PATENT SPECIFICATION

788,485

Date of Application and filing Complete Specification Jan. 27, 1956.

No. 2712/56.

Application made in Australia on Feb. 7, 1955.

Complete Specification Published Jan. 2, 1958.

Index at Acceptance:—Classes 74(2), C7; and 142(2), E1E(2: 5: 6: 8: 9), E1F, E8(A: C4: C6).

International Classification:—D03c. D04b.

COMPLETE SPECIFICATION

Improvements in Shuttleless Looms

We, CUCKSON TEXTILES PROPRIETARY LIMITED, of Windsor Road, St. Mary's, New South Wales, Commonwealth of Australia, a company registered under the laws of the State of New South Wales, Commonwealth of Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention pertains to shuttleless looms i.e., to looms deriving weft thread from a stationary supply. More particularly it relates to shuttleless looms for weaving comparatively narrow continuous strips of fabric such as ribbons, braids and fabric strips or tapes.

Looms of this kind, known hitherto, have employed a weft-inserting member to lay the weft thread in the shed of the warps and a thread-engaging element, such as a hook or knitting needle reciprocating in the same plane as the movement of the warp threads, to produce a looped or knitted selvedge.

It is an object of the present invention to provide in a shuttleless loom a weft-inserting member which, in addition to inserting the weft, also knits one selvedge of the woven fabric. This greatly simplifies the mechanism required for the laying of the weft threads and permits laying of these threads at much higher speeds than hitherto. This increased speed, however, will not be achieved if the weft-inserting member of the invention be associated with a shedding mechanism of a known type. A much higher operating speed will be required of this mechanism than it has previously been capable of providing over an extended period.

It is, therefore, a further object of the invention to provide in a shuttleless loom a shedding mechanism capable of operation at higher speeds than hitherto.

The invention in one form is a weaving loom having a hooked knitting needle mounted to one side of the fabric being woven, means for reciprocating the needle through the shed of warp threads, means for opening and closing the needle eye, a supply of weft thread on the far side of the fabric, means for moving a weft thread into the needle hook, the needle being adapted to retain the thread in the hook during far-to-near side movement and to knit the thread before beginning near-to-far side movement, and means for crossing the warp threads at the end of each far-to-near side movement of the needle.

In another form, the invention is a method of weaving including the steps of drawing a looped weft thread from a weft supply through a shed of warp threads by means of a reciprocating hooked needle, temporarily closing the needle eye to cast a previous weft loop over the drawn loop, crossing the warp threads to form a new shed, opening the needle eye to release the looped end of the drawn weft thread, returning the needle through the now stationary loop and the new shed to pick up a new weft thread from the weft supply and drawing the new looped thread back through the shed and through and out of the loop of the previous thread.

In yet another form, the invention provides in a weaving loom, a shedding mechanism for forming a plurality of sheds of warp threads, said mechanism comprising a plurality of movable healds all of which are arranged in a single line substantially parallel to the fell of the woven fabric.

One of the many possible forms of this invention includes a weft-inserting member such as a knitting needle having a hook at its free end by means of which a pick off weft is pulled from a suitable dispenser and drawn through the shed of warp threads. The pick of weft is bent double to form a loop or bend where engaged by the hook and the loop is located on the near side of the fabric at the end of the far-to-near side movement of the needle. The warp threads are then crossed and closed over the double weft thread in conventional manner to form a new shed. The motion of the healds is of sufficient amplitude to pro-

[Price 3s. 6d.]

vide a sufficiently obtuse angle between the uppermost and lowermost shed of the warp threads to overcome the resistance of sliding friction between the warp and weft threads. This obtuse angle is obtained without excessive movement of the healds because they operate very closely adjacent to the fell of the fabric. In the loom illustrated in the accompanying drawings the fell is spaced only $^3/_{16}$ of an inch from the healds. The conventional beating up comb can thus be dispensed with as the upper and lower sheds of warps force each pick of the weft closely into place against the previous pick. It will be readily seen that the elimination of the beat up comb and its associated operating mechanism simplifies construction and thus enables the loom to operate at a far higher speed.

An oscillating arm carries the weft thread onto the needle at its hooked end with the needle eye in its open position to allow the thread to enter the hook.

The needle then moves back through the shed. The needle eye is adapted to close during the far-to-near side movement and to release the looped thread near the end of the far-to-near side movement. The needle moves towards the far side of the fabric through the loop with the needle hook leading. Another thread is moved into the hook and retained there and the needle is drawn back to the near side. The looped end of the new double thread is drawn through the loop of the previous thread. The previous procedure is then repeated.

The means employed for reciprocating the needle and carrying out the other steps will be described hereafter.

By arranging the knitted selvedge to be nearer to the weft-laying member or needle in its retracted or near side position, it is possible to make the shuttleless loom more compact then heretofore. It is also possible to arrange that the stress in the weft-laying member due to the weft tension is tensile, thus reducing the masses of the moving parts of the components and obtaining greater reliability through reduced wear.

The above described arrangement makes it possible to insert the weft thread at a much faster rate than hitherto. However, to ensure a higher operating speed for the loom of this invention the shedding mechanism must be capable of moving the warp threads at increased speeds comparable with the increased rate of laying the weft threads.

To enable the shedding mechanism to attain these high speeds, by the invention moving parts, such as healds, are actuated by eccentrics so that each movement is a simple harmonic motion. A harmonic movement of this nature is not usually achieved by the cam operated mechanism of conventional looms. An added advantage gained when parts are adapted to be moved in accordance with the laws governing a simple harmonic motion is that such parts can be regarded as never being actually stationary, because the acceleration, which is proportional to the displacement, is diminished to such an extent at the extremities of travel as to give the effect of a dwell; this gives maximum smoothness of action at all displacements and gives positive control of the movement no matter how rapidly the oscillations are made to occur.

A preferred form of the invention will now be described with reference to the accompanying drawings in which:—

Fig. 1 is a front elevation of a loom according to the invention showing the lower cover plate removed to reveal the heald actuating mechanism;

Fig. 2 is a plan view with the upper cover removed;

Fig. 3 is a side elevation in section on the line 3—3 in Fig. 2;

Fig. 4 is a schematic layout in perspective of the various moving parts of the loom. The parts are not drawn to the one scale and some have been elongated or otherwise distorted for the sake of clarity;

Fig. 5 is a plan view in half section on the line 5—5 in Fig. 3 of the needle and needle eye closure mechanism and associated cylindrical cam;

Fig. 6 is a side elevation in perspective showing eight of the sixty healds displaced laterally from their normal position and disassociated from their actuating mechanism;

Fig. 7 is a plan view in section on the line 7—7 in Fig. 1, the feed rollers being omitted for clarity;

Fig. 8 is a front elevation in perspective of portion of the heald actuating mechanism;

Fig. 9 is a front elevation in perspective of the upper heald guide block and adjacent woven fabric support block, showing the friction plate displaced vertically from its normal position;

Fig. 10 is a side elevation of the needle threader crank;

Fig. 11 is a side elevation of the eye end of the needle on an enlarged scale;

Fig. 12 is an end elevation of the needle shown in Fig. 11;

Fig. 13 is a side elevation of the eye end of an alternative form of needle;

Fig. 14 is an end elevation in section on the line 14—14 in Fig. 13;

Fig. 15 is a side elevation in section on the line 15—15 in Fig. 2 showing the threader in the act of laying the weft thread in the eye of the needle which is at the extremity of its outward or near-to-far, travel between the sheds of the warp threads. The weft thread take up crank is shown just about to cast clear a length of slack in the weft thread;

Fig. 16 is a plan view of the mechanism shown in Fig. 15 and at the same point in the cycle of operation as shown therein;

Fig. 17 is a front elevation of the take up crank at the instant shown in Figs. 15 and 16;

Fig. 18 is a side elevation in section on the line 18—18 shown in Fig. 16;

Fig. 19 is a similar plan view to Fig. 16 but at such later stage in the cycle of operation when the needle is retreating from between the sheds of warps and drawing a loop of weft therebetween; the eye of the needle being closed to permit the loop of weft previously formed about its shank to pass over said eye;

Fig. 20 is a similar plan view to Figs. 18 and 19 showing the needle at the inward extremity of its travel and showing the eye now open, and with the single outer independently operated warp thread being moved upwardly by its actuating bell crank;

Fig. 21 is a side elevation in section on the line 21—21 in Fig. 20; and

Fig. 22 depicts a fragment of the woven fabric showing how the single independent warp thread forms an even knitted selvedge in the fabric.

In the preferred form of the invention the loom itself consists of a substantially rectangular main casing 23 carrying a main shaft 24 rotatably mounted in bearings 25 (see Fig. 7) approximately in the centres of the longer sides 26 and 27 of the main casing 23. A large bushing 28 is rigidly secured to the shaft 24 adjacent the housing wall 27 and two spur gear wheels 29 and 30 are rigidly secured to the shank 31 of the bush 28 so that they rotate with the shaft 24. The gear 29 is of slightly smaller diameter than the gear 30. A driving shaft 32 is rotatably mounted in a bearing unit 33 secured to the side wall 27 and adjacent to the end wall 34 so that the shafts 24 and 32 are parallel to, and in line with, each other. A small gear 36 carried on the inner end 35 of the shaft 32 meshes with the gear 30. The outer end 37 of the shaft 32 (see Fig. 3) is connected to a suitable prime mover 38. The diameters of the gears 30 and 36 are such that the shaft 24 rotates at one quarter the speed of the shaft 32. A suitable handwheel 39 is also secured to the shaft 32 outside the casing 23 in order that the mechanism can be turned over by hand during adjustment.

The other end 40 of the shaft 24 (see Fig. 4) is associated with the shedding mechanism and carries an integral eccentric crank pin 41. Two connecting rods 42 and 43 with big ends 44 comprising suitable ball bearings 45 are mounted on the crank pin 41 adjacent to one another so that the crank pin 41 may rotate within them to produce oscillations in said connecting rods 42 and 43 and consequently operation of the shedding mechanism. Four bell cranks 46, 47, 48 and 49 are pivotally mounted in pairs one above the other in the main casing wall 26 adjacent to the crank pin 41, each pair 46 and 47 and 48 and 49 being displaced an equal distance to each side of the vertical axis of the main casing 23. Each connecting rod 42 and 43 is pivotally attached to the free end 50 of a link 51, one of which is associated with the bell cranks 46 and 47 and the other with the cranks 48 and 49. Each link 51 is pivotally connected to short arms 52 formed integrally with each bell crank. The arms 52 on each pair of bell cranks are radially opposed so that longitudinal movement of the links 51 will produce opposed angular displacements, in each pair of cranks. Furthermore the positioning of the shaft 53 (Fig. 7) carrying the bell cranks 46, 47, 48 and 49 and the main shaft 24 is such that the longitudinal axes of the connecting rods 42 and 43 are at 90° to each other and at 45° to a vertical plane passing through the centre of the main shaft 24. Thus, rotation of the main shaft 24 produces angular movement in each pair of bell cranks, 46 and 47 and 48 and 49 of equal amplitude and opposed direction, but displaced in period by 90°.

Longer lever arms 54 are also formed integrally with each bell crank 46, 47, 48 and 49. Movement of the bell cranks causes the free end 55 of each lever 54 to rotate in an arc near the lateral centre line of the loom, each arc being equally disposed above and below the horizontal.

The forward longer wall 26 of the main casing 23 is stepped so that its lower portion 57 which carries the bell cranks 46, 47, 48 and 49 is displaced towards the middle of the casing 23. The upper portion 56 of the wall 26 is thus positioned approximately vertically above the levers 54 associated with said bell cranks.

An upper and a lower rectangular heald guide block 58 and 59 respectively are medially secured one above the other to the upper portion 56 of the wall 26. A set of sixty healds is carried in a rectangular medial slot 60 (see Figs. 8 and 9) in each guide block 58 and 59. The healds 61 are narrow strips of spring steel loosely crowded into said slots 60 so that each may be moved independently in a vertical plane. Normally, approximately one third of the upper length of each heald 61 projects above the upper heald guide block 58.

Centrally bored, laterally projecting, integral lugs 62 (see Fig. 6) are provided near the lower ends 63 of thirty of the healds 61. The remaining thirty have similar lugs 65 provided near their upper ends 64. The healds 61 are inserted in the guide blocks 58 and 59 so that fifteen having upper lugs 65 faced in one lateral direction whilst the remaining fifteen face in an opposed direction. The remaining thirty healds 61 having the lower lugs 62 similarly arranged. Individual healds are arranged in fifteen sets of four which will be designated A, B, C and D. Inspection of Fig. 6 will show that all healds designated A, have a lug 65 facing all in one direction. Healds

designated B, have a lug 62 facing in the opposed direction to A. Healds designated C, have a lug 65 facing in the same direction as B, and healds designated D, have a lug 62 facing in the same direction as A. Pins 66 (see Fig. 8) passed through the holes in adjacent lugs 62 or 65 unite the healds 61 into four independently movable groups A, B, C and D of fifteen. The aforementioned pins 66 are pivotally attached through pairs of arms or links 67, one group to each lever 54 actuated by the bell cranks 46, 47, 48 and 49. Thus rotation of the main shaft 24 causes the groups A, B, C and D of healds 61 to rise and fall so that at the stage shown in Fig. 6, one group, e.g. group B, is rising whilst another, e.g. group C, is falling; with the remaining two groups A and D approximately stationary, A at the upper and D at the lower extremity of travel. Also the angularity of the eccentric 41 is such that there is a dwell period during which pairs of groups are approximately stationary at the upper and lower extremities of travel. An oval hole 68 is formed in each heald 61 near its upper end 64 through which individual warp threads 69 from a suitable bank of bobbins (not shown) are led. The warp threads 69 then pass through a shallow longitudinal groove 70 (see Fig. 9) in a guide plate 71 which can be adjustably secured in a second longitudinal groove 72 in the top 76 of a take off block 73 by means of a slotted hole 75 in the plate 71, and a screw 75 secured to the guide block. The said take off block 73 is secured to the upper portion 56 of the wall 26 of the casing 23 and the guide plate is adjusted so that there is approximately $^3/_{16}$ of an inch clearance between its forward end 77 and the adjacent sides of the healds 61.

A removable friction plate 78 with a forward bevelled edge 82 fits into the groove 70. A tongue 80 in the guide plate 71 engages a slot 81 in the friction plate 78 so that its forward bevelled edge 82 will be held in line with the corresponding edge 77 of the guide plate 71. One side of the friction plate is chamfered at 83 as shown in Figs. 2, 16, 19 and 20.

A stud 84 is secured to the top 76 of the block 73 adjacent one side of the guide plate 71 and a "U" shaped bracket 85 is passed medially over the stud to contact the top 76 of the block, and also the friction plate 78. A thumb screw 87 engages the top of the stud 85 and a compression spring 86 (see Fig. 1) is interposed between the screw and the bracket. The loading of the friction plate against the woven fabric passing through the slot 70 can thus be adjusted by means of the thumb screw 87. The fabric then passes over an idler roller 90 set with its edge level with the groove 70 in the guide plate 71.

Two hardened steel knurled rollers 88 and 89 are mounted one above the other adjacent to the take off block 73 and below the roller 90. The lower roller 89 is pivotally mounted near the fulcrum of a spring loaded lever arm 91 so that it is forced up into contact with the upper roller 88. The upper roller is driven from the main shaft at a predetermined angular velocity through spur gearing so as to draw the warp threads 69 through the loom.

The drive to the roller 88 will now be described with particular reference to Figs. 4 and 7. A small spur gear 92 is rigidly secured to the main shaft 24 adjacent to the inwardly stepped portion 57 of the wall 26 of the casing 23. The gear 92 meshes with a large gear 93 free to rotate upon a lay shaft 94 carried in a bearing 96 secured to the portion 57 of the wall 26; the shaft 94 being spaced from, parallel to and in line with the shaft 24.

A second small gear 97, formed integrally with the gear 93, meshes with a second large gear 98, which is free to rotate on the shaft 24 adjacent to the gear 92. A third small gear 99, formed integrally with the gear 98, meshes with a third large gear 100 which is rigidly secured to the end 101 of the shaft 94. The shaft 94 is thus driven, at considerably reduced angular velocity, from the shaft 24. A small gear 102 is mounted on the outer end 106 of the shaft 94, and meshes with two idler gears 103 and 104, (see Figs. 1 and 4) which in turn mesh with a gear 105 attached to the roller 88.

The means employed for reciprocating the weft inserting member will now be described. A central partition wall 107 is spaced medially between and parallel to the walls 26 and 27 and is united to the upper portion 56 of the wall 26 by an integral floor portion 108 which is spaced horizontally above the gears 93, 97 and 100 (see Fig. 3).

A second lay shaft 109 (see Figs. 2 and 4) is rotatably mounted in bearings secured in the partition wall 107 and the wall portion 56. One end 110 of the said shaft carries a gear 111 of similar diameter to the gear 36 so that the shaft 109 will be driven at four times the speed of the main shaft 24. A cylindrical cam 112 is rigidly secured to the shaft 109 between the walls 107 and 56. An enlarged view of the cam can be seen in Fig. 5, said cam being composed of a central barrel portion 113 having a specially contoured raised flange 114 on its circumference. Two cup shaped end pieces 115 having their inwardly facing edges similarly contoured are rigidly secured to each end of the barrel so that two spiral grooves 117 and 118 are formed in conjunction with the flange 114. A "U" shaped cross head block 119 having, at one end 122, a longitudinal groove 120 is secured also between the walls 107 and 56 adjacent to the face of the cam 112. The longitudinal axis of the cross head is approximately in line with the edge 82 of the friction plate 78, and its end 121 extends through the wall 56 and is spaced approximately $^1/_4$" from the end 123 of the healds 61. The end 121 of the cross

head is provided with a longitudinal " U " shaped bore 124 which extends into the slot 120. A " U " shaped needle 125 is slidably carried in the bore 124, so that its end 126 is situated within the groove 120, and is slotted as shown in Fig. 5.

A rectangular cam follower block 127 is provided with tongues 128 which engage the slots in the needle end 126. An integral pin 129 in the block 127 engages the groove 117 in the cam 112 so that rotation of said cam causes the needle 125 to oscillate between the fully outwardly extended position shown in Figs. 5, 15 and 16, and the retracted position shown in Fig. 20.

The outer end 130 of the needle is chamfered and bent back upon itself to form a hook and an eye, an enlarged view of which can be seen in Fig. 11. During a portion of the travel of the needle 125 it is necessary to close the eye 130. This is accomplished by an approximately rectangular closure bar 131 which is free to slide longitudinally within the " U " shaped slot along the length of the said needle. The outer end of the bar 131 is cut away to form a lip 132 which, when advanced, extends over the top of the eye 130 and encloses it as shown in Fig. 11. When the bar 131 is retracted the eye 130 is open as shown in Fig. 5. To actuate the bar 131, its inner end 133 is provided with slots. A second rectangular cam follower block 134 which rides in the slot 120 in the cross head 119 between the block 127 and the bore 124, is provided with tongues 135 which engage the slots in the end 133 of the closure bar 131. The block 134 is also provided with an integral pin 136 which engages the cam groove 118, thus controlling the opening and closing of the needle eye 130.

The needle 125 remains retracted as shown in Fig. 20 for approximately 180° of angular movement of the cam 112 at which time both grooves 117 and 118 run in a parallel plane and at right angles to the cam axis as shown at 138 in Fig. 2. The needle 125 advances from near to far side when the arcuate portions 137 of the grooves 117 and 118, which can be seen in Fig. 2 and Fig. 4 contact the cam followers. In Fig. 2 it will be seen that the radius of curvature of the groove 118 at the point 139 is greater than that at the point 140 in the groove 117. This causes the closure bar 131 to retract at a slower rate than the needle 125 so that the eye 130 is closed at this stage i.e. from the point in its cycle shown in Fig. 19 to that shown in Fig. 20.

An alternative but not necessarily preferred form of the needle 125 is shown in Figs. 13 and 14. In this case the needle 125 is circular in cross sectional area. The closure member 131a is also a circular rod with its end 132a chamfered to enclose the eye 130a when in contact therewith. The operating mechanism is similar to that already described.

The shaft 109 is provided with a hollow medial bore 141 (see Fig. 5). A lay shaft 142 is free to rotate within said bore. A bell crank 143 is secured to the end 142 of the shaft 141 adjacent to the healds 61. The free outer end 144 of the crank 143 is bent at right angles towards the healds and is provided with a small hole 145 thereat. The bell crank 143 operates an independent warp thread 146 (see Figs. 18 to 21) for a purpose to be described later.

The remote end 147 of the shaft 142 carries a second bell crank 148, the free end 149 of which is provided with a cam follower pin which rides in an eccentric annular groove 150, cut in the face of a spur gear 151. The gear 151 is carried on a shaft 152 rotatably mounted in the wall 27 of the casing near the top thereof, and said gear meshes with the gear 29 on the main shaft 24. The diameters of the gears are such that the shaft 152 rotates at half the angular velocity of the shaft 109 and cam 112. The timing of the gears 29 and 151 is such that the crank 143 moves to the upper limit of its ~~arcuate~~ arcutate travel whilst the needle 125 is retracted on one cycle, and to the lower limit of its travel whilst the needle is retracted on its next cycle. When the needle 125 is advanced the crank 143 can be regarded as stationary with the end 149 of the crank at either one of the two dwell points 153 and 154 of the annular groove 150 (see Fig. 4).

A further auxiliary shaft 155 rotatably mounted parallel to the main shaft 24 is driven by a spur gear 156 meshing with the gear 30 on the main shaft also at four times the angular velocity of said main shaft. This second auxiliary shaft passes through the wall 56 of the main casing 23 and also through the take off block 73 where its end 157 enters a small rectangular gear box 159 (see Figs. 1 and 2). A projection 160 is formed on the gear box, and incorporates an arcutate slot 162 which passes over a stud 161 also attached to the side 158 of the block 73. The gear box can thus be locked in angularly adjustable position to the block 73. A spur gear 163 is secured to the end 157 of the shaft 155 and meshes with a gear 165 through an idler 164. The gear 165 is secured to a hollow shaft 166 (see Fig. 4) rotatable in the free end 167 of the gear box 159. The inner end of the shaft 166 carries a threader crank 171, and, its outer end, a take up crank 172, which can be seen in Figs. 15 to 20 and will be described later.

A boss 168 (see Fig. 1) is provided concentric with the shaft 166 on the face of the gear box remote from the loom casing 23. The vertical leg 169 of an " L " shaped bracket 170 is adjustably clamped about this boss 168. The horizontal leg 173 of the bracket 170 forms a platform for spring loaded friction discs 174 (see Figs. 2 and 3) which provide

a well known form of thread tensioning device. Curved torsion springs 175 and 176 with hooked ends are also secured to the leg 173 in the same plane as the discs 174. A flared tube 178, bent through a right angle is secured by one end 177 to the outer end 180 of the leg 170. The free end 179 of the tube 178 is directed downwards towards a weft thread supply spool 181 secured below the loom.

The threader crank 171 (see particularly Fig. 10) has one end 182 split and is provided with a locking set screw 183 thereat by means of which it may be adjustably clamped to the shaft 166 at the inner end thereof. A wire eye 185 extends from a hole in the face 187 of the crank adjacent its end 184 and the eye 185 may be locked in any angular position by means of a set screw 186.

The take up crank 172 (see particularly Figs. 15 to 17) at the reverse end of the shaft 166 is exactly similar to the crank 171 except that a wire striker 196 extends out parallel to the shaft 166 for a short distance and then is set back upon itself to form a leg 188 at 45° to the shaft and to the portion 196. A screw 189 locks the striker 187 in position and a screw 190 locks the crank to the shaft.

In operation the loom is provided with a supply of warp threads 69 which pass through the holes 68 in the healds 61 and are divided thereby into four sheds 69A, 69B, 69C and 69D. It will be assumed that weaving has been in operation in which case a length of woven fabric will be situated under the friction plate 78 and within the groove 70 in the guide plate 71. The fabric will also be passed around the roller 90 and between the driven roller 88 and loading roller 89. The weft thread 191 extends up from the spool 181, through the tube 178 and friction device 174 to the torsion spring 175 and thence to the torsion spring 176. It then passes through an eyelet 192 and thence through the hollow shaft 166 through the eye 185 of the threader crank 171 and joins the fabric at the fell 193 thereof at the end 82 of the friction plate 78.

The weaving action is as follows. In Figs. 15, 16 and 18 the needle is shown fully advanced through the sheds of the warp 69. At this point the shed of fifteen warp threads 69A and the fifteen warps shed 69D are approaching the upper and lower limits respectively of their travel whilst the sheds 69B and C are at an intermediate position. The needle eye 130 is open and the threader eye 185 swings the weft thread 191 through an arc of a circle about a point 194 (see Fig. 16) where said weft thread has been anchored adjacent the junction of the end 82 of the friction plate 78 and the chamfer 83 thereon. The needle lies in the path of the weft thread which becomes looped about the eye 130.

The take up crank 172 is secured to the shaft 166 approximately 70°, in advance of the threader 171, and its striker 196 rotates through a circular path so that it contacts the weft thread 191 between the shaft 166 and eyelet 192 at the lowermost point of said circular path. Continued rotation of the striker 196 draws the weft into a loop as shown in Figs. 15 and 16. As the weft is anchored at point 194 at this stage, thread to form the loop 195 is drawn from the spool 181 through the friction discs 174. When the srriker 196 passes about 20° beyond top dead centre as shown in Fig. 17 the leg 188 casts off the loop 195. At this stage the needle 125 commences to retract and begins to draw in the loop 195. The needle is thus relieved of the strain of drawing the weft from the spool 181, and through the friction device 174. The needle 125 draws a double looped weft thread 197 between the sheds of warp threads, and, at the stage shown in Fig. 19, the needle eye closes, so that the loop of weft 198, from the previous pick which surrounds the needle shank, can pass over the eye 130 and surround the new weft 197 as shown in Fig. 20.

Fig. 20 shows the needle 125 fully retracted and with the eye now re-opened. The needle 125 remains retracted for a period approximately as long as the period during which it was in motion. This dwell gives the healds time to perform two functions. Firstly the healds 61 in groups A and D reach extreme upper and lower limits of their movement so that the said warp groups 69A and D make an included angle greater than 90° at the weaving point 193. The previous pick of weft (the loop 198 only of which can be seen in Figs. 19 and 20), is thus forced tightly against the fell of the woven fabric. The function of a beat up comb has thus been accomplished without the necessity of incorporating such a mechanism.

The healds 61 now move so that the warp thread 69 cross; group 69D moves to the previous position occupied by 69B in Fig. 18, 69A moves to 69C, 69B moves to 69A and 69C moves to 69D. The weft thread 197 will now be enmeshed by the warp sheds A and D against the weaving point 193.

The needle 125 will now commence to move outwards between the sheds A and D and the weft loop 197 will now slide up the shank of the needle as did the previous loop 198. The needle 125 reaches the fully advanced point just before the eye 185 of the threader 171 reaches a horizontal plane through the threader axis. The threader then begins to lay a new weft loop in the needle eye 130 and the cycle is recommenced.

Because the loom incorporates four sheds of warps, the innermost warp thread in each shed would in turn form the boundary against which the weft loops would be knitted to form the selvedge 199. An examination of Fig. 22 will reveal that the thread 69A would form the boundary on one pick, followed by 69B on the next pick, and then 69C and 69D

on succeeding picks. The selvedge 199 would then present a ragged, saw toothed appearance, because the thread 69D is spaced approximately $^1/_{32}$ of an inch from the thread 69A.

To avoid this, the previously mentioned auxiliary single outer warp thread 146 is used to form the selvedge 199. The thread 146 is quite independent of the healds and is laid closely adjacent to the end 123 thereof and passes through the hole 145 in the end 144 of the crank 143. The said crank moves only during the dwell period when the needle 125 is fully retracted; and moves up during one dwell period and down during the next dwell. A close examination of Fig. 21 which shows the needle retracted during a dwell period, shows the crank moving upwardly so that the thread 146 lifts the loop 198 above the needle 125.

When the needle advances, it will pass beneath the thread 146 and the loop 198 will be wrapped around said thread 146.

During the next cycle the thread 146 will be lowered so that the needle will pass above it and the loop 198 will again encircle the thread 146 in the opposite direction.

The result is shown in Fig. 22 which shows that an even selvedge 199 having a neat linen finish will now be formed.

In the foregoing description the healds have been arranged in four groups to form four individual warp sheds. The woven pattern with this arrangement is the commonly known "herring-bone". Other types of patterns may be formed by different arrangements of the shedding mechanism. For example, to produce a linen finish the gearing is adjusted so that shaft 24 rotates at one half and not one quarter the speed of the shafts 109 and 155. The healds 61 would be arranged in two groups to form only two sheds. These two groups would be 180° out of phase with each other.

By varying the order of the healds in each group, various patterns in the finished weave can be obtained. In practice, a loom according to the invention operates satisfactorily at speeds of over 3,200 double picks per minute which is far in excess of the maximum possible weaving rate of existing looms of this type.

What we claim is:—

1. A weaving loom having a hooked knitting needle mounted to one side of the fabric being woven, means for reciprocating the needle through the shed of warp threads, means for opening and closing the needle eye, a supply of weft thread on the far side of the fabric, means for moving a weft thread into the needle hook, the needle being adapted to retain the thread in the hook during far-to-near side movement and to knit the thread before beginning near-to-far side movement, and means for crossing the warp threads at the end of each far-to-near side movement of the needle.

2. A weaving loom as claimed in Claim 1 having means for slackening the thread from the weft supply so that the thread is not pulled from the supply by the needle in its far-to-near side travel.

3. A weaving loom as claimed in Claim 2, wherein the slackening means is a striker engaging the weft thread between the weft supply and the needle to create slack in the thread.

4. A weaving loom as claimed in Claim 3, wherein a tensioning device is provided to maintain constant tension on the thread from the weft supply and to store the slackness in the thread created by the striker.

5. A weaving loom as claimed in Claim 3 or 4 wherein the striker rotates around the weft thread.

6. A weaving loom as claimed in any one of the preceding claims wherein the means for moving the weft thread is an eyeletted member through which the weft thread passes.

7. A weaving loom as claimed in Claim 6 wherein the eyeletted member rotates around the hooked end of the needle.

8. A weaving loom as claimed in Claim 6 or 7 in so far as Claim 6 depends upon any one of Claims 2 to 5, wherein the slackening means and the means for moving the weft thread are mounted on opposite ends of a hollow driven shaft.

9. A weaving loom as claimed in Claim 8 wherein the thread from the weft supply passes through the hollow shaft.

10. A weaving loom according to any one of the preceding claims wherein the needle is stationary at the near side of the fabric being woven for a period as long as the period during which it reciprocates through the shed of warp threads.

11. A weaving loom as claimed in Claim 10, wherein the means for reciprocating the needle is a grooved cam.

12. A weaving loom as claimed in Claim 11 wherein the needle is hollow, and wherein the means for opening and closing the needle eye is a closure bar slidable within the needle.

13. A weaving loom as claimed in Claim 12 wherein movement of the closure bar is controlled by a second groove in the said grooved cam.

14. A weaving loom as claimed in Claim 13 wherein the cam is driven by a shaft travelling at a speed which is an even multiple of the speed at which the crossing means for the warp threads is driven.

15. A weaving loom as claimed in any one of the preceding claims having means for supplying an additional warp thread which is not associated with the said means for crossing the warp threads.

16. A weaving loom as claimed in Claim 15 wherein the supplying means coacts with the

on succeeding picks. The selvedge 199 would then present a ragged, saw toothed appearance, because the thread 69D is spaced approximately $^1/_{32}$ of an inch from the thread 69A.

To avoid this, the previously mentioned auxiliary single outer warp thread 146 is used to form the selvedge 199. The thread 146 is quite independent of the healds and is laid closely adjacent to the end 123 thereof and passes through the hole 145 in the end 144 of the crank 143. The said crank moves only during the dwell period when the needle 125 is fully retracted; and moves up during one dwell period and down during the next dwell. A close examination of Fig. 21 which shows the needle retracted during a dwell period, shows the crank moving upwardly so that the thread 146 lifts the loop 198 above the needle 125.

When the needle advances, it will pass beneath the thread 146 and the loop 198 will be wrapped around said thread 146.

During the next cycle the thread 146 will be lowered so that the needle will pass above it and the loop 198 will again encircle the thread 146 in the opposite direction.

The result is shown in Fig. 22 which shows that an even selvedge 199 having a neat linen finish will now be formed.

In the foregoing description the healds have been arranged in four groups to form four individual warp sheds. The woven pattern with this arrangement is the commonly known "herring-bone". Other types of patterns may be formed by different arrangements of the shedding mechanism. For example, to produce a linen finish the gearing is adjusted so that shaft 24 rotates at one half and not one quarter the speed of the shafts 109 and 155. The healds 61 would be arranged in two groups to form only two sheds. These two groups would be 180° out of phase with each other.

By varying the order of the healds in each group, various patterns in the finished weave can be obtained. In practice, a loom according to the invention operates satisfactorily at speeds of over 3,200 double picks per minute which is far in excess of the maximum possible weaving rate of existing looms of this type.

What we claim is:—

1. A weaving loom having a hooked knitting needle mounted to one side of the fabric being woven, means for reciprocating the needle through the shed of warp threads, means for opening and closing the needle eye, a supply of weft thread on the far side of the fabric, means for moving a weft thread into the needle hook, the needle being adapted to retain the thread in the hook during far-to-near side movement and to knit the thread before beginning near-to-far side movement, and means for crossing the warp threads at the end of each far-to-near side movement of the needle.

2. A weaving loom as claimed in Claim 1 having means for slackening the thread from the weft supply so that the thread is not pulled from the supply by the needle in its far-to-near side travel.

3. A weaving loom as claimed in Claim 2, wherein the slackening means is a striker engaging the weft thread between the weft supply and the needle to create slack in the thread.

4. A weaving loom as claimed in Claim 3, wherein a tensioning device is provided to maintain constant tension on the thread from the weft supply and to store the slackness in the thread created by the striker.

5. A weaving loom as claimed in Claim 3 or 4 wherein the striker rotates around the weft thread.

6. A weaving loom as claimed in any one of the preceding claims wherein the means for moving the weft thread is an eyeletted member through which the weft thread passes.

7. A weaving loom as claimed in Claim 6 wherein the eyeletted member rotates around the hooked end of the needle.

8. A weaving loom as claimed in Claim 6 or 7 in so far as Claim 6 depends upon any one of Claims 2 to 5, wherein the slackening means and the means for moving the weft thread are mounted on opposite ends of a hollow driven shaft.

9. A weaving loom as claimed in Claim 8 wherein the thread from the weft supply passes through the hollow shaft.

10. A weaving loom according to any one of the preceding claims wherein the needle is stationary at the near side of the fabric being woven for a period as long as the period during which it reciprocates through the shed of warp threads.

11. A weaving loom as claimed in Claim 10, wherein the means for reciprocating the needle is a grooved cam.

12. A weaving loom as claimed in Claim 11 wherein the needle is hollow, and wherein the means for opening and closing the needle eye is a closure bar slidable within the needle.

13. A weaving loom as claimed in Claim 12 wherein movement of the closure bar is controlled by a second groove in the said grooved cam.

14. A weaving loom as claimed in Claim 13 wherein the cam is driven by a shaft travelling at a speed which is an even multiple of the speed at which the crossing means for the warp threads is driven.

15. A weaving loom as claimed in any one of the preceding claims having means for supplying an additional warp thread which is not associated with the said means for crossing the warp threads.

16. A weaving loom as claimed in Claim 15 wherein the supplying means coacts with the

needle to effect knitting of the selvedge of the fabric

17. A weaving loom as claimed in Claim 15 or 16 in so far as Claim 15 depends upon Claim 14, wherein the means for supplying an additional warp thread is driven by an oscillating shaft coaxial with the said cam shaft.

18. A weaving loom as claimed in Claim 17 wherein the cam shaft rotates twice to one oscillation of the coaxial shaft.

19. A weaving loom as claimed in Claim 17 or 18 in which the coaxial shaft is cam operated.

20. A weaving loom as claimed in any one of Claims 15 to 19 wherein the means for supplying an additional warp thread is a crank having an eyelet through which the warp thread passes.

21. A weaving loom according to any one of Claims 1 to 20 wherein the said means for crossing the warp threads is a shedding mechanism for forming a plurality of sheds of warp threads, said mechanism comprising a plurality of movable healds all of which are arranged in a single line substantially parallel to the fell of the woven fabric.

22. A weaving loom according to Claim 21 wherein the shedding mechanism is sufficiently close to the fell of the fabric, and the movement of the healds is such that the formation of a new shed causes the warp threads to slide the weft up tightly against the fell of the fabric being woven.

23. A weaving loom according to Claim 22 wherein the included angle between the warp threads forming the shed is more than 40°.

24. A method of weaving including the steps of drawing a looped weft thread from a weft supply through a shed of warp threads by means of a reciprocating hooked needle, temporarily closing the needle eye to cast a previous weft loop over the drawn loop, crossing the warp threads to form a new shed, opening the needle eye to release the looped end of the drawn weft thread, returning the needle through the now stationary loop and the new shed to pick up a new weft thread from the weft supply and drawing the new looped thread back through the shed and through and out of the loop of the previous thread.

25. A weaving loom substantially as hereinbefore described with reference to the accompanying drawings.

26. A method of weaving substantially as hereinbefore described.

27. A tape produced from a weaving loom as claimed in any one of Claims 1 to 23 and 25.

28. A tape woven in accordance with the method claimed in either Claim 24 or 26.

MARKS & CLERK.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press,—1957.
Published at the Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

