beating-up. Occasionally for this purpose the back rest is so constructed as to vibrate and yield to these varying strains, the oscillation being obtained by means of a swinging back rest, operated by a suitable lever actuated by a cam fixed on the crank-shaft. The disadvantages may be summarized as follows: Expenses incurred in the renewal of ropes; the difficulty experienced by the weaver when taking back the warp on to the beam after picking out, and also of regulating the tension on the warp in order to start up without showing a shady place in the piece; and the amount of attention demanded from the tuner or weaver to adjust the weight as required by the decreasing diameter of the warp on the beam.

The last of these factors is a constant source of defective pieces. The grip on the ruffles must be gradually diminished, in relation to the decreasing leverage which the warp line possesses at various stages. This is further explained by reference to Fig. 47, in which the lines 3, 2, 1 represent the position of the warp line at the start of each cut in a three-cut warp. The leverage from the centre of the beam to the point 4 is 10in.; this leverage at the end of the first cut is reduced to $8\frac{3}{4}$in., and at the end of the second cut to $6\frac{3}{4}$in. From these approximate figures it will be evident that if the force of the beat-up and the strain due to shedding are equal throughout the warp, the beam will be drawn round much more easily at the commencement, or during the first cut, with a leverage of from 10 to $8\frac{3}{4}$ in., than during the last cut, with a leverage of from $6\frac{3}{4}$ to 3in., which is the radius of the beam. Defects due to the above are most prevalent when weaving fabrics containing a few number of picks per inch, and are always accentuated in the last cut off the warp. From observations made it was found that many of the pieces defective in this particular were the last cut off the beam. This is readily explained when it is remembered that the decrease in the diameter of the warp changes much more quickly during the last cut than during the first, the proportion being as 3 to 1. In such defective pieces the worst examples of these defects were found to be more noticeable in the last 10 to 15yds. of the piece. For this particular class of fabrics it is an advantage to use cased beams, say with a diameter of 8in., in preference to solid beams of about 6in. diameter, as there would not be such a marked difference in the changing diameter during the last cut off the beam.

Positive Let-off Motions.—The construction of the different types of these motions varies only in matters of detail. The principal features involved are the sensitive back-rest over which the warp is passed, and the method of operating the let-off shaft.

The construction of a type of positive let-off motion is illustrated in Fig. 48. The worm-wheel A fixed to the warp beam is made to gear with the worm B on the let-off shaft C. This shaft is supported in suitable brackets fixed to the loom frame, usually on the inside, the back bracket shown at D being made in cup form for the purpose of retaining a quantity of oil, in which the worm rotates. On the shaft C a ratchet wheel E is secured, the ratchet being actuated by means of the catches F and F^1, which are supported in the catch-box G fulcrumed on the let-off shaft. The catches are made of different lengths, the catch F being half the pitch of the teeth in the ratchet wheel longer than F^1. This provision renders the motion more sensitive to any variation in the tension applied to the warp. The shaft C is prevented from turning too freely by means of a brake strap acting on the brake wheel H. The catches are operated from the crankshaft by means of the eccentric J and the cranked lever K, the lower arm of this lever being connected to the catch-box by means of the rod K^1. The stroke of the catches, and consequently the amount of warp let off, is determined as follows:

(*a*) By the length of the regulating rod L, which is secured at one end of the lever K, and at the other end, which is provided with a slot, to the stud L^1 in the back-

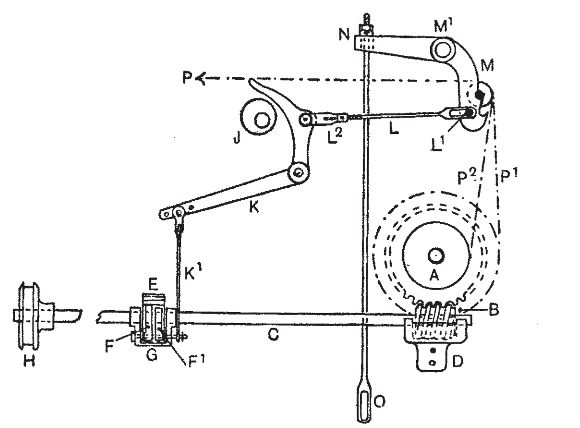

FIG. 48.

rest bracket M. The length of the rod can be easily altered by slipping it off the stud L^1 and screwing it farther into or out of the screw-threaded bracket L^2.

(*b*) By the movement of the back-rest M, which has its fulcrum on the stud M^1. The upper arm of the back-rest M is suitably connected to the weight lever by means of a connecting rod at the points N and O respectively.

The movement of the back-rest bracket is influenced by the tension applied on the warp at the time when beating-up takes place. The force of the beat-up draws the warp in the direction indicated at P, and simultaneously causes the back-rest to move inwards; this allows the rod L to work forward, and the lever K and the catch-box to fall, with the result that the catches engage with the teeth of the ratchet wheel at a lower point than would be possible if there was no movement of the back-rest. It should be noticed that the cam J on the crankshaft is so fixed that the throw—*i.e.*, the swell of the cam—has worked clear of the lever K when beating-up is taking place, and therefore permits the lever and the catches to drop to the full extent, as determined by the movement of the back-rest. It will be obvious that any weight on the weight lever will result in great resistance to the movement of the back-rest, and consequently will increase the impact during beating-up of the weft, and *vice versa* with a reduced weight on the lever at O. The successful working of this class of motion depends on maintaining a correct relation between the stroke of the lever K and the movement of the back-rest M, as the requisite amount of warp may be let off with more or less movement of the back-rest. If the stroke given to the lever K from the cam J is not sufficient to rotate the ratchet wheel and let off the necessary amount of warp, the tension on the warp will quickly increase, drawing forward the back-rest and lifting the weight lever, thereby increasing the stroke of the lever K, so that the catches take more teeth of the ratchet wheel. To avoid this the motion should be regulated by means of the rod L, which must be lengthened in order to give a greater stroke to the lever K with less movement of the back-rest. On the other hand, this should not be carried to the extreme until very little movement of the back-rest is perceptible. The best results are obtained when the motion is set so that the weight lever rises and falls regularly at the beat-up. When the proper relation has once been obtained, the motion will yield very satisfactory results, as any tendency for the warp to increase in tension is indicated through the sensitive back-rest to the lever K, whilst any slackening in the tension is taken up by reason of the weight lever drawing down the rod N, and moving the back-rest and the stud L^1 to their backward position, which shortens the stroke of the lever K and reduces the amount of warp let off.

This particular feature might appear to be a rather defective arrangement—namely, that the regulation is obtained after the tightening or slackening of the warp has taken place. With careful setting at the commencement of a warp the motion can be made very sensitive and to respond to any slight variation in the tension, therefore immediately correcting its action before any defect is produced in the woven fabric.

Regulating this Class of Motion.—It must not be inferred from the foregoing remark that no regulating of the motion is necessary from the commencement to the finish of a warp. The writer has, however, had experiences with warps of very fine counts, one and two cuts in length, which have been woven without the motion rod or the weight on the lever requiring any adjustment throughout the warp. There are two factors which have a direct influence on the amount of attention necessary to keep this class of motion working uniformly throughout the warp. The first is the alteration in the diameter of the warp from a full to an empty beam, and secondly, the alteration in the direction of the resultant of the forces P and P^1 when the beam is full, to the resultant of the forces P and P^2 when the beam is nearly empty.

Obviously the warp beam must travel quicker as the diameter decreases in order to let off the same amount of warp. This, as already explained, should be effected by regulating at the motion rod L, giving a greater traverse to the catches and the let-off shaft, without the movement of the back-rest being increased, which would be the inevitable result if any adjustment of the motion is ignored. This particular feature is most noticeable when weaving warps of thick counts, with extreme diameters of the warp beam, and which vary more quickly than in warps of finer counts.

It will also be observed that the weight lever will be lifted more easily as the angle formed by the warp line P, P^1, and P, P^2, becomes more acute. This necessitates a slight increase in the weight on the lever at O as the warp beam empties, in order to maintain uniformity in the force of the beat-up throughout. The above conclusions will be found to obtain in actual practice—namely, as the diameter decreases, the motion rod requires letting out and the weight in the lever increasing, in order to keep the movement of the back-rest and the resistance to the beat-up regular and uniform.

An improved type of this class of let-off motion is shown in Fig. 49, the principle being now employed on most modern looms. The development of this type of motion from the former consists in the introduction of a shield A, fixed to the lever A^1, which works between the ratchet wheel B and the catches C and C^1, the latter being supported on the toothed quadrants D and D^1 on either side of the ratchet wheel. The quadrants are geared with the double quadrant lever E, which is operated from the lay sword, to which it is connected by means of the rod F. The above parts are shown more in detail in Fig. 50; which shows a front elevation of the double quadrant E; a side elevation of the front quadrant and the ratchet wheel in the upper right-hand diagram; and a side elevation of the shield and ratchet wheel in the lower right-hand diagram.

It will be observed that the movement of the catches is a reciprocating one; and without any interposition of the shield they would engage with the ratchet wheel, and cause the let-off shaft to travel at a uniform rate. The shield A, constructed of sheet metal and semicircular in form, is employed to regulate the amount of warp to be let off;

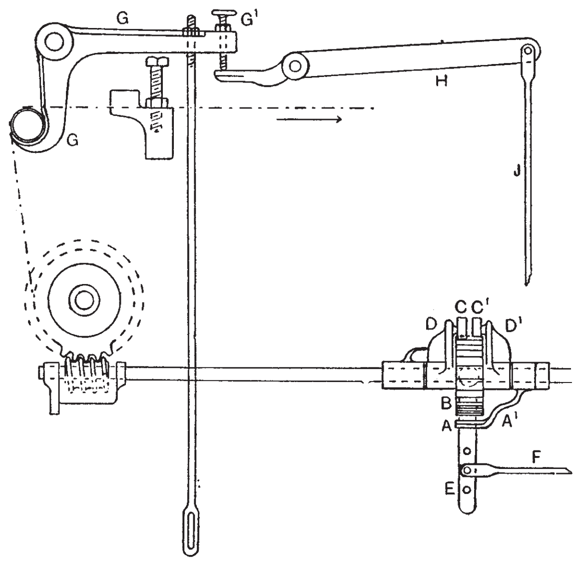

FIG. 49.

its action is governed by the movement of the back-rest G. Any movement of the back-rest is transmitted through the medium of the lever H and the rod J to the shield, which, as already indicated, is influenced by the variation in the tension on the warp. If the tension is increased, the back-rest is drawn inwards, raising the regulating screw G^1; this allows the lever H to lower the connecting rod and the shield, and as the latter is withdrawn, more of the teeth in the ratchet wheel are exposed to the catches. Similarly, with any slackening of the warp the back-rest is drawn in the opposite direction, raising the rod J and interposing the shield between the catches and the ratchet wheel, and so reducing the amount of warp let off.

The following advantages can be claimed for this motion over the former type: On account of the catches

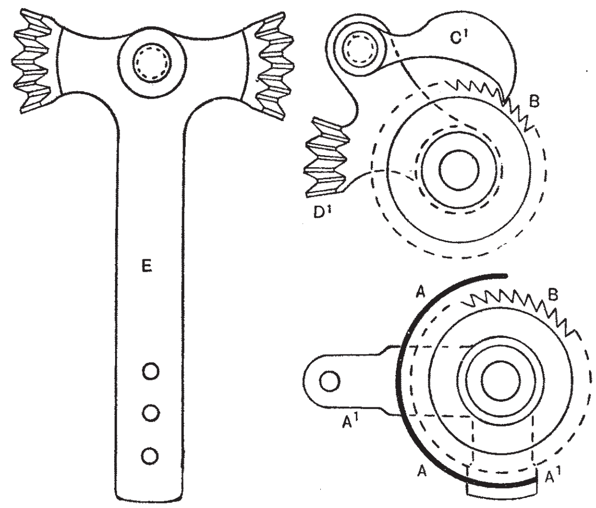

FIG. 50.

being duplicated and operating alternately, the warp is let off more regularly and in smaller quantities, whilst the shield, and not the catches, only being operated from the back-rest, the motion is more sensitive in its action.

A more recent addition to this class of let-off motions is a type in which provision is made for turning the warp back on to the warp beam when unweaving for any defect in the cloth. The object of this improvement is to make the motion entirely automatic in its action by reason of the weaver not being required to turn the warp back by hand in order to regulate the tension on the warp prior to restarting weaving.

The principle and the construction of the chief parts in such a type of motion are shown in Fig. 51. This motion has many points in common with other types of this class, but can only be employed in combination with a positive take-up motion. Fixed to the let-off shaft A are two ratchet wheels B and B^1 set with their teeth in opposite directions. Two catches C and C^1 are employed for operating the ratchet wheels B and B^1 respectively. The catches being attached to the upper arm of the lever D, which is actuated from the lay sword, have a reciprocating motion imparted to them. A shield E operated from the sensitive back-rest is interposed between the catches and the ratchet wheels. When the shield is in its middle position as shown, both catches are prevented from engaging with their respective wheels. As the tension on the warp increases, the shield is withdrawn from under the letting-off catch C, allowing it to engage with the ratchet wheel B; during this time the taking-back catch C^1 works backward and forward on the top of the shield. The catches are dovetailed into each other, and held together by means of a spiral spring C^2, such provision being necessary to allow of both catches being disengaged at the same time when necessary.

When, for any reason, unweaving has to take place the pattern lags and the take-up motion are first reversed, then the weft removed as the loom is turned over pick by pick. Immediately the tension on the warp is released, the weight lever gradually draws down the back-rest, and at the same time reverses the position of the shield. This disengages the letting-off catch and allows the taking back catch C^1 to engage with the ratchet wheel

B^1, and so winds back the warp on to the beam. It will be observed that this motion can only be applied to those looms in which unweaving is effected by the loom being turned over pick by pick, as in the Hattersley loom, the makers of which are the patentees of this particular type of motion.

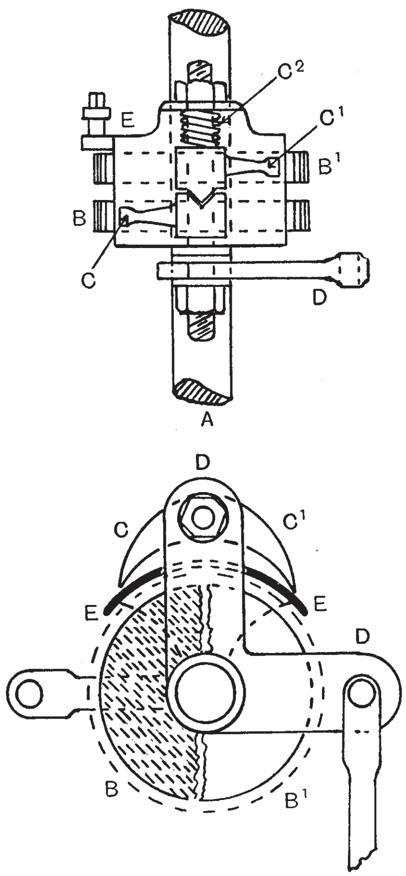

FIG. 51.

Positive let-off motions are no doubt better adapted to the requirements of heavy and medium fabrics. They are, however, not so well adapted for weaving light wefted cloths, as the regular movement of the back-rest is largely controlled by the beating-up of the weft, which in a light wefted cloth is insufficient for this purpose. This class of motion also requires less attention on the part of the tuner.

The following is a summary of the causes of defective pieces due to defects in the letting-off motion, the remedies for which are obvious: The beam wheel springing out of gear with the worm; the beam wheel and worm short of oil; defective brake strap due to the presence of grease or dirt; irregular movement of the back-rest; the catches missing when they are worn down or the teeth in the ratchet wheel worn down or broken; strained warp beam shaft; and tampering with the motion on the part of the weaver.

CHAPTER VIII

TAKE-UP MECHANISM

THE function of a take-up motion is to draw the cloth forward as it is woven. The operation is performed by means of a taking-up roller actuated by suitable mechanism in such a manner that the cloth is drawn forward regularly. The various types of these motions may be divided into two classes—namely, negative and positive. In the former class the principal feature is the method by which motion is imparted to the taking-up roller, the amount of cloth drawn forward at each pick being determined by the force applied by the reed to the fell of the cloth at the beat-up. It is only as the cloth is pushed forward by the reed that it is possible for the motion to register any take-up. In the latter class the taking-up roller is driven in a positive manner by a suitable train of wheels actuated from some convenient part of the loom, so that the same length of warp is drawn forward for each pick of weft inserted.

Another feature of difference in the construction of the two classes of motions is as follows: In the negative motions only one taking-up roller or cloth beam is employed, which performs the double function of drawing the cloth forward as it is woven, and at the same time winding it on to itself. In the positive motions there are two rollers—the taking-up roller, which is employed solely for drawing the cloth forward, and the cloth beam on to which the cloth is wound.

NEGATIVE MOTIONS.—The construction of a type of this class of motion is illustrated in Fig. 52. To the shaft of the cloth beam A the spur-wheel B is secured, the latter being geared with the pinion wheel C which is compounded with the ratchet wheel D. The latter is actuated by the pawl E, which is attached to the upper arm of the three-armed lever F fulcrumed at F^1. Motion is imparted to the lever F in one direction by means of the stud G which is fixed in the lay sword. A forward movement of the lever and pawl is obtained by reason of the weight H on the arm of the lever F overcoming the tension or pull of the piece at the time when the reed J is beating up the weft. The retaining catches K are necessary in order to prevent the motion from reversing owing to the tension and pull of the piece being again applied immediately the reed recedes from the fell of the cloth. This type of motion is largely employed on plain tappet looms weaving medium and heavy woollens and union fabrics, for which it is specially adapted on account of the quick movement which may be imparted to the cloth beam when weaving fabrics containing few picks per inch. This feature is made possible by reason of the movement of the ratchet wheel being transmitted directly to the cloth beam through the medium of the pinion wheel C.

Fig. 53 illustrates another type of negative motion somewhat different in construction from that already described. It is better adapted for weaving cloths containing a large number of picks per inch, the ratio of the first driver to the last follower being increased by the introduction of an intermediate wheel and pinion. The cloth beam A supported by the arbors A^1 is provided with a spur-wheel B which is in gear with the intermediate pinion C. This pinion is secured to the shaft of the intermediate wheel D, which in turn is geared with the ratchet pinion E compounded with the ratchet wheel F. The ratchet wheel is actuated by means of the pawl G attached to the upper arm of the lever J, the lower arm J^2 being in contact with the stud L fixed in the lay sword, from which it is operated in one direction. When the

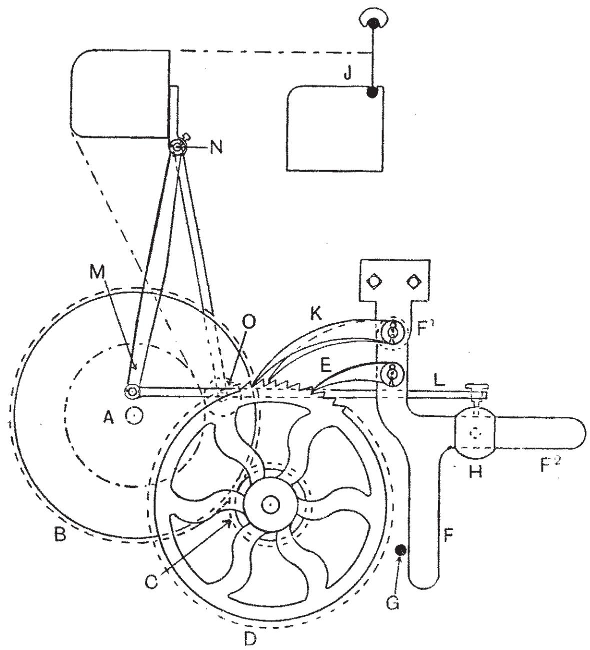

FIG. 52.

tension on the piece is relieved at the beat-up, the pawl, assisted by the weights K, and in some instances by means of a spiral spring substituted for one or both the weights, draws the ratchet wheel forward, and so winds the cloth on to the beam. The various parts of this motion are suitably carried in the bracket M bolted to the loom frame; the retaining catches are shown at H.

The successful working of this class of take-up motion

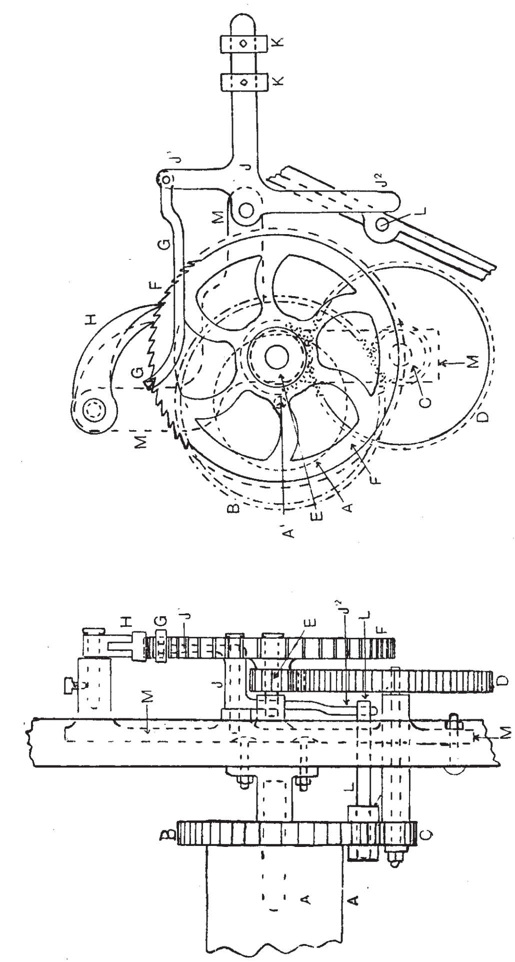

FIG. 53.

depends upon the maintenance of correct relation between the tension on the cloth at the time when the beat-up takes place and the action of the taking-up lever. This is more readily understood if the following factors are taken into consideration: The tension of the cloth exercises a force which acts through the train of wheels in the direction opposite to the taking-up lever. Further, this force increases with the gradually increasing diameter of the cloth beam, consequently more weight, or its equivalent, the substitution of a spring, must be applied to the taking-up lever. It might be assumed that as the reed works forward to the same point at each beat-up the resistance offered to the take-up motion due to the tension on the cloth is always uniform. It should be observed, however, that the tension on the cloth between the fell of the cloth and the cloth beam is never entirely overcome; for when the reed is in contact with the fell of the cloth there must always be sufficient tension on the warp to resist the beat-up and obtain the requisite number of picks per inch. In addition, the motion needs some slight regulation by reason of the increasing weight of the piece beam, due to the addition in the length of cloth woven.

Automatic Regulating Motion.—For the purpose of regulating the motion automatically several mechanical contrivances have been introduced. The construction and principle of such a motion are shown in Fig. 52. The weight H is caused to slide along the arm F^2 of the taking-up lever by the rod L pivoted on the weight and to the lever M. This latter lever in turn is secured to the outward end of the rod N, which extends some distance in front of the breast beam. The rod then extends downwards, and is again cranked to carry the wooden roller O, which works in contact with the cloth beam. As the diameter of the cloth beam increases the roller is forced outwards, and at the same time the weight is moved further along the arm of the lever, thereby yielding the increased power necessary to actuate the take-up motion.

When the relation between the tension of the cloth and the weight is once obtained, any slight discrepancy in the take-up is quickly corrected. If the motion is not setting up quickly enough the reed comes in contact with the fell of the cloth sooner, and the tension is relieved to a greater extent, this being attended by a corresponding increase in the take-up. Similarly, any excess of setting up would correct itself by reason of the beat-up decreasing in force, and the slackening of the piece not being sufficient to allow any take-up to be registered until the tension again became normal.

Features of Negative Motions.—This class of motion is most advantageously employed for heavily wefted goods. These are liable to slip on the friction roller of a positive take-up motion, and are therefore better woven with a negative motion, where the piece is wound direct on to the cloth beam. It is also preferable for weaving cloths in which the weft yarns are of different counts, also in fancy vestings and similar fabrics in which the picks per inch vary on account of the extra silk spotting picks. This class of motion is unsuitable for weaving lightly wefted goods in which the reed is not required to beat up the picks, but merely to push them into position with the preceding picks. In the absence of the beat-up the motion requires more attention from the weaver if the picks per inch are to be kept uniform. Frequent measurement of the picks should be made, as under the above conditions the motion may vary the number of picks inserted per inch very considerably. The weaver should be warned against tampering with the amount of weight on the taking-up lever, as it is a very common practice for the weaver to keep a supply of weights, consisting of parts of broken loom castings, by means of which some alteration in the number of picks per inch may be effected without in any way regulating the let-off motion. The amount of weight on the taking-up lever should always be attended to when starting a fresh piece. It is the practice, when one piece follows another out of the same warp, to weave what is called a " lapping-on " into the succeeding piece, usually from two to three yards; the full piece is then pulled off the beam, and the lapping-on length used to start again for the new piece. Unless there is a reduction of the weight on the taking-up lever to compensate for the reduced diameter of the cloth beam a reduction in the number of picks per inch will inevitably take place. In order to avoid this the tuner should make it a condition for the weaver not to proceed with the next piece until the weight has been regulated and the picks per inch have been counted.

Positive Take-up Motions.—There are several well-known types of this class of take-up motion, the principle involved in each being practically the same. The construction of the various types only differs in minor details, the method of imparting motion to the train of wheels employed for driving the take-up roller being the chief point of difference. Some motions are driven intermittently by means of a pawl and ratchet wheel; others are driven continuously by means of a worm and worm-wheel.

A type of an intermittent motion is illustrated in Fig. 54. The take-up roller A, frequently referred to as the friction roller, feed roller, sand roller or the " gratter," is clothed with perforated sheet metal, which is wound round the roller with the rough side outward, for the purpose of increasing the grip on the cloth to prevent slipping. To the shaft of this roller a spur-wheel B is secured, this being geared with the pinion wheel C compounded with the intermediate wheel D; the latter is geared with the wheel E, which is the change-wheel of the motion, this being secured to the shaft of the ratchet wheel F. To operate the ratchet wheel a pawl G is employed, which is pivoted on the swing lever H; this in turn receives motion from the stud J attached to the lay sword and working in the slot of the lever H. Tracing out the method of working, it will be observed that the ratchet wheel is pushed forward by the pawl simultaneously with the forward movement of the lay sword. Usually the stroke of the pawl is such as to move the ratchet wheel one tooth forward at each pick, although by altering the position of the stud J in the slot of the lever, two teeth of the ratchet wheel may be taken by the pawl at each stroke. The piece is drawn forward by the take-up roller, round which it is passed until it reaches the guide bar K, over which it travels on to the cloth beam, the latter being driven by frictional contact with the take-up roller; the requisite pressure is obtained by means of chains and weights.

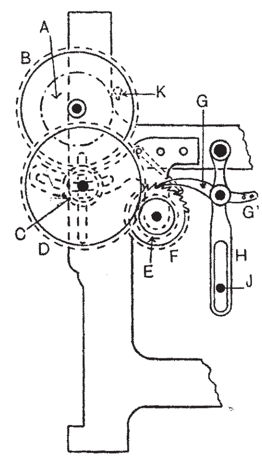

FIG. 54.

A continuous type of a positive motion is illustrated in Fig. 55. The take-up roller A is mounted with a worm-wheel A^1, driven by means of the worm B, this being provided with a sleeve bored to admit the shaft C, and which is supported in the brackets D, D^1, the hand-wheel E being fixed on the end of the worm sleeve. Provision is made for connecting or disconnecting the hand-wheel and the worm to the shaft C by means of the knob F, as shown in the sectional drawing in Fig. 56. Fitted to the end of the shaft is a short arm G; this is bored to receive the pin H, which forms part of the knob. The face of the hand-wheel is provided with a series of holes at equal distances apart, into any of which the pin on the knob may enter, being held in position by means of the spring J. When the pin enters one of the holes the hand-wheel

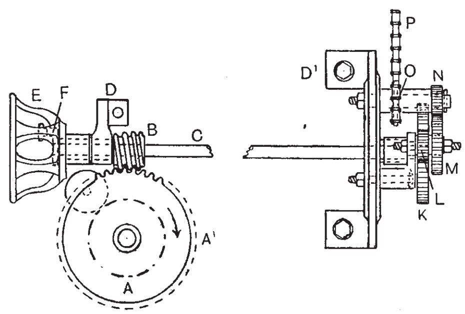

FIG. 55.

and the worm must travel with the shaft C, this being driven by a train of wheels as follows: To the end of the shaft the spur-wheel K is secured, this being geared with the pinion wheel L compounded with the change-wheel M; the change-wheel is geared into the star-wheel pinion N, which is compounded with the star-wheel O. Continuous motion is imparted to the train of wheels from a star-wheel, secured to the reversing shaft of the top cylinder, which drives the star-wheel O by means of a pitch chain P.

FEATURES OF POSITIVE MOTIONS.—The intermittent type of motion is best adapted for weaving fabrics figured by means of extra weft. As previously pointed out such spotting picks are considered as extra picks, unless the figure is continuous—*i.e,* where the figuring picks are arranged in some regular proportion with the ground as 1 and 1, 2 and 1, etc. This type of motion is specially suitable for this particular class of fabric owing to the facility with which the motion may be rendered negative in its action when the extra picks are being inserted. This is usually done by making some suitable connection from the short arm G^1 (Fig. 54) of the pawl to a jack in the dobby, or to the shuttle-box in which the extra weft shuttle is run, so that the pawl is lifted out of action with the ratchet wheel when the extra picks are put in. The chief defect of this type of motion is the liability to produce shady pieces, by reason of some irregularity in the take-up. This may be due to the pawl, the retaining catch, or the teeth in the ratchet wheel being worn down or broken, and therefore liable to miss.

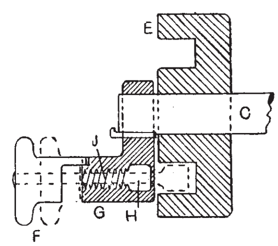

FIG. 56.

The continuous type of motion is rarely the cause of shady pieces, as the worm-and-worm-wheel method of driving the cloth beam is safer in action. A further advantage of this method of driving is obtained on account of the motion being actuated from the reversing shaft in the dobby. When the dobby is reversed by the weaver for the purpose of taking out the picks, the take-up motion is also reversed, so that the cloth is unwound from the cloth beam in the same ratio as it was wound on. This makes it much easier for the weaver to turn back the exact amount of warp on to the warp beam to prevent shadiness when the warp is not wound back automatically, as explained in the preceding remarks on let-off motions.

Some objections to the type of motion shown in Fig. 55 are as follows: The position of the taking-up roller in relation to the piece is such that it acts on the face of the piece, which in certain fabrics may be damaged. The position of the cloth beam in relation to the take-up roller is also such that the back of the cloth cannot be seen unless the piece is let slack for this purpose. It is an advantage, if not an essential, that the weaver should be able to examine the back of the piece, and especially in backed and double-cloth fabrics, as defects may be discovered which would otherwise run throughout the piece. It is worthy of note that the makers of this type of motion have overcome the above defects by altering the position of the take-up roller, which is now fixed immediately under the breast beam, the direction of rotation being also reversed.

Calculations for Take-up Motions.—For the purpose of effecting any alteration in the number of picks per inch, one of the wheels in the train is a change-wheel; this change-wheel may be either a driver or a driven wheel. In the type of motion illustrated in Fig. 54 the change-wheel E is a driver. Obviously any increase in the number of teeth in this wheel will result in the following wheels and the taking-up roller drawing the cloth forward more quickly, with a corresponding reduction in the picks per inch; whilst the substitution of a wheel containing a less number of teeth will increase the picks. For the purpose of finding the number of teeth the change-wheel must contain for a given number of picks per inch, it is customary to supply the tuner with the dividend number or gauge point of the motion. This is obtained by the following formula:

$$\frac{\text{No. of teeth in ratchet wheel F} \times \text{No. of teeth in inter. wheel D} \times \text{No. of teeth in roller wheel B}}{\text{No. of teeth taken by the pawl G at each pick} \times \text{No. of teeth in pinion wheel C} \times \text{Circum. of the roller A in inches}} = \text{Dividend number.}$$

Assuming the particulars for such a motion to be: Pawl taking one tooth of ratchet wheel per pick; the ratchet wheel, 60 teeth; the intermediate wheel, 120 teeth; pinion wheel, 30 teeth; roller wheel, 110 teeth; circumference of taking-up roller, 16in. The dividend number will be:

$$\frac{60 \times 120 \times 110}{1 \times 30 \times 16} = 1650.$$

Then to find the change-wheel, 1650 divided by the picks per inch required equals the number of teeth the change-wheel must contain. And conversely 1650 divided by change-wheel equals picks per inch. This motion is suitable for weaving cloths varying from 28 to 60 picks per inch. The series of change-wheels for these and the intervening number of picks per inch could be employed for weaving cloths containing less than 28 down to 14 picks per inch, by setting the pawl to take two teeth of the ratchet wheel forward at each pick. To avoid working out a separate calculation for each differently picked cloth, it is advisable for the tuner to work out a table of the picks per inch and a list of the change-wheels required; this should be posted up near to where the spare change-wheels are kept, for ready reference.

In the motion illustrated in Fig. 55 the change-wheel is a driven wheel. The velocity ratio of this train of wheels is so arranged that the number of teeth contained in the change-wheel indicates the picks per inch in the piece. The particulars for this motion are as follows:

First driver is the star-wheel on the top cylinder shaft, making one revolution per pick, and contains 8 teeth.

Second driver is the star-wheel pinion N			= 20 teeth.
Third	,,	,, change-wheel pinion L	= 18 ,,
Fourth	,,	,, worm B	= 1 tooth.
Fifth	,,	,, circumference of take-up roller A	= 20in.
First driven wheel is the star-wheel O			= 8 teeth.
Second	,,	,, change-wheel M	= x ,,
Third	,,	,, shaft-wheel K	= 84 ,,
Fourth	,,	,, roller wheel A^1	= 85 ,,

The working for the above may be stated as follows:

$$\frac{\text{Drivers} = 8 \times 20 \times 18 \times 1 \times 20 \times (p = \text{picks per inch})}{\text{Driven} = 8 \times (x = \text{teeth in change-wheel}) \times 84 \times 85} = \frac{120\,p}{119\,x}$$

Therefore *x*, the number of teeth in the change-wheel, equals *p*, the picks per inch, when a small percentage for shrinkage in the piece is allowed, which takes place between the fell of the cloth and the taking-up roller; this shrinkage will vary slightly in different cloths.

An advantage of this motion is, that a very wide range of cloths can be woven from a small stock of change-wheels, a large star-wheel containing 16 teeth being provided for this purpose. This wheel may be substituted for the star-wheel on the top cylinder shaft to act as a driver, or be used in place of the star-wheel O as a driven wheel. When the 16 wheel is employed as a driver, the change-wheel indicates half the number of picks—*i.e.*, a 40 wheel would give 20 picks; when used as a driven wheel, a 40 change-wheel would give 80 picks. Assuming the highest and lowest change-wheels of the series in stock to be 60 and 30 respectively, a range of cloths could be woven containing as many as 120 picks with the 60 change-wheel down to 15 picks with a 30 change-wheel.

CHAPTER IX

AUXILIARY MECHANISM

WITH the object of making the power-loom more automatic in its action, various mechanisms have been introduced, the chief of which are the weft stop-motion, warp protector motion, warp stop-motions, and temples. In addition various patents are being invented from time to time, the introduction of which makes the duties of the tuner more exacting; needless to say, such additional mechanism which does not justify its permanent adoption is quickly discarded.

WEFT STOP-MOTION.—The function of this motion is to stop the loom when the weft supply fails or breaks. Such a motion is practically indispensable on fast-running looms engaged in weaving the more intricate and expensive fabrics. There are, however, many types of plain looms employed for weaving low woollen and union fabrics, on which weft stop-motions are not adopted.

There are two distinct types of these motions, known as the " side weft fork " and the " centre weft fork." A type of the former is illustrated in Fig. 57. The weft fork A fulcrumed on the rod B is made with the hooked end slightly heavier than the forked end, which consists of three prongs bent at right angles. The rod B is held in position by the knob of the pistol lever C, this being placed in close proximity to the starting lever D. The hooked end of the fork works over the snecked surface of the hammer lever E, the lower arm E^1 extending downwards and projecting over the low shaft F. On this shaft is fixed the cam G, which, making one revolution every two picks, lifts the lever E^1 and throws back the upper arm E on alternate picks. Fixed in the shuttle race at the entrance to the shuttle-box is a grid H, which contains three apertures to admit the prongs of the fork when the reed comes to its front position at the beat-up. The method of working is as follows: When the weft is present it is laid across the grid so that the prongs of the fork are prevented from entering freely, and as a result the fork is tilted just at the time when the hammer lever E is thrown back by the cam G. If the weft is missing, the prongs of the fork enter the grid, so that the hooked end is allowed to engage with the sneck in the surface of the hammer lever, which draws back the fork and the pistol lever C, and at the same time knocks the starting lever out of the retaining notch, transferring the belt on to the loose pulley. When the loom is stopped by the action of the weft fork, the brake motion is brought into operation to prevent the loom over-running; also the take-up motion is rendered inoperative, and in circular box looms the boxes are prevented from turning during the finding of the pick and replenishing the weft. From these particulars it will be readily seen how the weft stop-motion may be made to assist in no small measure in the production of a perfect piece.

Satisfactory working of this motion depends on accuracy of setting. The cam G must be set to lift the lever E^1 in unison with the beat-up, at which time the weft fork will be tilted by the presence of the weft, or allowed to engage with the sneck in the hammer lever E if the weft is missing. The tensioning of the weft in the eyelets of the shuttle needs very careful adjustment; if left too slack it would fail to tilt the fork. The fork should be set to allow the prongs to enter the grid quite freely, and not touch the sides of the bars or the bottom of the groove cut in the race. The result of this would be for the fork to be tilted independently of the weft and not indicate when the weft had broken or become spent out.

This type of motion possesses the disadvantage that the weft fork indicates only on alternate picks, by reason

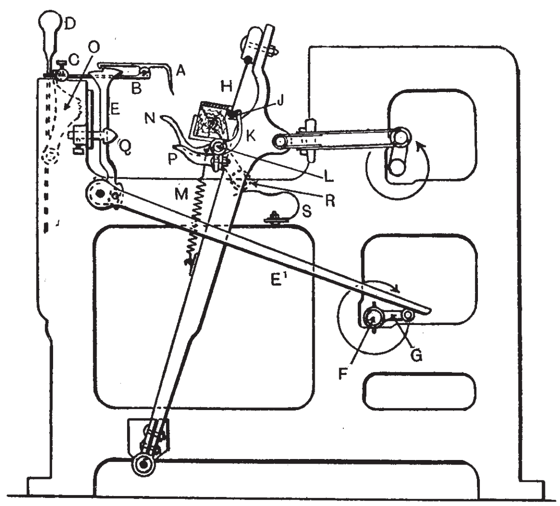

FIG. 57.

of its being placed at one side of the loom. On this account it is possible for the weft to break and catch on again during the return pick, which without giving any indication to the weft fork would allow partly broken picks to be made in the piece. By reason of the above defect this type of weft stop-motion is only adopted on looms employed for weaving plain calico, linsey, low woollens, and other fabrics, in which a broken pick is not considered a serious defect in the finished cloth.

Centre Weft-fork.—This motion, as the name implies, is fixed in the centre of the shuttle race, with the object of indicating on every pick. This is essential in the majority of woollen, worsted and other expensive fabrics in which broken and missing picks are considered as defects, and which must be remedied prior to the finishing of the piece. The construction of such a motion is illustrated in Fig. 58. In the centre of the race a groove is cut into which the weft feelers A may enter and so drop below the level of the race-board. The feelers are fixed in the winged bracket B supported by means of the screws C which are fixed in the arms of the bracket D secured to the front of the going part. A sliding bracket E on which are two inclined planes is placed to work beneath the wings B^1 and B^2. A lateral motion is imparted to the bracket E by means of the rod F, which is pivoted in the socket G secured to the breast-beam. As the going part moves backward the sliding bracket E is drawn in the direction of the arrow, and the inclined plane H engaging with the wing B^1 raises the feelers A; during this time the shuttle passes across the race, leaving a pick of weft beneath the feelers. As the going part again moves forward, the sliding bracket is forced in the reverse direction. The presence of the weft supports the feelers and keeps the wing B^1 clear of the notch E^1 cut in the inclined plane H; this allows the sliding bracket to move back to the extremity of its stroke. If, however, the weft is missing, the feelers drop into the groove, and the wing B^1 enters the notch E^1; this arrests the sliding bracket on its return movement in such a position as to stop the projection J, connected to the bracket by means of the rod K, directly opposite the finger L. As the going part comes forward the projection strikes the finger, which, being fixed to the pistol lever, dislodges the starting handle and so stops the loom. The spring F^1 is neces-

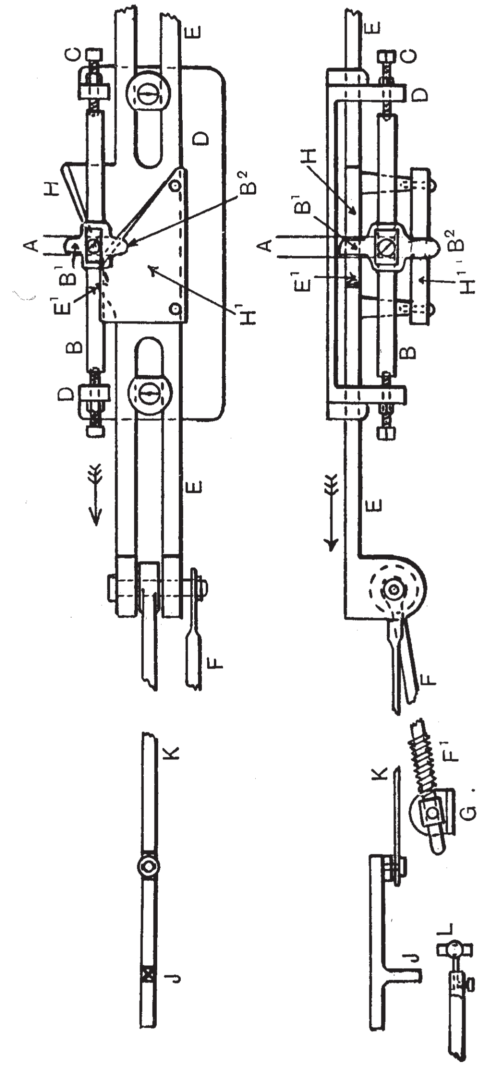

FIG. 58.

sary as an escape motion when the sliding bracket is locked by the absence of the weft; whilst the function of the inclined plate H^1 working in contact with the wing B^2, serves to prevent the feelers rising too high, also to make their downward motion positive until the level of the plate is reached, after which they are left quite free to drop into the groove, or rest on the weft pick until they are drawn off by the forward movement of the going part.

DEFECTS DUE TO WEFT STOP-MOTIONS.—The weft may be cut if the prongs are set to pass too far through the grid or allowed to touch the sides of the bars. Weft loops may be the result of defective working or irregular tension on the weft; broken picks if the weft stop-motion fails, also short checks when weaving check patterns. Constant knocking-off of the loom due to imperfect setting and timing. The centre weft fork may be responsible for throwing the shuttle or tearing the piece if the feelers are not set to rise at the proper time.

WARP PROTECTOR MOTION.—The object of this motion is to protect the warp from being broken if the shuttle through any cause is caught in the shed when the beat-up is about to take place. There are two general types of these motions, known as the "loose reed" and the "fast reed" warp protectors. An illustration of the former is given in Fig. 57, and is employed on most quick-running looms weaving light and medium wefted fabrics. The feature of this motion is that the reed is knocked out of position when the shuttle is trapped in the shed, as an alternative to the shuttle being forced through the warp, breaking down some portion of the threads, which in many instances would be equal to the length of the shuttle.

The reed is held in position by fitting the top rib to the groove cut in the hand tree; and at the bottom by the angle plate J. This extends the full width of the reed, and is supported by the arms K fixed to the rod L. Easy contact is maintained between the angle plate and the bottom rib of the reed, during the forward movement of the going part, by means of two spiral springs M. If the shuttle is in the shed at this time the angle plate yields to the pressure and allows the reed to swing backwards out of position. At the same time the rod L is tilted, lifting the finger N to engage with the rack lever O. The latter being connected to the pistol lever, releases the starting handle and so stops the loom. To prevent the reed being knocked out of position by the force of the beat-up, two projections P, fixed to the rod L, are set to pass underneath the frogs Q, which are bolted to the front of the breast beam, thereby locking the reed in position to give a firm beat-up to the weft. To keep the reed from vibrating during the passage of the shuttle, the rod L is provided with a short arm carrying an anti-friction pulley R. This engages with the flat spring S and applies extra pressure to the bottom rib of the slay through the medium of the angle plate J and the arms K.

The successful working of this type of motion depends on careful setting and adjustment of the various parts, as may be required by the class of fabric to be woven. The length of the frogs Q must be adjusted to meet the fingers P according to the resistance offered to the slay whilst pushing the weft into position. This will vary with the fineness of the setting of the warp and the quality of the warp yarn. The reed should be fixed so as to be easily displaced if the shuttle is trapped in the shed. The finger N must be set to engage with the rack lever in order to dislodge the starting handle, and bring the brake motion into operation in order to stop the loom as quickly as possible.

Fast Reed Motion.—This style of motion is employed on looms weaving the heavier builds of cloth, in which the resistance to the reed during its forward motion is excessive, and therefore requires the various parts to be very rigid at the beat-up. As the name implies, the reed is secured firmly in position between the hand-tree A and the groove cut in the going part to receive the lower rib of the reed. To protect the warp from breakage when the shuttle is trapped in the shed, the going part must be brought to a stop before any pressure is applied on the shuttle, which would result in the warp being severely damaged. The manner in which this is effected is illustrated in Fig. 59. Fixed in front or below the going part is a stop-rod B. This is provided with two stout blades C, usually welded to the stop-rod. At each end of the rod is secured a finger D, which is kept in contact with the shuttle box swell E by means of a spring; the curved portion or belly of the swell projects into the box for a short distance. Knocking-off frogs F are provided, these being placed below the breast beam, with which the protector blades C engage if there is no shuttle in the box. When the shuttle enters the box the swell is forced outwards, and with it the finger D; this tilts the stop-rod and lowers the protector blades, which miss the frogs and so allow the going part to work forward. If the shuttle fails to reach the box, the swell is not forced outwards, consequently the protector blades strike the frogs, which arrest the going part in its forward movement, bringing it to an abrupt stop. Suitable connections are made between the outer end of the frogs and the starting lever G to transfer the belt on to the loose pulley. In order to reduce the vibration and strain on the various parts of the loom when knocking-off takes place, strong springs H are employed which serve as cushions for the frogs F.

With faulty setting undue knocking-off will take place, and as a result breakages of the loom parts will be frequent. To reduce knocking-off to a minimum the picking motion must be kept in good working order, and the protector motion set correctly. The chief causes of the latter defect are: (*a*) One or both of the fingers D not touching the box swell; (*b*) the box-swell pins being worn down; (*c*) the swell not projecting far enough into the box; and (*d*) too much vibration of the protector blades when the shuttle enters the box. The effect of the above defects will result in the protector blade engaging with the frogs from time to time, so that the respective parts should be

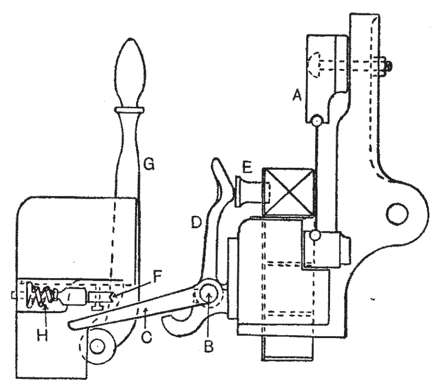

FIG. 59.

set to allow of the blades being kept well clear of the frogs with the shuttle in the box. Considerable difficulty is occasionally experienced in rising and drop box looms by reason of the curve on the box swells not being in the same relative position on each. If to this condition is added some slight difference in the size of the respective shuttles, which are run into various boxes during one repeat of the wefting plan, occasional knocking-off will result. A further and more serious defect in the working is experienced when one of the blades engages with its respective frog, whilst the other may clear when knocking-off takes place. This is chiefly due to the stop-rod being twisted, or it may be due to the going part not working squarely throughout its stroke. In any case, this defect should receive immediate attention from the tuner, or serious results, chiefly twisting of the lay or breakage of the lay swords, will ensue.

WARP STOP-MOTION.—The function of this motion is to stop the loom when a warp thread breaks. This accessory to the power-loom is one to which considerable attention has been directed during recent years. This feature is no doubt largely due to the increasing development of automatic weft-replenishing mechanisms. Until recently warp stop-motions have been chiefly confined to those branches of the weaving industry in which a number of looms are under the supervision of one weaver —*e.g.*, looms employed in weaving such goods as silk and cotton umbrella cloths, Madras muslin and harness and leno fabrics, where the breakage of a warp end has to be repaired prior to finishing; if such goods contain a number of warp floats they are classed as seconds. A brief consideration of warp stop-motions discloses a multiplicity of parts, and also their somewhat delicate, if not intricate, construction. These factors, accompanied by the increased duties of the tuner attendant upon their adoption, are features which have to some extent retarded their initiatory stages. The tendency to the introduction of these accessories to the power-loom does not appear to be such as to warrant any prediction that they will become general at an early date, or even that they are absolutely essential on all classes of looms, although for certain looms they may eventually become more generally adopted. The main advantage which is to be derived from their application is in the production of a more perfectly woven piece, rather than in any increase in loom production.

There are two classes of these motions—the "mechanical" and the "electrical" warp stop-motion. A type of the former class consisted of a porcupine brush roller, placed immediately above the back-rest in such a position as to exercise a slight brushing action on the warp. The least resistance to the roller being sufficient to stop its rotation, additional mechanism, which received indication from the rotation or stoppage of the roller, was employed for stopping the loom. With the continuous motion of the roller the loom continues to run; when one or more of the warp threads break, they are brushed out from among the tight threads, and speedily picked up by the brush roller. The warp thread being fastened at the warp beam, directly it is drawn tight the stoppage of the roller is caused, giving indication to the mechanism employed for stopping the loom by shipping the starting lever out of the retaining notch.

Another type of mechanical motion consists of the application of a special indicator attached to each warp thread. This is illustrated in Fig. 60. The droppers A rest on the warp threads B as shown. Two rows of droppers admit of 100 per inch being employed. A trough C is fixed between the back-rest and the healds, over which fit the forked opening of the droppers. When a warp thread breaks, the dropper falls and allows its forked end to project below the bottom of the trough. This results in the feeler bar D, which is made to oscillate by suitable mechanism operated from the low shaft, being tilted from its normal position; and the feeler bar D being connected to the starting lever, knocks it out of the retaining notch and so stops the loom. It is claimed that this motion is suitable for any counts of yarn, different weights of droppers being supplied to suit yarns ranging from fine silk to thick heavy yarns of various materials.

Electrical Warp Stop-motion.—In this class of motion a weak electric current is employed. The current serves as the indicating medium between the warp thread and the mechanism employed for displacing the starting lever. In the mechanical type of motion a certain amount of vibration and shock is transmitted to the various parts, by reason of the mechanically actuated feeler bar being brought to an abrupt stop. For the electrically controlled mechanism it is claimed that the connection between the warp thread and the starting lever is rendered more gentle and sensitive in its action.

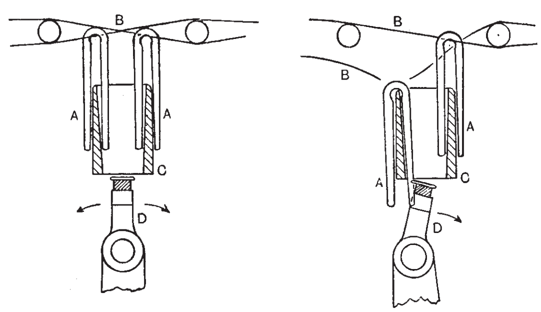

Fig. 60.

A type of this motion is illustrated in Fig. 61, and consists in the application of a spring wire A to act as detector, one such wire being employed to serve for every two threads. The wires are passed between the warp threads in the lease in such a way as to prevent their touching one of the lease rods B as shown. With the breakage of one or other of any pair of threads, the respective detector springs back to touch the contact bar C on the lease rod B. The result of this is to close the electric circuit between the brass fittings D in the bar tree E, which supports the spring wires A, and give indication to a small electro-mechanical motion which displaces the starting handle of the loom. The current to operate the mechanism is derived from two dry cells, suitably applied to each loom, or in a complete installation it may be derived from a small dynamo, from which it is conveyed to the looms by suitably protected wires, to prevent the possibility of fire by spark or fusing.

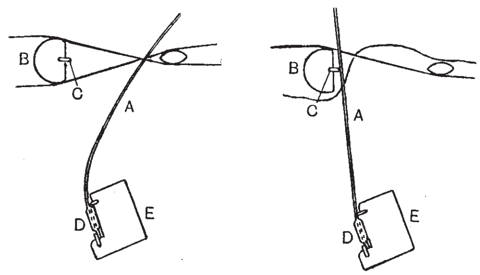

FIG. 61.

TEMPLES.—Temples are used to hold out the fabric during weaving to the width that the warp is set in the reed; and to enable the selvages better to resist the pull or drag of the weft, and consequently prevent excessive shrinkage weft-way of the cloth. There are various causes which tend to make a fabric shrink in width immediately it is drawn forward and released from the distending influence of the slay and temples—*e.g.*, the nature and quality of the weft yarns, the relative counts of the warp and weft yarns, the difference in the tension on the warp and weft during weaving, and the structure of the fabric—*i.e.*, the plan of interlacing.

Obviously, weft yarns possessing good elastic properties when employed for weft will shrink more than yarns which do not possess the same degree of elasticity. When the warp yarn is thicker and stronger than the weft yarn, the latter will be deflected more than the warp, providing the weave is composed of some regular order of interlacing, as in a plain twill or hopsack weave shown at A and B, Fig. 62. With the warp and the weft yarns equal in counts and quality, the tension to be necessarily placed on the warp during weaving, being in excess of the tension on the weft, will impart a greater degree of deflection to the weft threads. The plan of interlacing the

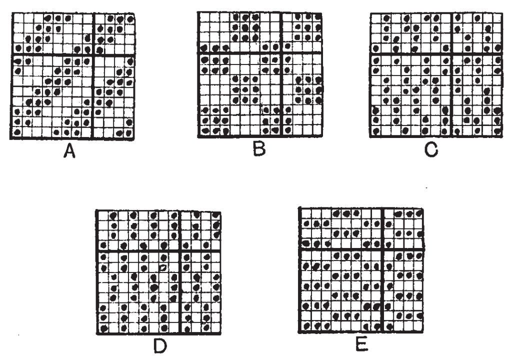

Fig. 62.

warp and the weft is a factor which influences to a considerable degree the amount of shrinkage warp-way or weft-way of a fabric. A good example of this is shown when weaving warp and weft cords. Taking the weaves given at D and E, which are warp and weft cords respectively, it will be noticed that in the weave D there would be three picks in the same shed; these would form themselves into one thick thread, and resist any deflection due to the increased tension on the warp. The picks would lie perfectly straight in the cloth, but the warp would be subject to excessive bending and corresponding take-up. The conditions would be reversed with the weft cord weave E, as here the warp threads work together in groups of three, and would therefore resist deflection by the weft, which would shrink or take up considerably.

The following particulars will further help to illustrate this feature. The plans shown at Fig. 62 were each woven in the same warp, half a yard of cloth being woven to each plan, a space of two inches of warp being left on each in order to allow the separate cloths to shrink freely.

Warp : 2/48's Botany worsted, 21 reed 4's.
Width in reed, 32in. inside lists.

Weave A,	woven with	2/48's,	84 picks per inch ;		width out of loom,	30in
,, B,	,,	,,	,,	,,	,,	30in.
,, C,	,,	,,	,,	,,	,,	31in.
,, D,	,,	,,	,,	,,	,,	32in.
,, E,	,,	1/48's	,,	,,	,,	28½in.

Types of Temples.—There are many different types of temples employed—barrel, star and roller temples. In the former type a barrel composed of spiked rings and plain discs is employed over which is fitted the temple cap, the piece being held firmly between the semi-circular grip of the temple cap and the spiked rings. The difference in the types of barrel temples consists in the length and shape of the barrel and in the number of the spiked rings employed in each. The barrel may be up to five inches in length, and fitted with inclined spiked rings throughout, or such a barrel may contain five spiked rings to engage with the list of the piece, the remainder being plain or rubber rings. This type is specially adapted for a variety of fabrics, the hold on the cloth being very effective.

Another type of this temple is made with the barrel tapered, which holds the selvage very firmly, but gradually diminishes its grip on the piece towards the end of the barrel. This type is specially useful for delicate fabrics tightly woven, in order to prevent the piece from splitting near to the end of the barrel. Another common type is known as the "star" temple. This consists of one or two metal rings about 2in. in diameter and ¼in. thick; the periphery being fitted with rows of fine pins. The rings are supported in the temple brackets in a horizontal position, and take hold of the selvage of the cloth only. This type is specially suitable for fine fabrics which would be easily damaged by the spiked rings or marked by the temple cap.

ROLLER TEMPLES.—These are different from the former types and consist of a roller which runs to the full width of the piece, that is supported in a semicircular trough placed between the fell of the cloth and the breast beam. The surface of the roller is fluted at varying angles, in order to obtain a rough surface and so maintain a firmer grip of the fabric, which is in contact with half of the circumference of the roller. Such temples are employed for weaving light to medium fabrics, for which the spiked ring type of temple is altogether unsuitable, by reason of the spikes displacing and distorting the threads during weaving.

SUMMARY OF DEFECTS CAUSED BY TEMPLES.—The rings must be kept free from waste and grit, otherwise they cannot rotate freely, and the cloth is prevented from passing forward. The spikes may be damaged by being turned up at the point and formed into a small hook. These catch on to the fibres and threads of the fabric, and retard the forward movement of the piece until they tear themselves free, thus damaging the fabric. Many temple caps are made of brass; these quickly wear down when weaving some classes of goods, with the result that they fail to hold the piece out to the width in the slay, the warp threads being chafed down at the selvage. Occasionally the cap is indented or the barrel pin strained by reason of the shuttle being trapped in the shed, so that the piece is chafed while passing through the temple or kept from working forward freely. The temples may be set too near, so that the weft is cut between the temple and the reed wires, or the wires become strained, causing reed marks in the piece. Temple marks are sometimes due to the cap being set too keen or close to the barrel, which in some fabrics leaves the impression of the cap when the loom is left standing any length of time; such defects are usually more pronounced and developed during finishing. Defective beaming of the warp—*i.e.*, tight or slack sections at the lists — is a common cause of the temples not being able to hold the piece effectively during weaving.

SELVAGES.—With the object of facilitating the operation of weaving and the subsequent processes of manufacture, it is customary to put a selvage on each side of piece-goods. Although that portion of the piece of cloth formed by the selvages is not intended to be utilized in the made-up garment, they may be considered as essential from an economical standpoint. It is important that suitable yarns should be employed for the purpose, this being a factor which very largely affects the weaving operation. Selvages are very desirable in those woven fabrics which are submitted to the operation of drying, after scouring, etc., on the tentering machine, as such a process results in the edges or selvages of the piece being rendered worthless. Badly-formed selvages detract from the value of the piece; on the other hand, a well-woven selvage always adds to the general appearance, and gives enhanced value to the finished fabric.

The large diversity of cloths manufactured results in a variety of selvages being used. Worsted cloths woven in the grey to be piece-dyed may have the selvage made of the same count and quality of yarn as that used for the warp, but with one or two cotton threads run in from half to three-quarters of an inch from the edge to form the selvage. Fancy worsteds are usually made with a solid coloured selvage of white or black yarns. White selvages have the disadvantage of showing up any irregularity of weaving or other defect. When black or other dark-coloured yarn is employed it is advisable to run one or two ends of some highly coloured yarn as a dividing line between the selvage threads and those of the warp.

Woollen fabrics have a greater variety of selvages than worsteds, including diversity of counts, quality and colour. Woollen warps made from single yarns generally require the yarn used for the selvages to be twofold, due to the single yarn not being sufficiently strong to withstand the strain and chafing to which they are subjected during weaving. Woollen cloths being submitted to severe treatment during the finishing processes, particularly in the scouring and milling operations, demand special attention in the selection of the yarn to be used for the selvages. If the yarn selected does not possess the same degree of felting property as the warp yarn, long or short lists will result. Without trespassing too far into the domain of the finisher, the general effect of this may be briefly stated, as there is to a certain extent something in common between the selection of unsuitable yarn and defective interlacing of the selvages during weaving. Either error may be the cause of short or long lists, which cockle the piece by allowing the centre of the cloth to run slack during the finishing processes, whilst the sides of the piece are held tight, and must necessarily bear all the drag. On the other hand, when the lists are too long the piece is held tight in the centre, and the sides of the cloth run slack. This results in a very unsatisfactory finish being obtained on the piece, the centre and the sides not receiving the same treatment in the subsequent finishing processes.

There are other defects in selvages for which the weaving operation is more directly responsible. Occasionally the weaver will alter the healding and the reeding of the selvage threads as a remedy for frequent breakages—

probably the effect of the selection of faulty yarns, the selvage threads being drawn two in a mail on the outside edge to give additional strength. With thick woollen yarns this is not advisable, as the lists have then a tendency to curl, and may readily mill fast to the fabric if subjected to too much milling. When the threads are drawn double in this way, the list is increased in bulk, which retards the various subsequent processes, and produces " listed pieces "—*i.e.*, lack of finish at the sides.

Many pieces are spoiled by reason of one list being badly woven while the other may be perfect. This may be due to various causes. An imperfectly formed shed will result in one or both the lists possessing a ragged appearance. When the heald shafts are not adjusted correctly, some of the threads will either hang slack in the shed or be drawn excessively tight; this prevents the weft and the selvage threads from being drawn compactly together.

Uneven tensioning of the weft in the shuttles will produce an unsatisfactory list. In a piece woven with two or more shuttles running pick and pick, or two and two, and the weaver using one or two change shuttles, it is possible for the weft to be more heavily tensioned in one shuttle than in another; usually this is the result of the shuttle peg being set too low, so that the weft cannot pass freely off the bobbin. The effect of this would be to draw the lists tighter each time that particular shuttle was running, which would show down the list of the piece for a distance equal to the weaving length of the yarn on the bobbin. Such a defect may be the cause of the piece working out of the temples during weaving, and is a frequent cause of a variation in the width of the finished fabric. Cloths woven with two shuttles are liable to have a defective list on one side of the piece only. When the shuttles are started from the same side of the loom, the tension on one selvage due to the drag on the weft will be greater than on the other. This defect is accentuated when the shuttles start from that side of the loom where the eyelet of the shuttle, when at rest in the box, is nearest to the picker.

When weaving with two or more shuttles on even picking, they should not be allowed to run so that the weft in each is spent and run off at the same time. It is understood that the drag on the weft increases as the bobbin empties, and the longer the bobbins or cops, the greater the difference in the drag between a full and nearly spent bobbin. Take, for illustration, the weaving of low woollens. The tendency during late years has been to increase the bobbins in length, and by this means obtain an increase in the number of yards on each bobbin so as to reduce shuttle changing. When very long bobbins are used it will readily be seen to what extent the drag on the selvage will vary from the full to the empty bobbin. Under such conditions the weft in the shuttles should not be allowed to run off at the same time, but arranged so that when one bobbin is full the other is half spent. By this means the drag on the selvages is kept more uniform, and better woven lists are produced.

Selvage Motions.—Frequently the selvages are required to be woven differently from the body of the cloth. Many warp-faced cloths necessitate a plain or weft-faced selvage to prevent them from curling. To produce such selvages on the piece extra heald shafts, known as skeletons, are sometimes employed, these being operated by means of special tappets or from spare jack levers in dobby looms. There are, however, many devices known to the tuner by which plain and other selvages can be produced without the aid of special heald shafts. The following are examples of a few of those generally employed:

The selvage threads on a cloth made with the prunella warp twill, woven back up as shown at A in Fig. 63, may be interlaced as shown at A^1. The odd threads in the selvage are drawn between the heald bands above the heald eye on the second and third shafts, and not through the eyelet in the ordinary way; the even threads are drawn through the eyelets of the first heald shaft. The draft for the threads in the warp is shown in dots, and the draft for the selvage in crosses. The effect of this arrangement is to produce a selvage with two picks of weft in the same shed, and one pick of weft in the alternate shed. To draw down those selvage threads which are passed between the bands on the second and third shafts, a selvage hook is employed, which is hooked on to these threads, and suitably weighted to draw them down to their bottom position—*i.e.*, on a level with the shuttle race every third pick, when the even threads are lifted by the first heald shaft.

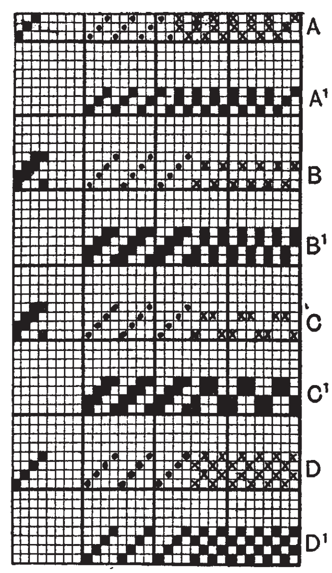

FIG. 63.

When such a selvage is produced on a fabric to be woven with one shuttle, it is necessary to draw the last three threads of the selvage through the eyelets of the healds, one on each shaft, to prevent the weft from being drawn back through the selvage up to the warp threads, where the two picks are put into the same shed, or as an alternative method to fix up a catch thread.

The draft B shows a method of healding the selvage threads to obtain two picks in each of two different sheds, when the weave for the piece is the $\frac{2}{2}$ twill. The order of interlacing is given at B^1. To prevent the weft from drawing back through the selvage, if woven with one shuttle, the healding of the threads at each side of the piece must be so arranged as to cross on the weft. This can be done by drawing the threads at one side of the piece on the first and third heald shafts, and those on the other side on the second and fourth shafts.

By a slight modification of this principle a selvage may be woven with two ends and two picks working together, forming a hopsack or mat weave, the plan of the cloth remaining $\frac{2}{2}$ twill. This is illustrated at the draft C, which indicates two threads drawn through separate healds on the same shaft; these should be split in the reed to prevent them rolling together, the order of interlacing being as shown at C^1.

To obtain a plain woven selvage on the $\frac{1}{3}$ twill, the odd threads would be drawn between the heald bands above the eyelets on the first and third shafts, and the even threads would be drawn between the heald bands on the second and fourth shafts, as shown in the draft plan D, the order of interlacing for the piece and selvage being as in D^1. Selvage hooks, as in example A, would be necessary for each set of threads, to draw them down to the level of the shuttle race. This would necessitate one of the sets of threads in each selvage being left longer than the other at the commencement of the warp, to avoid the hook on one set when lifted to its highest point from coming in contact with the alternate set of threads. The effect of this would probably be to lift them off the shuttle race, and produce a defective interlacing or render them liable to be broken with the passing shuttle.

CENTRE SELVAGES.—It is occasionally the practice to weave narrow pieces, termed splits, side by side in a broad loom, *e.g.*, worsted trouserings are frequently woven in this way. The warp pattern for the two pieces will be different; the wefting pattern and the yarn for each being the same, usually a solid colour. Pieces woven in this way require to have the list ends of the false selvage formed up the centre, one on each of the two narrow pieces, stitched. These threads are not stitched as tightly to the fabric as the outer lists, which are bound to the fabric by reason of the weft doubling back.

To prevent the centre selvages from fraying after the pieces are separated by cutting up the centre, usually after finishing, various methods are adopted. The object being to bind the outside threads on each of the selvages to the piece by twisting two or more threads round each other, and to interlace them with the weft in such a way as to produce as near as possible a perfect selvage.

When narrow pieces are regularly woven in a broad loom it is advisable to employ one of the several centre selvage motions obtainable for this purpose.

When such goods are only occasionally required there are a few contrivances by which the desired result can be obtained.

A very simple but effective method of stitching the centre selvage consists of an arrangement usually termed a "monkey," the crossing of the stitching thread being effected as shown in Fig. 64. A number of reeds are left empty between the two pieces, to allow of them being cut apart after finishing without in any way cutting the warp threads. If the ground of the fabric is working plain, one or two of the warp threads A, according to their strength, are taken and passed through a guide wire B fixed behind the healds in such a position as to keep the threads on a level with the bottom shed line of warp. These threads are not passed through a heald but are stationary.

Next a crossing thread C of sufficient strength wound on to a special bobbin D, made with a grooved end for the purpose of braking, is suitably suspended behind

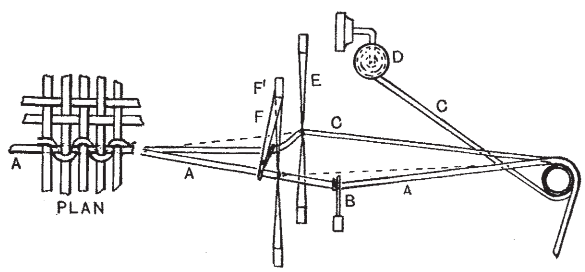

FIG. 64.

the loom. The crossing thread is first passed through a heald on the back shaft E; the stationary thread is drawn through the gear to the right of the heald E, which is shown lifted. The crossing thread C is next passed through a mail or bead attached by a loop of strong smooth cord F to the front shaft F^1, which is shown depressed.

The loop F is long enough to allow it to be drawn under the stationary thread and lifted up along with the crossing thread C to half the depth of the shed by the back shaft E. On the next pick the crossing thread would be drawn under the stationary thread, and lifted up the other side by the first heald to a height equal to half the depth of the shed. The stationary thread is always under the weft, but is stitched to the selvage by reason of the crossing thread being lifted up on each side alternately and interlacing with the weft as shown in plan, Fig. 64.

The above arrangement is capable of application to a cloth weaving 2-and-2-twill. The crossing thread is operated by the first and third heald shafts, as these have a reciprocal motion and would stitch the crossing thread round the stationary thread once in every two picks.

The disadvantages of this method are twofold. First, the crossing thread, only forming a shed equal to half of the shed proper, requires careful adjustment to ensure perfect interlacing with the weft. Second, the crossing thread and the loop heald are subject to severe chafing and quickly wear out. When either of the threads or the loop heald breaks the selvage weaves forward unstitched.

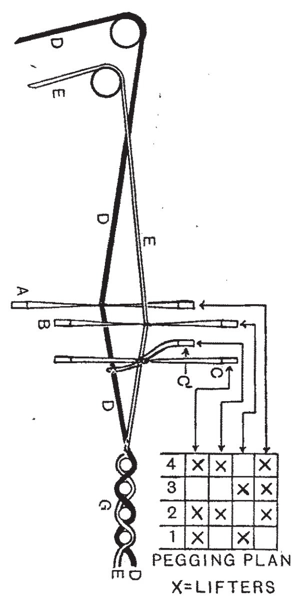

Fig. 65.

Doup Heald.—A further method occasionally employed for stitching the selvages on narrow webbings when woven in a broad loom is illustrated in Fig. 65. The principle consists in the application of a doup heald, such as is employed in the production of leno and cross warp effects. Two ordinary healds, A and B, are employed in addition to the doup heald, which consists of the heald C and the half heald C^1. The crossing threads D are all put on to a spare beam or light roller.

The crossing thread is first drawn through the heald of the shaft A, then passed through the doup eyelet formed by the heald loop C[1], being interlaced with the mail or eyelet of the heald C. This is so arranged as to allow the loop C[1] to slide through the mail of C, when the crossing thread D is drawn down by the heald shaft A to the right of the thread E as shown in Fig. 65. The crossing thread is drawn down on the alternate or left side of E by the doup C and C[1].

The method of working is further illustrated by the pegging plan of the figure.

The first pick of the plan gives the position of the healds and threads as shown.

The second pick indicates for the next change as follows: The heald A, the doup C and C[1] and the thread D are lifted, whilst the heald B and the thread E are down.

The third pick indicates the healds A and B lifted, also both the threads D and E, but the doup heald C and C[1] is down, therefore the thread D is drawn down on the left side of E and across it. Owing to the thread D being lifted by the heald A, but depressed by the doup heald C and C[1], it is essential to slacken the thread D to facilitate the crossing. This is usually accomplished by drawing the back-rest forward by some mechanical contrivance, *e.g.*, this may be performed by means of a spare jack in the dobby.

The fourth pick is like the second—the crossing thread is lifted, the thread E being depressed.

The manner in which the crossing thread interlaces with the picks is shown at G. From this it will be observed that the threads D and E work plain, also cross and re-cross every two picks.

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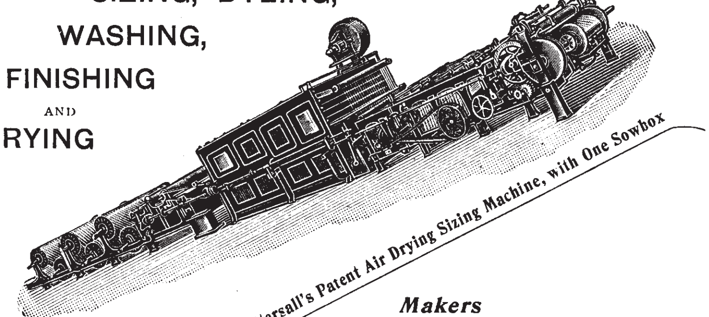

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