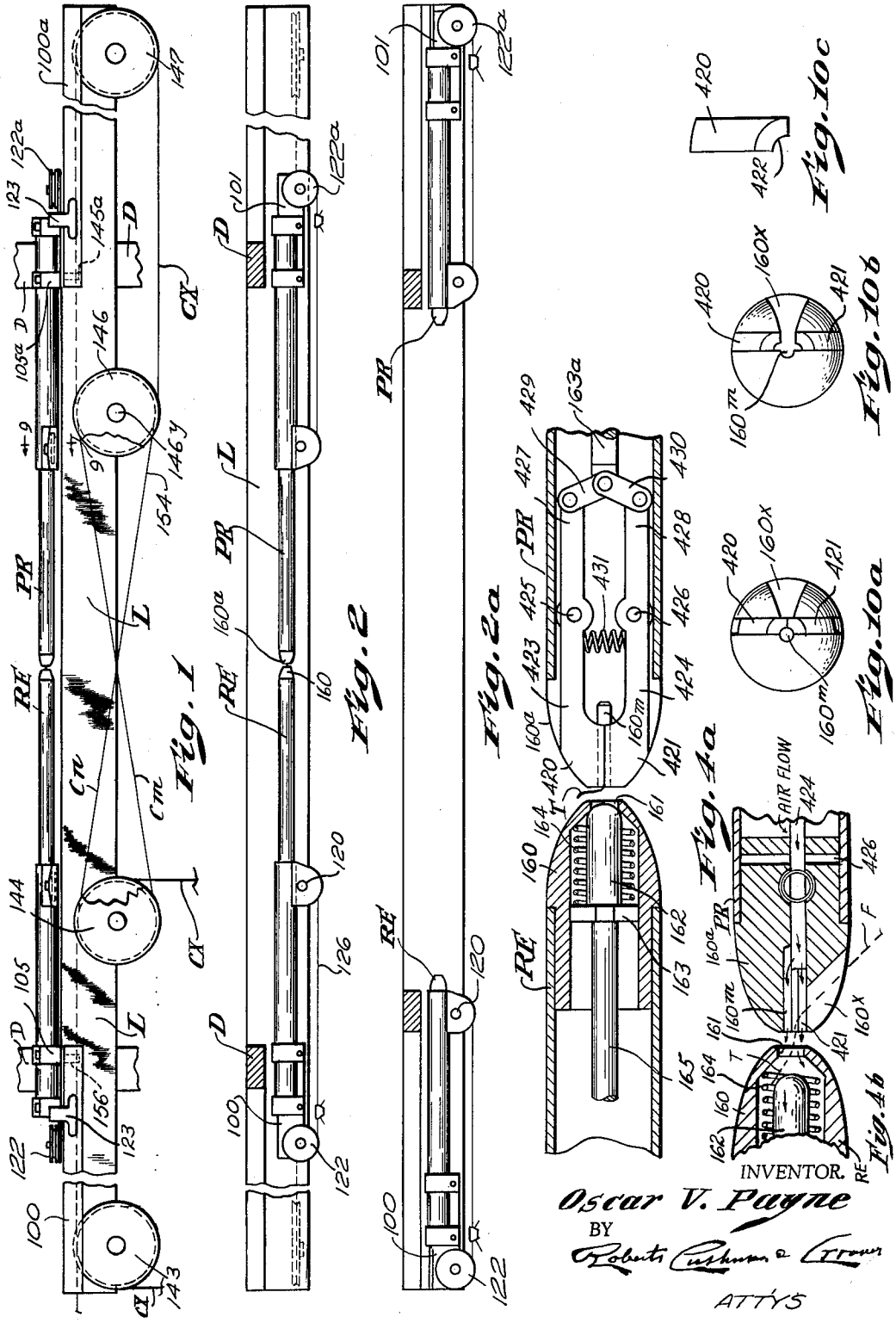
May 3, 1966 O. V. PAYNE 3,249,127

NEEDLE LOOM

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NEEDLE LOOM

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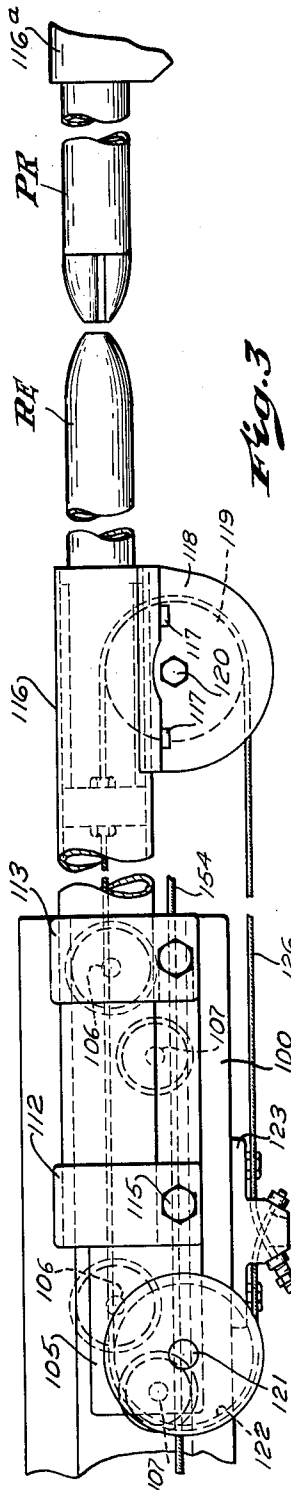


Fig. 3

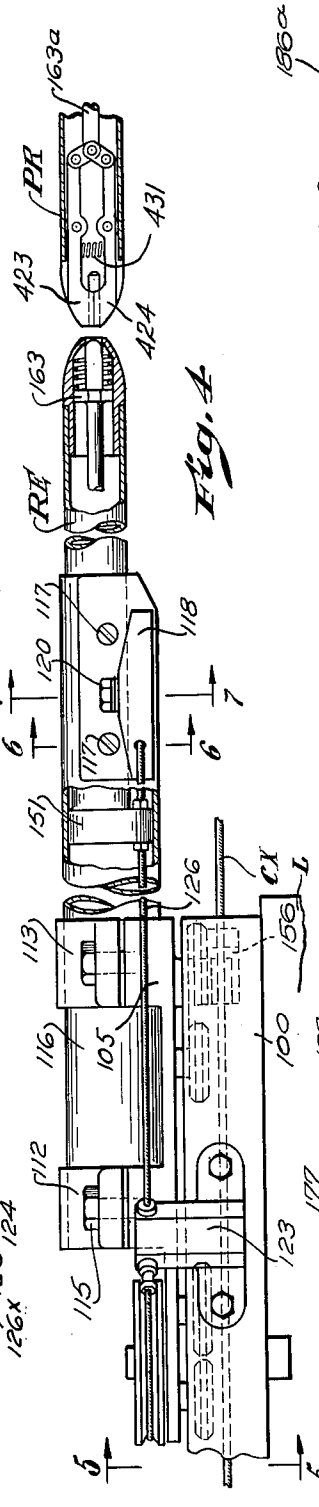


Fig. 4

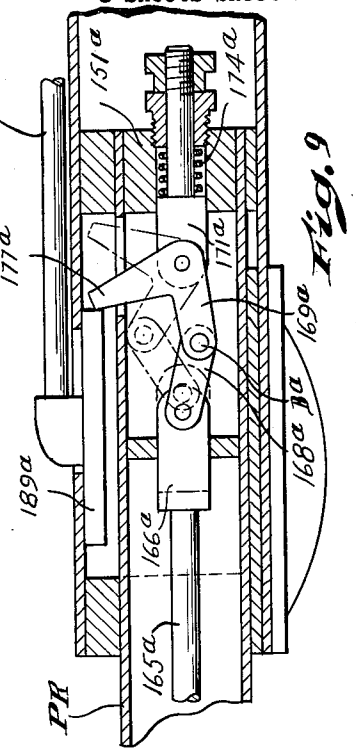


Fig. 9

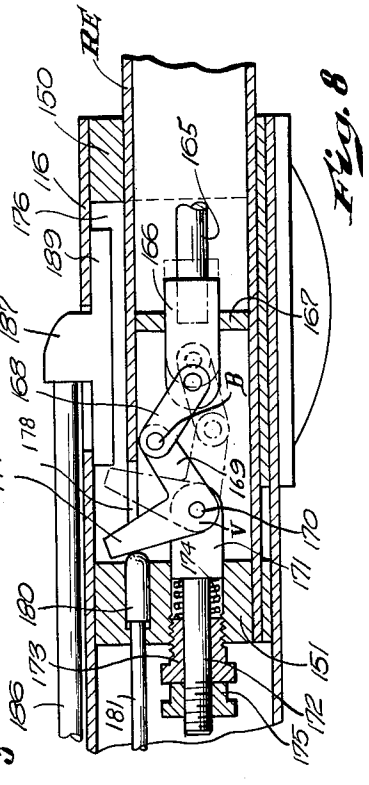


Fig. 8

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NEEDLE LOOM

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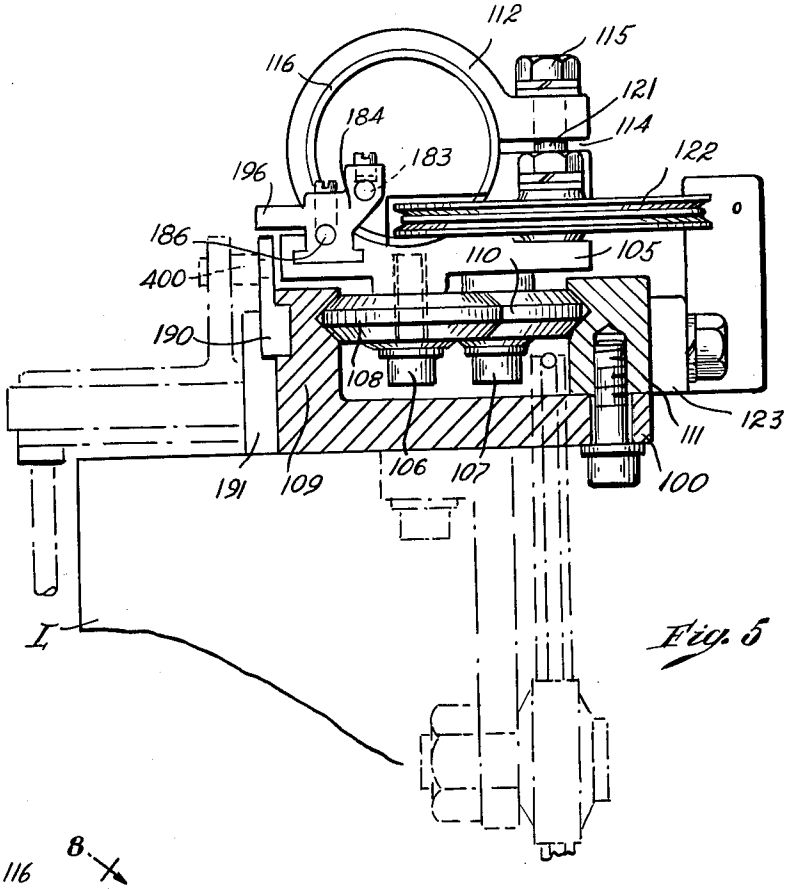


Fig. 5

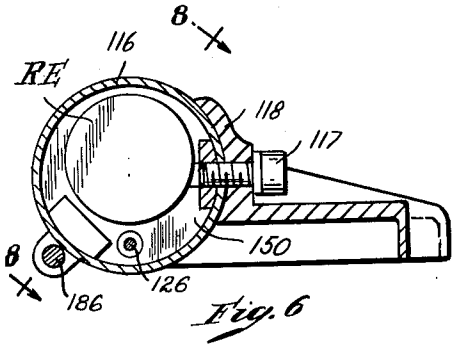


Fig. 6

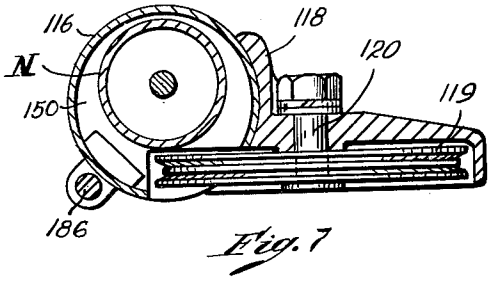


Fig. 7

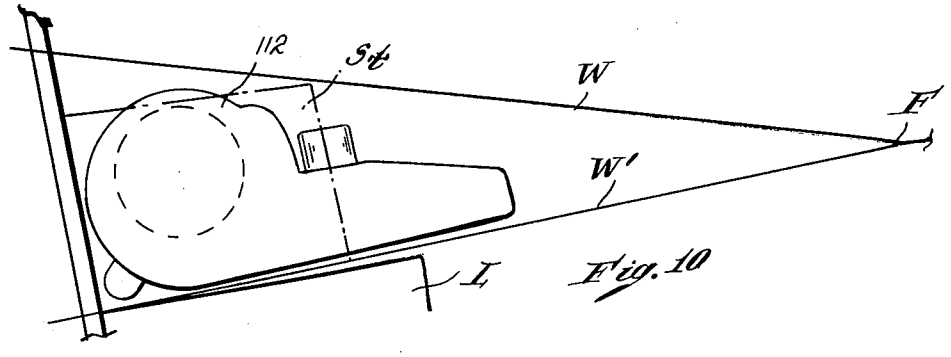


Fig. 10

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NEEDLE LOOM

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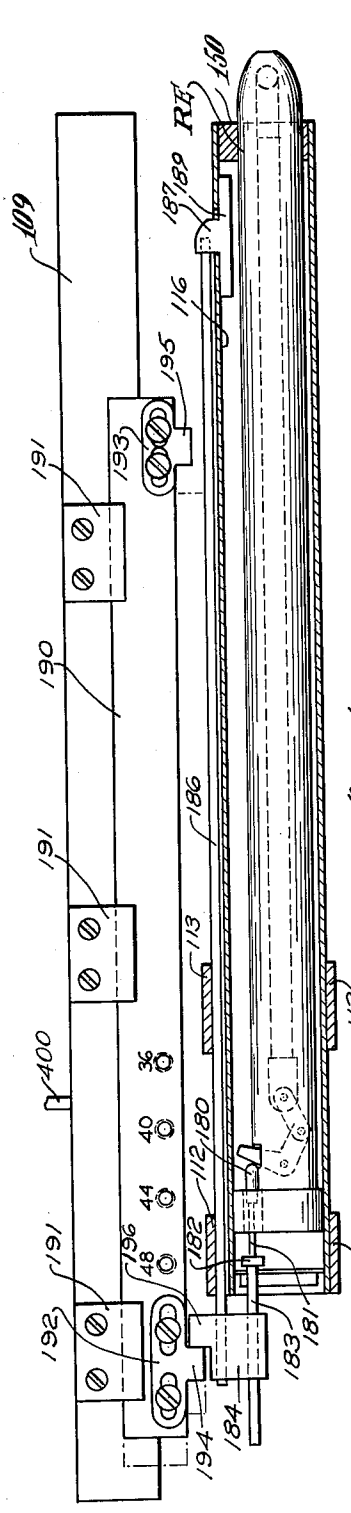


Fig. 12

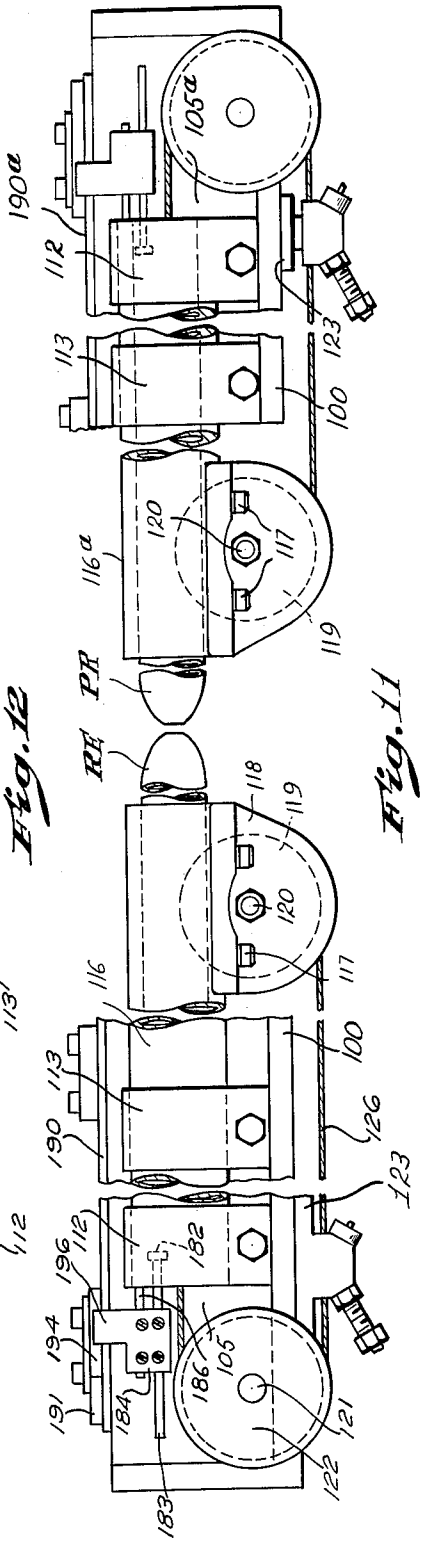


Fig. 11

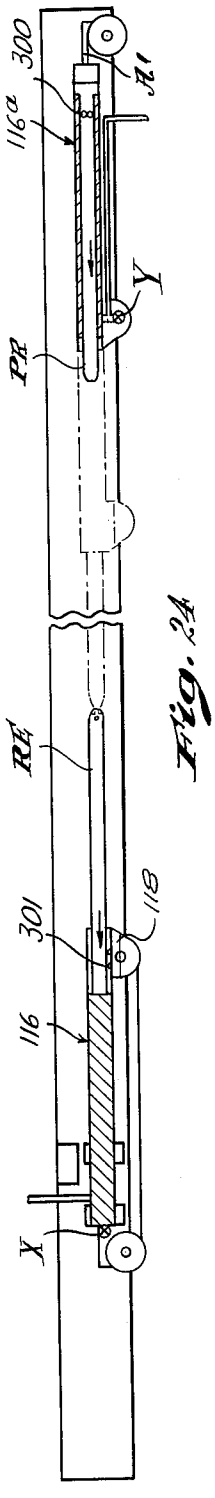


Fig. 24

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NEEDLE LOOM

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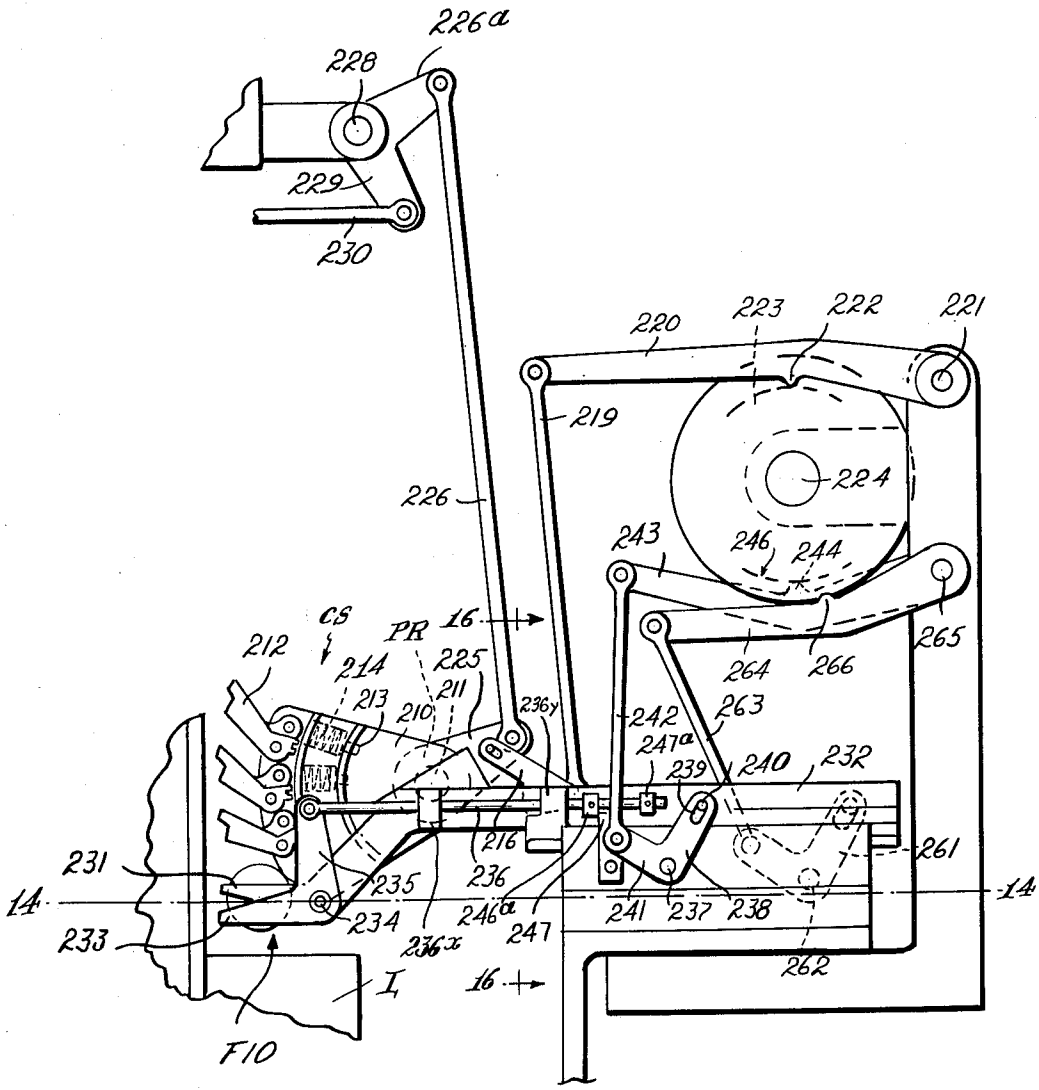


Fig. 13

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NEEDLE LOOM

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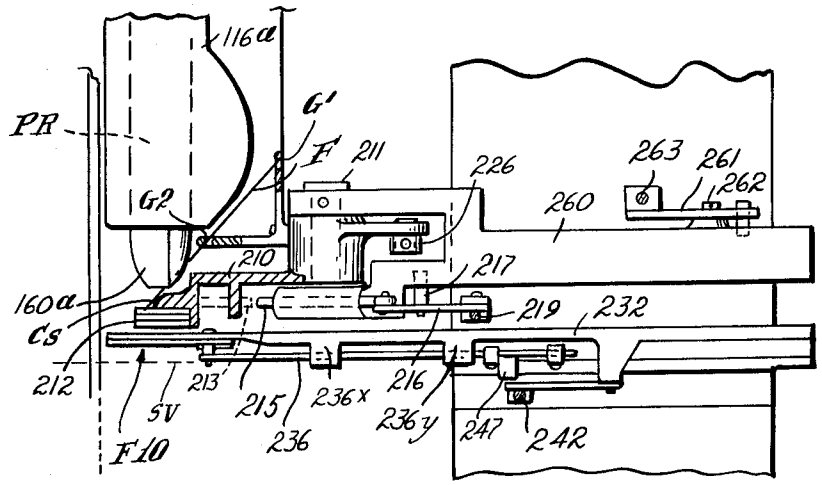


Fig. 14

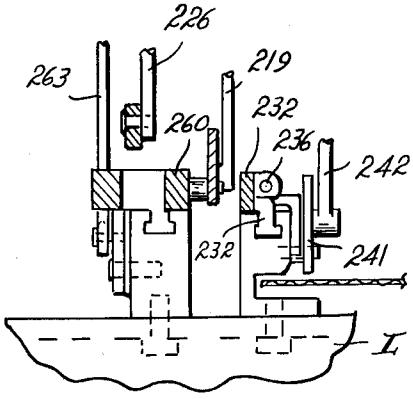


Fig. 16

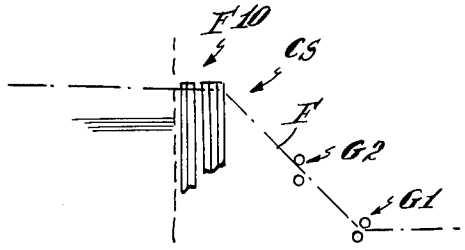


Fig. 15

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NEEDLE LOOM

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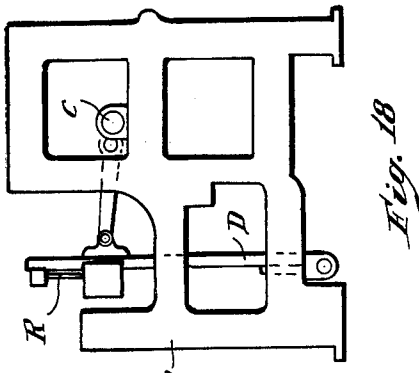


Fig. 18

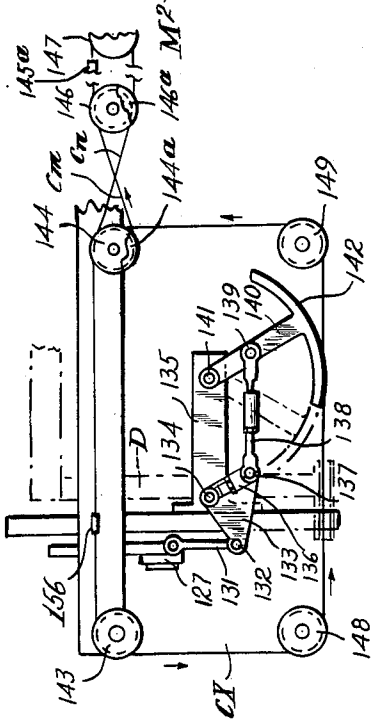


Fig. 19

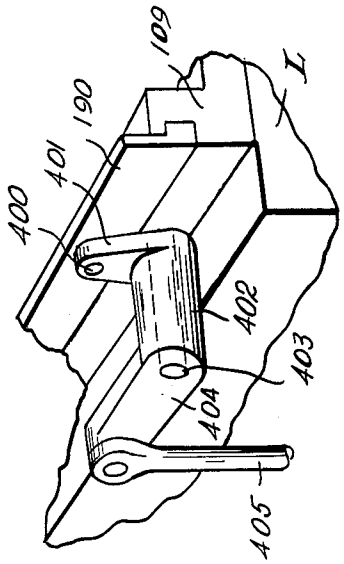


Fig. 22

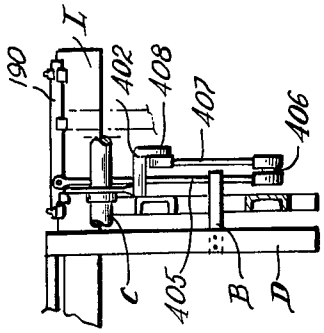


Fig. 21

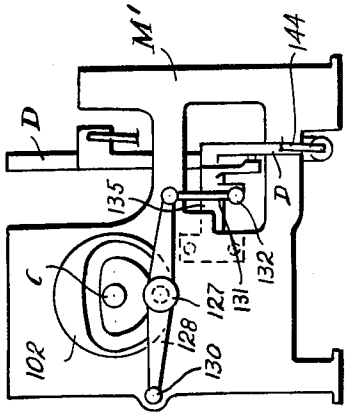


Fig. 17

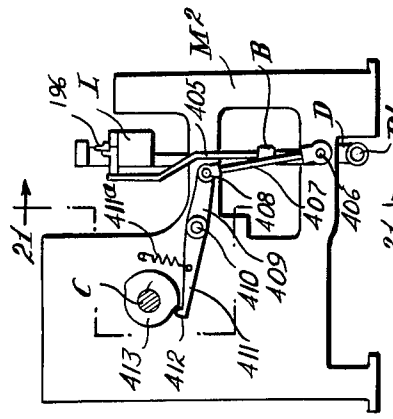


Fig. 20

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NEEDLE LOOM

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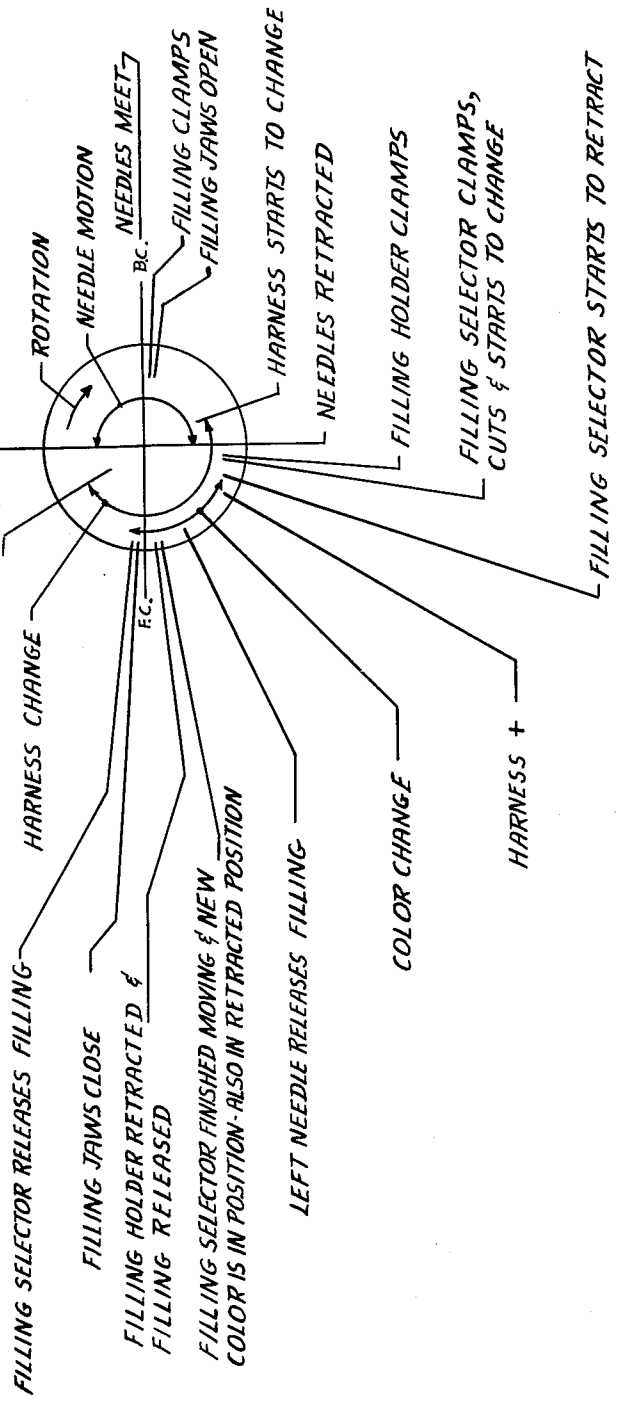


Fig. 23

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3,249,127

NEEDLE LOOM

Oscar V. Payne, East Road, Greenfield, N.H.

Filed Jan. 2, 1964, Ser. No. 335,713
43 Claims. (Cl. 139—127)

This invention pertains to weaving looms, in particular to needle looms, and more especially to a needle loom of the type wherein a single weft pick is inserted at each weaving cycle by a so-called "needle," and in the embodiment here illustrated, but without limitation with respect to its broader features, to a needle loom of that kind wherein an end of the filling yarn is carried partway across the shed to a transfer point (by a yarn-presenting needle, hereinafter for convenience sometimes referred to as the "PR needle"), where the end of the filling yarn is taken by a yarn-receiving needle (hereinafter for convenience being referred to at times as the "RE needle"), and wherein, while the presenting needle retracts for replenishment, the yarn end is carried the remainder of the distance across the shed by the yarn-receiving needle. The invention is more especially concerned with improvements in the yarn-presenting and yarn-receiving needles and the means for actuating them in properly timed relation, it being understood that many of the improved features herein disclosed are such as may be incorporated in existing looms of commercial type.

Among the objects of the invention is to provide a needle loom of the above type so designed as to minimize its width thus making possible its installation in a space substantially smaller than is required for most prior commercial needle looms of similar capacity, and in the attainment of this object to provide means whereby each needle proper requires a much shorter stroke in reaching the transfer point than is customary, although permitting each needle to be retracted so that its yarn-engaging end is outwardly beyond the selvage when fully retracted. A further object is to provide novel means for delivering the yarn end to the yarn-presenting needle and for actuating yarn-gripping means by which the end of the yarn is seized while the PR needle is retracted and for so actuating the gripping means as to release the yarn at the transfer point. A further object is to provide novel means whereby the yarn end is taken and gripped by the yarn-receiving needle at the transfer point and then released from the RE needle when the latter is fully retracted. A further object is to provide novel means whereby the yarn end, when released by the yarn-presenting needle, is transferred to the yarn-receiving needle. A further object is to provide novel means for advancing and retracting the needles and novel means whereby compressed air may be supplied and vacuum may be created, desirably by the motion of the needles themselves, as a means for effecting yarn-transfer.

Other and further objects and advantages of the invention will be pointed out in the following more detailed description and by reference to the accompanying drawings wherein:

FIG. 1 is a diagrammatic, small scale front elevation of the needle-actuating mechanism of the present invention, omitting most of the loom parts and showing the needles at the yarn-transfer point;

FIG. 2 is a plan view of the mechanism of FIG. 1;

FIG. 2*a* is a view similar to FIG. 2, but showing both needles completely retracted;

FIG. 3 is a fragmentary top plan view, to larger scale than FIG. 1, showing the tips of the needles at or approximately at the thread-transfer position and showing, in somewhat greater detail, the means for actuating the yarn-receiving needle;

FIG. 4 is a fragmentary front elevation, with parts in vertical section, showing the ends of the needles in the position of FIG. 3, and with the thread-gripping elements of both needles in closed or thread-clamping position, but omitting the thread;

FIG. 4*a* is a fragmentary section in the same plane as FIG. 4, showing the ends, only, of the needles, to larger scale, and in the same relative position as in FIG. 4;

FIG. 4*b* is a fragmentary section in a plane perpendicular to that of FIG. 4*a*, showing the air passage and the free end of the yarn floating in the air stream;

FIG. 5 is a vertical section, on the line **5—5** of FIG. 4, with certain parts shown in broken lines and in elevation;

FIG. 6 is a fragmentary vertical section on the line **6—6** of FIG. 4;

FIG. 7 is a fragmentary vertical section on the line **7—7** of FIG. 4;

FIG. 8 is a fragmentary section in the plane of the line **8—8** of FIG. 6;

FIG. 9 is a section similar to that of FIG. 8, but substantially at the location of the line **9—9** of FIG. 1;

FIG. 10 is a diagrammatic view showing the location of the apparatus of the present invention as related to the lay-beam of the loom;

FIG. 10*a* is an end elevation of the yarn-presenting needle showing the ends of the yarn-gripping jaws in closed position, but omitting other parts;

FIG. 10*b* is a view similar to FIG. 10*a*, but showing the jaws open;

FIG. 10*c* is an end elevation, to larger scale than FIG. 10*a*, showing the operative end of one of the jaws;

FIG. 11 is a fragmentary plan view showing both needles in retracted position;

FIG. 12 is an inverted rear elevation showing the yarn-receiving needle in retracted position and the means for actuating its yarn-clamping device;

FIG. 13 is a fragmentary diagrammatic elevation illustrating filling control mechanism useful for color variation, shown with reference to parts of the loom and to the position of the weft-presenting needle PR;

FIG. 14 is a fragmentary horizontal section on the line **14—14** of FIG. 13, showing the end of the yarn-presenting needle when in yarn-receiving position and showing the course of the yarn being laid into the needle, the loom crank being at front center;

FIG. 15 is a diagrammatic elevation showing the course of the yarn relative to the yarn changer and yarn holder when the crank is at bottom center;

FIG. 16 is a fragmentary section on the line **16—16** of FIG. 13;

FIG. 17 is a diagrammatic small scale end elevation of the loom frame showing the crankshaft and diagrammatically indicating the means for actuating the needles;

FIG. 18 is a diagrammatic elevation of the opposite end of the loom frame;

FIG. 19 is a fragmentary diagrammatic elevation illustrating details of the means for driving the needles;

FIG. 20 is a diagrammatic end elevation, to the same scale as FIG. 17, showing the mechanism for actuating the filling-yarn gripping means of the yarn-receiving needle;

FIG. 21 is a fragmentary rear view, partly in section, on the line **21—21** of FIG. 20, showing the parts illustrated in FIG. 20;

FIG. 22 is a fragmentary perspective view showing the crank for actuating the slide by means of which the yarn-gripping element of the yarn-receiving needle RE is actuated;

FIG. 23 is a timing chart showing the sequence of events during one revolution of the loom crankshaft; and

FIG. 24 is a diagrammatic horizontal section, to small

scale, illustrating an arrangement whereby the needles themselves provide air pressure and suction to aid in yarn transfer.

Referring to the drawings (FIGS. 1 and 2), the needles and needle -actuating mechanism of the present invention are shown as mounted upon the lay L of a loom, which, in general, may be of a known type, and are so designed as to occupy but little more space than is required for the customary shuttle, so that the application of this novel mechanism to the loom does not require any substantial change in or interfere with the operation of the conventional shedding mechanism.

As diagrammatically illustrated in FIG. 10, a portion of one end of the lay-beam, with one needle support, according to the present invention, mounted thereon, is shown in full lines and, for comparison, the outline of a conventional shuttle S*t* is indicated in broken lines with the shed comprised of the warp sheets W and W¹ extending to the fell F of the cloth.

In FIGS. 17 and 18, there are shown diagrammatically and to small scale the opposite end frames M¹ and M² respectively, of a conventional loom, the loom crankshaft being indicated at C and lay swords at D. A cam **102** for actuating the needles and associated parts is shown mounted on the crankshaft C. Since the means for supporting and actuating the needles RE and PR are substantially alike, the description which follows is directed specifically to the needle RE and associated parts and will be followed, where necessary, by a description of such unlike details as pertain, respectively, to the individual needles.

Referring to FIGS. 3, 4 and 5, the support **100** for the needle RE is shown as mounted upon and secured to the lay-beam L in any desired manner. On this support **100** there is a horizontally movable carrier **105** (FIGS. 3, 4 and 5) provided with four downwardly directed stud shafts **106**; **107** (FIG. 3), the two shafts **106** carrying beveled-edged guide rolls **108** (FIG. 5) which engage a horizontal groove in the inner face of a vertical flange **109** on the support **100**, while the two shafts **107** carry similar guide rolls **110** which engage a horizontal groove in the inner face of a parallel flange or part **111** of the support **100**, the carrier **105** thus being accurately guided for movement longitudinally of the lay-beam. The carrier **105** comprises two coaxial clamping rings **112** and **113** respectively (FIGS. 3, 4 and 11), each of these rings preferably being split as shown at **114** (FIG. 5) and provided with a bolt **115** by means of which it may be adjusted as to effective diameter. Adjustably secured in these rings is a tubular, cylindrical needle holder **116** (FIG. 3) having attached to one side, as by means of screws **117** (FIGS. 3 and 11), a housing **118** for a grooved sheave **119** (FIGS. 3, 7 and 11) arranged to turn about a vertical shaft **120**. The carrier **105** is provided with a second vertical shaft **121** (FIGS. 3 and 11), upon which there is mounted to turn a guide sheave **122** like the sheave **119**. The support **100**, which is fixed to the lay beam, is provided at its forward edge with an anchorage device **123** (FIGS. 3, 4 and 11) to which the opposite ends **124** and **125** of an endless needle-actuating band **126** are secured, the band embracing both of the sheaves **119** and **122** and being secured at an intermediate point in its length, as hereinafter described, to the yarn-receiving needle RE. Since the sheaves **119** and **122** are carried by the longitudinally slidable carrier **105**, while the ends of the band are secured to a relatively fixed anchorage at **123**, movement of the carrier **105** longitudinally of the lay L causes reciprocation of the needle RE relatively to the holder **116** clamped within the guide rings **112** and **113**. As shown in FIG. 3, one end of the band **126** is provided with means **126***x* whereby its tension may be adjusted.

Referring to FIGS. 17, 18 and 19, the cam **102** on the crankshaft C engages a cam follower roll **127** carried by a lever **128** which rocks about a fixed pivot pin at **130** carried by the loom frame. A rigid link **131**, pivotally connected to the forward end of the lever **128**, is attached by a universal joint connection at **132** (FIG. 19) to one corner of a triangular plate **133** pivotally secured at **134** to a member **135** constituting a part of the side M¹ of the loom. A bracket **136**, adjustably attached to the plate **133**, carries a pivot pin **137** to which one end of a link **138** of adjustable length is attached, the other end of this link being pivotally connected at **139** to a radius arm **140** pivotally connected at **141** to the part **135** and which carries an arcuate, peripherally grooved sector **142** of approximately a quadrant of arc. Adjustment of the bracket **136** is to adapt the loom for weaving cloth of different widths, while adjustment of the length of link **138** is for varying the location of the yarn transfer point.

Freely rotatable, grooved guide rolls supported on the lay structure guide an endless cable CX (FIGS. 1, 4 and 19), by means of which the carriers for the two needles are actuated. Two of these rolls **148** and **149** define a substantially rectilinear run of the cable CX which is attached, at an intermediate point, to the sector **142** so that, as the sector rocks, the cable is pulled alternately in opposite directions. Two of the guide rolls **143** and **144** define a rectilinear run to which the carrier **105** for needle RE is attached at **156** (FIGS. 4 and 19), while two other guide rolls **146** and **147** define a rectilinear run to which the carrier **105***a* for the needle PR is secured at **145***a*.

Coaxial with the rolls **144** and **146** respectively, are two independent, freely rotatable guide rolls **144***a* and **146***a*. Between these two pairs of guide rolls, runs C*m*, C*n* (FIG. 1) of the cable CX cross each other. Thus, as the cable is moved back and forth by the sector **142**, the carriers **105** and **105***a* are moved in opposite directions.

The needle holder **116** (FIGS. 6 and 8) is provided at its forward end with an internal eccentric bushing **150** for guiding the needle RE, and the rear end of this needle (FIG. 8) is closed by a block **151** which slides in the tubular holder **116**. The block **151** (FIG. 4) has an eccentrically located hole through which the endless band **126** passes, the band being fixedly secured to the block **151** by appropriate clamping devices.

As shown in FIG. 4*a*, the needle RE has a hollow tip **160** at its forward end, said tip having a smooth, semi-ellipsoidal outer contour and having a yarn-receiving orifice or port **161** in its end. The inner surface of this hollow tip, bordering the yarn-receiving port, is of truncated conical contour providing an annular line-contact for the spherical end surface of a cylindrical yarn-gripping plug **162** (FIGS. 4 and 4*a*). This plug has a guiding spider **163** which slides within the bore of the hollow tip and which forms an abutment for one end of a coiled compression spring **164** whose opposite end seats against the aforesaid conical surface so that the spring thus urges the plug **162** away from its seat. The plug **162** has a stem **165** (FIGS. 4*a* and 8) which extends rearwardly through the hollow needle RE and is secured to a shackle **166** (FIG. 8), slidable in a guide opening in a web **167** fixed within the needle. This shackle **166** is connected by a link **168** (FIG. 8) to one arm **169** of a bell-crank lever V fulcrumed at **170** on a part **171** which slides within a bore in the block **151** which closes the rear end of the needle. The link **168** is connected by a pivot B to the arm **169** of the bell-crank lever V thus providing a locking toggle. The part **171** has a stem **172**, screw-threaded at its outer end, which passes through an axial bore in an externally screw-threaded sleeve **173** having threaded engagement with a screw-threaded portion of the wall of the axial bore in the block **151**. A spring **174**, interposed between the sleeve **173** and the part **171**, yieldably urges the part **171** toward the forward end of the needle. A locking nut **175**, engaging the stem **172**, secures the parts in adjusted position.

As above noted, the bushing **150** in the needle holder **116** is eccentric to the holder so that the needle is not coaxial with the holder, thus leaving a space **176** (FIG. 8)

between the needle and the holder at one side of the latter. The bell-crank lever V above referred to has a second arm **177** which extends into this space, through a slot **178** in the wall of the needle. A lock-actuator or tappet **180**, for rocking the bell-crank lever V in one direction, slides in a bore in the block **151** with its inner end opposed to the arm **177** of the bell-crank lever V. The tappet **180** has a stem **181** (FIGS. 8, 11 and 12) whose outer or rear end (FIG. 12) is opposed to an actuating member **182** (FIG. 12) having a stem **183** which is adjustably fixed in an opening in a block **184** (FIG. 12) to which there is secured the outer end of a rod **186** (FIG. 12) which is guided to slide longitudinally in openings in the rings **112** and **113** and to whose inner end there is secured a toggle-locking member **187** (FIGS. 8 and 12) which slides in a slot in the wall of the holder **116** and has an elongate portion **189** which engages the inner surface of the tubular holder.

In the operation of the needle RE, it is necessary that the yarn-clamping plug **162** be in retracted position when the needle is at the transfer point in order that the end of the yarn may enter the orifice **161** (FIG. 4*a*). Such retraction of the plug **162** is automatically caused by the action of spring **164** (FIG. 4*a*) when the stem **165** of the plug is permitted to move rearwardly, that is to say, away from the port **161**. On the other hand, as soon as or desirably before the needle RE begins to retract, the plug **162** should be advanced thereby to clamp the end of the yarn between the plug and the conical interior surface of the hollow tip of the needle and the plug should be locked in this clamping position until the needle has been retracted until its tip is outwardly beyond the selvage line of the cloth. Then when the needle RE reaches this position, the plug **162** should again be permitted to retract in response to the spring **164** thereby to release the yarn end.

For thus controlling the position of the plug **162**, the lay-beam L is provided with a slidable control bar **190** (FIG. 12), movable longitudinally of the lay-beam and guided and held in assembled relation to the lay-beam by suitable retaining and guiding clips **191**. On this bar **190** there are adjustably fixed two dogs **192** and **193** respectively, having tails **194** and **195** which are engageable alternately with opposite parallel faces of a lug **196** on the part **184**. As shown in FIG. 12, the bar has a series of screw-threaded holes, so spaced apart that the dog **192** may be adjusted for different widths of cloth.

For actuating the slidable control bar **190**, the latter is provided with a rearwardly directed pivot pin **400** (FIG. 22) which is received in a bearing opening in the upwardly directed arm **401** of a crank device comprising a sleeve portion **402** which turns on a pin **403** rigidly secured to the part **109** (FIGS. 5 and 22). This crank device also comprises an arm **404**, at right angles to the arm **401**, which is pivotally connected to the upper end of a connecting rod **405** (FIGS. 20 and 21) whose lower end is connected to a floating pivot pin **406** (FIG. 20) to which there is also connected the lower end of a rod **407** whose upper end is pivotally connected at **408** to one arm **409** of a lever pivotally mounted at **410** on the end frame of the loom, the lever having a second arm **411** provided at its free end with a cam follower element **412** (FIG. 20) which engages the peripheral edge of a cam **413** mounted on the loom crankshaft C. A tension spring **411***a* holds the cam follower **412** in yielding contact with the cam.

The lay sword D of the loom is secured at its lower end to a rock shaft D^1 and carries a bracket B (FIG. 21) having a guide opening for the lower part of the connecting rod **405**, thus keeping the pivotal axis at **406** in line with the lay sword, so as to avoid error due to the motion of the sword as the lay rocks. As shown in FIG. 20, the cam **413** is at that point in the cycle at which the crankshaft is 25° in advance of front center.

The yarn-presenting needle PR and the means for actuating it are generally similar to the yarn-receiving needle RE and the parts associated with the latter as heretofore described. Corresponding parts, pertaining to the respective needles are herein designated by the same numerals except that in some instances the numerals for designating the corresponding parts associated with the needle PR have the superscript *a*.

The tip of the needle PR (FIGS. 4*a*, 10*a* and 10*b*) is of approximately the same external contour as that of the needle RE, but instead of a relatively large yarn-receiving port at its tip, like the port **161** of the needle RE, the needle PR has a semicircular recess **169***m* in its tip, of a radius, for example, of the order of one-sixteenth of an inch, and a narrow slot intersecting the recess **160***m* for the reception of oppositely movable jaws **420**, **421** (FIG. 10*b*), each jaw having a recess **422** (FIG. 10*c*) at its inner corner defining a quadrant of the yarn-receiving opening. The jaws are at the ends of two levers **423**, **424**, respectively, pivoted at **425** and **426** and having tail portions **427**, **428** which are connected to an actuating rod **163***a* by links **429**, **430**. A coiled spring **431** urges the jaws apart. As shown in FIGS. 10*a* and 10*b*, the tip portion of the needle has an outwardly flaring throat opening **160***x* which, when the jaws **420** and **421** are separated, as shown in FIG. 10*b*, leads to the yarn-receiving recess **160***m*.

As here illustrated (FIGS. 13, 14 and 15), the loom is provided with a color selector CS and a filling-end holder and cutter F^{10}, the color selector being designed to present yarns of different colors, or differing in other characteristics, to the needle PR, as controlled by a pattern chain or equivalent device, the color selector being provided with a plurality of pairs of relatively movable, yarn-holding jaws which may be selectively positioned, in accordance with the pattern control, to dispose the end of any yarn, held be one of said pairs of jaws, in operative relation to the open jaws of the needle PR. Each of these sets of jaws comprises a pair of jaws operative, at times, to clamp a yarn leading from a supply, and a cutter jaw operative, at the proper time, to sever a yarn at a point adjacent to the filling-end holder.

When the needle PR is fully retracted, its tip portion **160***a* is spaced outwardly from the selvage of the cloth, indicated diagrammatically at SV in FIG. 14, and is so disposed that a filling yarn F, extending from a source of supply and passing through guide eyes G^1 and G^2 to one pair of yarn-holding jaws **212**, is tensioned to enter through the flaring throat **160***x* until it is within the semicircular recess **160***m* and between the opposed edges of the open jaws of the needle PR.

The color selector CS may be of generally conventional type and, as here shown, comprises a segment **210** (FIGS. 13 and 14) pivotally supported on a shaft **211** and to which the movable jaw of each of the several pairs of yarn-holding jaws is fixed. Each movable jaw, for example the jaw **212** (FIG. 13), is pivotally connected to one end of a slidable actuator rod **213** which is urged toward jaw-closing position by a spring **214**. For closing the jaws of any selected pair, there is provided a plunger **215** (FIG. 14) (engageable with the end of the rod **213** of that pair of jaws which has been selected) which is actuated by a rocker member **216** FIGS. 13 and 14 pivotally supported at **217** and having an arm which is connected by a rod **219** (FIGS. 13, 14 and 16) to the free end of a lever **220** (FIG. 13) pivotally supported at **221** and which has a cam follower element **222** engageable with a cam **223** fixed to a shaft **224** which is driven by suitable connections (not shown) to turn in time with the loom crankshaft.

The segment **210** which supports the several pairs of color selector jaws is provided with a crankarm **225** (FIG. 13) which is connected by a rod **226** to one arm **226***a* of a bell-crank lever pivoted at **228** to a fixed support and having a second arm **229** which is connected by a rod **230** to a suitable pattern-controlled device (not shown).

For example, the rod **230** may correspond to the rod "19" of the mechanism disclosed in the patent to Payne, No. 3,101,098, dated August 20, 1963. By this means any desired one of the pairs of color selector jaws may be brought into the position relative to the tip of the needle PR as indicated in FIG. 14.

The yarn holder and cutter F^{10} (FIGS. 13 and 14) comprises a fixed clamping jaw **231** carried by a slide bar **232**, and a movable jaw **233** pivotally supported at **234** and having an actuating arm **235** (FIG. 13) which is connected to a slidable rod **236** (FIG. 13). The rod **236** is guided to slide in bearing brackets **236***x* and **236***y* on the slide bar **232** which is mounted on the breast-beam. A bell-crank lever (FIG. 13), fulcrumed at **237** (FIG. 13) on a fixed part, has an arm **238** provided with a slot **239** The other arm **241** of the bell-crank lever is pivotally connected to the lower end of a rod **242** whose upper end is pivotally connected to a lever **243** having a cam follower **244** which engages a cam **246** on the shaft **224**. This cam is so contoured as to move the yarn holder, as a whole, toward and from the loom reed. Two adjustable dogs **246***a* and **247***a* are mounted on the rod **236** and disposed at opposite sides of a fixed stop **247** (FIG. 14) thereby moving the rod **236** relatively to the slide bar **232** as the latter is moved toward and from the reed and thus operating to open and close the jaws of the yarn holder.

The shaft **211** on which the segment **210** is mounted and the shaft **217** (FIG. 14) on which the rocker **216** is mounted are carried by a slide **260** (FIG. 16) mounted on the breast beam. This slide is moved toward and from the reed by a bell-crank lever (FIG. 13), fulcrumed at **262** on a fixed support, the arm **261** of which is connected to the slide **260**. The other arm of this bell-crank lever is connected by a rod **263** to a lever **264** which is fulcrumed at **265** on a fixed support and which has a cam follower element **266** which engages a cam fixed to the shaft **224**.

In accordance with the present invention, the transfer of the filling end from the needle PR to the needle RE at the transfer point is insured by directing a jet of air from the needle PR toward the yarn-receiving port **161** in the end of needle RE, while concomitantly creating suction at said yarn-receiving port. This pneumatic action may be provided by delivering compressed air from any suitable source to the interior of the needle PR as the latter approaches the transfer point and by connecting the needle RE to a vacuum pump or other source of low pressure as the latter needle approaches the transfer point. For this purpose, the interiors of the hollow needles may be connected by means of flexible tubing or its equivalent to a source of compressed air and vacuum respectively, with valves, of any suitable and/or conventional type, responsive to the motion of the needle carriers **105** and **105***a* respectively, for opening the valves as the needles approach the transfer point and for closing them as the needles begin to retract. However, it is preferred, in accordance with the present invention, that the motion of the needles themselves create the desired pressure and vacuum.

Thus, as illustrated diagrammatically in FIG. 24, the needle PR is hollow and provided with air inlet ports **300** near tis rear or outer end so that the interior of the needle communicates with the space between the outer surface of the needle and the interior of the holder **116***a*. This space is provided near its front or inner end with a normally closed conventional check valve Y. In this view, the walls of the holder and needles are indicated by single lines, and the cross-hatched areas represent air filled spaces.

The space within the holder **116***a* to the rear of the block **151***a* is vented to the atmosphere at A^1.

In the same way, the hollow needle RE is open at its rear end to the space within the holder **116** and the latter has vent ports **301** near its forward or inner end, and at its rear or outer end is closed except for the provision of a normally closed check valve of conventional type indicated at X.

As above described, the holder for the needle RE (FIG. 8) is provided at its forward end with an internal eccentric guide bushing **150** for guiding the needle and the rear end of the needle is closed by a block **151** which slides within the holder **116**.

When the needle RE advances, the block **151**, acting like a piston, creates low pressure behind it since no air can enter through the closed check valve X, while air can escape freely through the vents **301** in the side of the needle holder. Thus low pressure is created at the rear of the needle, with consequent suction at the needle tip so as to draw the yarn into the orifice **161** in the tip. When the needle retracts, air is driven out through the check valve X and enters freely through the vents at the side of the needle holder, although some air may be driven out from the tip of the needle, thus clearing the passage.

When the needle PR advances, its block **151***a* (FIG. 9), acting like a piston, compresses air before it within the needle holder, the check valve Y now being closed and so air enters the needle through the holes **300** in the side of the needle and is discharged as a jet at the top of the needle. When the needle PR is retracted, its piston **151***a* pushes air out through the check valve Y while air freely enters through the lateral vent ports.

GENERAL OPERATION

Referring to the timing diagram (FIG. 24), the sequence of operations of the needle loom is as follows: When the crankshaft is approximately at bottom center, both needles PR and RE are in retracted position with the jaws of needle PR open; the harness has begun to change; the filling holder clamps the yarn end; and the color selector clamps and cuts the filling. As the crankshaft continues on toward the front center, the needle RE releases the end of filling which it has pulled through the shed; the color selector is fully retracted and holding the new end of filling; and as the crankshaft passes the forward center, the filling holder, now in retracted position, releases the yarn and the jaws of the needle PR close on the filling. When the jaws of the needle PR close, the yarn is gripped within the opening **160***m* and as the color selector releases the yarn and retreats, a short end or "tail" of yarn is left projecting from the end of the needle PR. As the crankshaft approaches the top center, the harness change is completed and as the crankshaft reaches top center both needles start inwardly through the open shed. As the crankshaft now continues toward the back center the needles continue to move in and at the time when the crankshaft has reached the back center, the tips of the needles are at the transfer point where they are from one-fourth to one-eighth of an inch apart. The tail T of filling (FIG. 4*b*) projecting from the jaws of the needle PR is instantly directed toward the port **161** in the tip of needle RE (a jet of compressed air issuing from the tip of needle PR) and is drawn into the needle RE by suction, and is gripped by the clamping device **162**. An instant thereafter, the jaws of the needle PR release the filling and are locked in open position as the needle PR retreats. The needles now begin to retract and reach their fully retracted position when the crankshaft has arrived at the bottom center, the needle RE now releasing filling end, while the needle PR is now in retracted position with its jaws open in readiness to take another filling end from the selector.

Details of operation of needle PR

Starting with the lay L at front center, the needle PR is now retracted and the nipper jaws **420**, **421** are open as shown in FIG. 10*b*. The selected filling is now disposed, as shown in FIG. 14, with its end portion extended, and under tension between the nipper jaws of needle PR. At

this time, slide **190***a* (FIG. 11) at the right-hand side of the loom will be moved by the cam (corresponding to the cam **213**, FIG. 20) to push the tappet **180***a* to the left, that is, to the position shown in FIG. 8, thus moving the rod **163***a* toward the center of the loom or to the left and closing the nipper jaws on the filling. It will be noted that the jaws **420**, **421** are narrow and seize the filling at a distance from its extreme end and that a short length or tail T (FIG. 4*a*) of filling projects beyond the closed jaws.

It is to be noted that the nipper jaws are now locked due to the fact that the toggle linkage was pushed past dead-center. In so doing, the toggle linkage compressed the spring **174***a* (FIG. 8) which acts against the support for the fulcrum pivot of the bell-crank lever.

As the loom crankshaft now moves to top center the needle PR starts moving through the open shed carrying the clamped filling end. When the crank reaches the back center the needle PR is at the end of its forward stroke with its tip in the middle of the shed in juxtaposition to but spaced from the tip of the needle RE and with the short tail T of filling projecting from the jaws. At this time, slide **190***a* (FIG. 11) is moved by its actuating cam toward the outside of the loom or to the right (FIG. 11). As the slide thus moves the part **189***a* (FIG. 9) contacts the arm **177***a* of the bell-crank and pushes the bell-crank in the clockwise direction until the pivot B*a* passes the dead-center, whereupon the spring **174***a* snaps the linkage to the dotted line position (FIG. 9) and opens the nipper jaws. Then, when the crank, in continuing to turn, reaches the bottom center, the needle PR will have been returned to the retracted position, the nippers remaining open until the front center position is again resumed.

Details of operation of needle RE

With the lay L at the front center, the needle RE is in retracted position (FIG. 4*b*), with the filling gripping plug **162** spaced from the conical seating surface at the inside of the needle tip, so that the port **161** is open. As the loom crankshaft moves to top center, the needle RE starts to enter the open shed. When the crank reaches back center, the needle RE is at the end of its forward stroke, and the free tail T of filling, which now projects from the jaws of the needle PR (FIG. 4*a*), is presented to the needle RE. This free tail of the filling at this time projects directly forwardly from the nipper jaws, due to an air jet discharged from the needle PR and, because vacuum is now created at the port **161** in the needle RE, this tail of filling is drawn into the port **161**. Now the cam **413** on the crankshaft C, operating through its linkage, pushes slide bar **190** toward the outside of the loom or to the left (FIG. 12), thus moving rod **186**, the bell-crank and toggle link into the full line, locked position shown in FIG. 8. This moves the gripper plug **162** to clamp the filling end against the conical seat surface at the inside of the tip of the needle RE. The crank now moves to bottom center thus retracting the needle RE and completing the travel of the filling end through the shed.

Just before the crank reaches front center and while the lay is about ¾ of an inch away from the fell of the cloth, the cam **413**, through its linkage, moves slide bar **190** toward the center of the loom or to the right. This pushes tappet **180** against the arm **177** of the bell-crank and thus breaks the toggle linkage to allow the spring **164** to retract the plug **162** and release the filling.

While one desirable embodiment of the invention has herein been disclosed by way of example, it is to be understood that the invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A needle loom of the kind comprising a yarn-carrying needle, having yarn-gripping jaws designed to receive and hold conventional limp filling yarn, means for actuating said jaws to seize an end portion of a pick of filling yarn at one side of the loom and advance said end portion of the filling yarn, with a short terminal length thereof projecting forwardly from between the gripping jaws, to a yarn transfer point approximately midway across the loom, and a yarn-receiving device, comprising rigid yarn-clamping elements, which receives said terminal length of filling from said needle at the transfer point and completes its advance to the opposite side of the loom, means for supporting and moving said needle comprising a carrier, guided for movement longitudinally of the lay, a needle holder mounted upon and normally fixed to the carrier, the needle being slidable within said holder, means for moving the carrier with the holder thereon from one side of the loom toward the other side, means operative to move said needle relatively to the holder in the same direction as the carrier but at a relatively greater speed, and means operative to transfer said terminal length of filling from the needle to the yarn-receiving device while the latter is at the transfer point but spaced from the needle.

2. The combination according to claim **1**, further characterized in that the means for moving the yarn-receiving device and needle is so devised that, when the yarn-receiving device is at the limit of its motion from one side of the loom toward the other side, the tip of the needle and the yarn-receiving device are spaced apart.

3. The combination according to claim **1**, wherein for moving the needle, relatively to the holder, the carrier supports two sheaves turning about parallel axes and located, respetcively, near opposite ends of the holder, a flexible band embracing both sheaves, said band comprising parallel runs, means attaching one of said runs to the needle, and means for attaching the other of said runs to the lay whereby, as the holder moves relatively to the lay, the effective length of the band, between its point of attachment to the needle and the respective sheaves, varies.

4. In combination, in a needle loom comprising a lay and which is of the kind which has means located at one side of the loom for holding an end of a pick of filling yarn, and a tubular needle operative to take said end from the holding means and carry it part-way, only, across the shed to a transfer point, said needle comprising relatively movable jaws for gripping the yarn end, and means, comprising parts housed within the tubular needle, operative to open said jaws to receive the yarn end from the holding means, means to close the jaws and for locking them in closed position as the needle moves to the transfer point; and to open the jaws when they arrive at the transfer point thereby to release the yarn end.

5. The combination according to claim **4**, further characterized in that yarn-holding means is so located, relatively to the fully retracted needle, that it is operative to position the end portion of a selected pick of filling yarn so that it extends, under tension, between the open jaws of the gripping means with a short length of the yarn located between the holding means and the bite of the jaws when the latter close.

6. In combination, in a needle loom of the kind which has means located at one side of the loom for holding one end of a pick of filling yarn, and a needle operative to take said end from the holding means and carry it part-way, only, across the shed to a transfer point, said needle comprising relatively movable jaws for gripping said yarn end, means operative to open said jaws to receive said yarn end from the holding means, means for closing the jaws and for holding them in closed position as the needle moves to the tranfer point, and means operative to open the jaws when they arrive at the transfer point thereby to release said yarn end wherein the means for opening the gripper jaws comprises a spring, and wherein the means for closing the jaws comprises a toggle linkage, said linkage being so designed that, when the jaws are closed, the linkage is in locked position, further characterized in having means

operative, as the jaws arrive at the transfer point, for unlocking the toggle linkage.

7. In combination, in a needle loom of the kind which has means located at one side of the loom for holding an end of a pick of filling yarn, and a needle operative to take said end from the holding means and carry it part-way, only, across the shed to a transfer point, said needle comprising relatively movable jaws for gripping the yarn end, means operative to open said jaws to rereive the yarn end from the holding means, means for closing the jaws and for holding them in closed position as the needle moves to the transfer point, and means operative to open the jaws when they arrive at the transfer point thereby to release said yarn end, wherein the needle which carries the yarn end toward the transfer point has a yarn-guiding opening in its tip and a slot which intersects said opening, a pair of relatively movable jaws in said slot operative, when closed, to clamp a yarn within the opening, the tip having a yarn-guiding throat which opens into said yarn-guiding opening when the jaws are open, and means operative, when the jaws are open and the needle is in retracted position, to draw a tensioned yarn inwardly through the throat and into said opening.

8. A shuttleless loom according to claim 4, further characterized in having yarn-holding and cutting means operative to hold and cut each of a plurality of yarns of different characteristics, respectively, pattern means operative to select that one of said yarns, held by the yarn changer, which is to be presented to the needle, and means for moving the yarn changer bodily from an inoperative position to a position such as to dispose the selected yarn between the open jaws of the needle.

9. A shuttleless loom according to claim 8, further characterized in having a yarn end holder disposed between the yarn changer and the line which is the locus of the selvage edge of a woven web, during normal operation of the loom, said holder having a pair of relatively movable yarn-gripping jaws and a yarn cutter for each individual yarn end, means for moving the holder bodily from an inoperative position toward yarn-holding position, and means for moving the gripping jaws and cutters of the yarn holder.

10. In combination, in a needle loom of the kind which has means located at one side of the loom for holding an end of a pick of filling yarn, and a needle operative to take said end from holding means and carry it part-way, only, across the shed to a transfer point, said needle comprising relatively movable jaws for gripping the yarn ends, means operative to open said jaws to receive said yarn end from the holding means, means for closing the jaws and for holding them in closed position as the needle moves to the transfer point, and means operative to open the jaws when they arrive at the transfer point thereby to release said yarn end, a yarn changer operative to hold a plurality of yarns of different characteristics respectively, pattern means operative to select that one of said yarns, held by the yarn changer, which is to be presented to the needle, and means for moving the yarn changer bodily from an inoperative position to a position such as to dispose the selected yarn between the open jaws of the needle, a yarn end holder disposed between the yarn changer and the selvage edge of the woven web, said holder having relatively movable yarn-gripping jaws, means for moving the holder bodily from an inoperative position toward yarn-holding position, and means for relatively moving the jaws of the yarn holder, wherein the yarn changer and the yarn holder are mounted, respectively, upon slide members movable transversely of the lay, and cams mounted on a shaft which turns in accurately timed relation to the rotation of the crankshaft for moving said slides and for actuating the jaws of the yarn changer and the yarn holder.

11. The combination according to claim 1, further characterized in that the yarn-receiving device is a second needle, coaxial with the first, and arranged to convey the yarn from the transfer point across the remainder of the shed, means substantially like that which supports, guides and moves the first needle for actuating the second needle, the second needle moving oppositely to the first needle, the means for moving the needles being so devised that at the transfer point the ends of the needles are spaced apart, and pneumatic means for transferring the terminal length of filling, released from the open jaws of the first needle, to the second needle.

12. A needle loom according to claim 1, further characterized in that the yarn-receiving comprises a second needle coaxial with the first, a tubular holder for said second needle, a carrier guided for movement longitudinally of the lay on which said last-named holder is mounted, means for moving the second-named carrier from one side of the loom toward the opposite side, and means operative to move the second needle relatively to its holder in the same direction as the carrier on which its holder is mounted but at relatively greater speed, the means for moving the carriers comprising a single endless cable and means for moving the cable alternately in opposite directions, the stroke of the cable being such that, in approaching each other, the tips of the needles never contact..

13. A needle loom according to claim 12, further characterized in that the means for moving the cable comprises relatively movable parts so adjustable as to vary the location of the transfer point.

14. A needle loom according to claim 1, having two oppositely directed, axially aligned yarn-carrying needles with their yarn-holding ends opposed to each other, a carrier for each respective needle mounted upon and movable longitudinally of the lay, means for moving said carriers toward each other simultaneously until the yarn-carrying ends of the needles are closely adjacent but spaced apart at a yarn transfer point approximately midway between the ends of the lay, means operative so to deliver the end portion of a pick of soft, limp filling yarn to the yarn-holding end of one of said needles, while the latter is in retracted position adjacent to one end of the lay, that a short length of the filling yarn projects from the end of said needle, and means operative to transfer said projecting yarn end to the other needle while they are at the transfer point, and means operative to release the yarn end from the needle to which it is last delivered when said latter needle is in retracted position adjacent to the side of the loom.

15. A needle loom according to claim 14, wherein the means for moving the two carriers comprises a single endless cable passing about sheaves mounted upon the lay, and means for moving said cable in opposite directions during each successive cycle of operation of the loom, said cable comprising runs which cross each other at a point intermediate said carriers and having two other runs to which the two carriers, respectively, are attached.

16. The combination according to claim 14, wherein the needle which first takes the yarn has relatively movable yarn-gripping jaws and the needle which takes the yarn from the first needle has a yarn-receiving orifice, and means for gripping the end of a yarn which enters said orifice.

17. In a needle loom of the kind wherein a crankshaft, turning once for each weaving cycle, carries a cam for rocking a lay, and wherein a yarn-carrying needle, mounted on and movable longitudinally of the lay, take an end of a single pick of filling at one side of the loom and carries it to a transfer point intermediate the sides of the loom, means operative to receive said end of filling at the transfer point and complete its traverse to the opposite side of the loom, means for supporting and moving the needle comprising a carrier mounted upon and movable longitudinally of the lay-beam, a tubular needle holder mounted on and normally fixed to the

carrier, a needle slidable within said holder, and means actuated by the crankshaft for reciprocating the carrier to move from one side of the loom toward the other and then back again during each rotation of the cam shaft, the means for reciprocating the carrier comprising a sector mounted to rock upon a supporting member, a cam fixed to the crankshaft, and means actuated by said cam for rocking the sector back and forth once for each revolution of the crankshaft, and an endless cable which passes about guide sheaves mounted on the lay, said cable having a run which is fixed to the carrier and having a second run which is fixed to the sector whereby, as the latter rocks, the cable is pulled first in one direction and then in the other, and means operative, during each cycle of motion of the carrier, to advance the needle relatively to the holder as the carrier moves from one side of the loom toward the other and to retract it within the holder as the carrier moves in the reverse direction.

18. A needle loom of the kind which comprises means for advancing the end of a pick of filling yarn through the open shed to a transfer point intermediate the ends of the lay, and a needle which receives the yarn end at the transfer point and completes its advance to the opposite side of the loom, characterized in that the needle which takes the yarn at the transfer point has a hollow tip of smooth semielliptical external shape and a yarn receiving orifice at its end, the inner surface of said hollow tip being of truncated conical contour, and a yarn-gripping element comprising a plug, arranged within said hollow tip and having a spherically curved surface operable to make a line contact with said truncated conical surface, the plug having an axial guiding stem, and a spring which urges the plug toward said truncated conical surface to prevent withdrawal of a yarn end which has entered the orifice.

19. A needle loom of the kind wherein a needle takes the end of a pick of filling yarn and carries it to a transfer point, and a second needle receives the yarn end from the first needle at the transfer point and completes its travel to the opposite side of the loom, and comprising means operative to advance both needles simultaneously toward the transfer point until, at their closest point of approach, the ends of the needles are spaced apart a distance of from ⅛ to ¼ of an inch and then immediately to retract both needles from the transfer point, and means operative to transfer the end of a soft, limp filling yarn from one needle to the other while the needles are at the transfer point, characterized in that the needle which receives the yarn at the transfer point is hollow and has a yarn-receiving orifice at its end, a yarn-clamping element operative, at times, to close said orifice and thereby clamp a yarn end, which has been entered into the orifice by the transfer means, against the inner surface of the needle, spring means operative, while the needle is approaching the transfer point, to hold the clamping element in retracted position thereby to permit a yarn to be entered into the orifice by the transfer means, and means operative, before the needle begins to retract from the transfer point, to move the clamping element to yarn-clamping position.

20. A needle loom of the kind wherein a needle takes the end of a pick of filling yarn and advances it to a transfer point, and a second needle receives the yarn end at the transfer point and completes its advance to the opposite side of the loom, characterized in that the needle which takes the yarn at the transfer point is hollow and has a yarn-receiving orifice at its end, means within said hollow needle operative to prevent withdrawal of a yarn end which has entered the orifice, said means comprising relatively movable, cooperating rigid elements designed to grip a yarn between them, one of said elements being annular; within the needle; and coaxial with said orifice, and the other of said elements being within the needle and movable axially of the needle and being such as to make a line contact with said annular element, spring means urging said movable element toward the annular element, and means operative to retract the movable element from the relatively fixed annular element and for positively locking it in retracted position.

21. In combination, in a needle loom of the kind having means operative to take the end of a filling pick at one side of the loom and carry it to a transfer point approximately midway between the sides of the loom where a needle receives the end of said filling pick and carries it to the opposite side of the loom, and wherein the needle which takes the yarn end at the transfer point is hollow and has a yarn-receiving orifice at its end, a movable yarn-clamping element within said hollow needle operative to prevent withdrawal of a yarn end which has entered the orifice, spring means tending to retain said clamping element in inoperative position thereby to permit a yarn end to enter said orifice, means operative, so to actuate said clamping element as the needle begins to retract from the transfer point, as to clamp and hold the yarn end within the orifice as the needle retracts, and means operative, when the needle is fully retracted, to release the clamping element so that it may be retracted from the orifice by the spring.

22. The combination according to claim **21**, wherein the means for placing and holding the clamping element in operative position comprises a toggle linkage, means for so actuating the toggle linkage, when the needle is at the transfer point, as to move the clamping element to operative position thereby to clamp the end of the yarn and to dispose the toggle linkage in locked position, and means operative, at the completion of the retraction of the needle from the transfer point, to unlock the toggle linkage and thereby to permit the spring to retract the clamping element from the yarn-receiving orifice.

23. The combination according to claim **22**, further characterized in that the actuating means for the toggle linkage is so devised as to accommodate the apparatus to the weaving of cloth of different widths.

24. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon a lay and guided to slide longitudinally of the lay, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said needles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at a transfer position, means operative to position the yarn-gripping means of the other needle, as the latter approaches the transfer point, to receive the end of yarn released from the gripping means of the first-named needle, means operative to transfer said released yarn to the yarn-gripping means of the second-named needle, and means operative to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft to the grippig means of each of the respective needles in properly timed relation.

25. A shuttleless loom according to claim **24**, further characterized in having positive locking means operative to keep the yarn-gripping means of each respective needle closed in yarn-gripping position while the respective needle is performing its yarn-carrying function.

26. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon the loom lay and guided to slide longitudinally of the lay toward and from a transfer point, intermediate the ends of the lay, at which the yarn-carrying ends of the needles are closely juxtaposed, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said nee-

dles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at the transfer position, means operative to close the gripping means of the other needle when the latter is at the transfer point thereby to grip a yarn end received from the first-named needle and to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft for actuating the gripping means of each of the respective needles in properly timed relation, and wherein the motion-transmitting means for actuating the gripping means of each respective needle comprises a toggle linkage, means for so actuating each respective toggle linkage as to lock the yarn-gripping means of each respective needle in yarn-gripping position while the needle is performing the yarn-carrying function, and means for unlocking the toggle linkage when each respective needle has completed its yarn-carrying motion.

27. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon the loom lay and guided to slide longitudinally of the lay toward and from a transfer point, intermediate the ends of the lay, at which the yarn-carrying ends of the needles are closely juxtaposed, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said needles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at the transfer position, means operative to close the gripping means of the other needle when the latter is at the transfer point thereby to grip a yarn end received from the first-named needle and to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft for actuating the gripping means of each of the respective needles in properly timed relation, and wherein the motion-transmitting means for actuating the gripping means of each respective needle comprises a toggle linkage, means for so actuating each respective toggle linkage as to lock the yarn-gripping means of each respective needle in yarn-gripping position while the needle is performing the yarn-carrying function, and means for unlocking the toggle linkage when each respective needle has completed its yarn-carrying motion, and wherein the means for locking and unlocking the toggle linkage comprises a power-driven rotary cam which makes one revolution for each weaving cycle.

28. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon the loom lay and guided to slide longitudinally of the lay toward and from a transfer point, intermediate the ends of the lay, at which the yarn-carrying end of the needles are closely juxtaposed, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said needles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at the transfer position, means operative to close the gripping means of the other needle when the latter is at the transfer point thereby to grip a yarn end received from the first-named needle and to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft for actuating the gripping means of each of the respective needles in properly timed relation, and wherein the motion-transmitting means for actuating the gripping means of each respective needle comprises a toggle linkage, means for so actuating each respective toggle linkage as to lock the yarn-gripping means of each respective needle in yarn-gripping position while the needle is performing the yarn-carrying function, and means for unlocking the toggle linkage when each respective needle has completed its yarn-carrying motion, and means for locking and unlocking the toggle linkage comprises a power-driven rotary cam which makes one revolution for each weaving cycle, further characterized in having means for transmitting motion from the rotary cam to the toggle linkage, comprising relatively movable parts adjustable, in accordance with the width of the cloth to be woven.

29. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon the loom lay and guided to slide longitudinally of the lay toward and from a transfer point, intermediate the ends of the lay, at which the yarn-carrying ends of the needles are closely juxtaposed, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said needles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at the transfer position, means operative to close the gripping means of the other needle when the latter is at the transfer point thereby to grip a yarn end received from the first-named needle and to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft for actuating the gripping means of each of the respective needles in properly timed relation, and wherein the motion-transmitting means for actuating the gripping means of each respective needle comprises a toggle linkage, means for so actuating each respective toggle linkage as to lock the yarn-gripping means of each respective needle in yarn-gripping position while the needle is performing the yarn-carrying function, and means for unlocking the toggle linkage when each respective needle has completed its yarn-carrying motion, and wherein the toggle linkage for actuating and locking the yarn-gripping means of each respective needle is located within the respective needle, and wherein, for actuating the toggle linkage of each respective needle, there is mounted upon the loom lay a longitudinally slidable bar which is moved back and forth by a cam on the crankshaft, and a pair of spaced dogs on each of said bars operative, as the bar moves in opposite directions, to lock and unlock the toggle linkage.

30. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon the loom lay and guided to slide longitudinally of the lay toward and from a transfer point, intermediate the ends of the lay, at which the yarn-carrying ends of the needles are closely juxtaposed, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said needles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at the transfer position, means operative to close the gripping means of the other needle when the latter is at the transfer point thereby to grip a yarn end received from the first-named needle and to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft for actuating the gripping means of each of the respective needles in properly timed relation, and wherein the motion-transmitting means for actuating the gripping means of each respective needle comprises a toggle linkage, means for so actu-

ating each respective toggle linkage as to lock the yarn-gripping means of each respective needle in yarn-gripping position while the needle is performing the yarn-carrying function, and means for unlocking the toggle linkage when each respective needle has completed its yarn-carrying motion, and the means for locking and unlocking the toggle linkage comprises a power-driven rotary cam which makes one revolution for each weaving cycle, and wherein the toggle-actuating dogs on the slidable bar are relatively adjustable longitudinally of the bar thereby to provide for the accurate timing of the locking and unlocking of the toggle linkage.

31. A shuttleless loom of the kind wherein a crankshaft makes one revolution for each weaving cycle and wherein two coaxial yarn-carrying needles, each having a yarn-carrying end, are mounted upon the loom lay and guided to slide longitudinally of the lay toward and from a transfer point, intermediate the ends of the lay, at which the yarn-carrying ends of the needles are closely juxtaposed, the yarn-carrying end of each respective needle being provided with yarn-gripping means, means operative to close the yarn-gripping means of one of said needles when the latter is fully retracted thereby to grip the end of a yarn presented to said gripping means and to open said gripping means and release said yarn end when said first-named needle is at the transfer position, means operative to close the gripping means of the other needle when the latter is at the transfer point thereby to grip a yarn end received from the first-named needle and to open the gripping means to release the yarn end when the second-named needle is fully retracted, and means for transmitting motion from the crankshaft for actuating the gripping means of each of the respective needles in properly timed relation, and wherein the motion-transmitting means for actuating the gripping means of each respective needle comprises a toggle linkage, means for so actuating each respective toggle linkage as to lock the yarn-gripping means of each respective needle in yarn-gripping portion while the needle is performing the yarn-carrying function, and means for unlocking the toggle linkage when each respective needle has completed its yarn-carrying motion, and wherein the toggle linkage for actuating and locking the yarn-gripping means of each respective needle is located within the respective needle, and wherein, for actuating the toggle linkage of each respective needle, there is mounted upon the loom lay a longitudinally slidable bar which is moved back and forth by a cam on the crankshaft, and a pair of spaced dogs on each of said bars operative, as the bar moves in opposite directions, to lock and unlock the toggle linkage, further characterized in that the bar which carries the toggle-actuating dogs is provided with means whereby the spacing of the dogs may be adjusted to correspond with variations in the width of the woven web thereby to determine the time of actuation of the toggle linkage to correspond to the width of the weft being woven.

32. In a shuttleless weaving loom of the kind which comprises a yarn-carrying device operative to carry the end of a filling pick part of the way, only, across the shed to a transfer point, and a second yarn-carrying device operative to take said end at the transfer point and complete the travel of said end across the shed, the first-named of said devices comprises relatively movable jaws for gripping the yarn end, means operative to open and close said jaws, means for so presenting a yarn end to said jaws, when the latter are open, that when the jaws close the extreme end of the yarn will extend as a freely movable tail from said jaws, and means operative to urge said tail toward the second of said devices when both devices are at the transfer point.

33. The combination according to claim 32, wherein the means for closing the jaws comprises a toggle linkage operative to lock the jaws in closed position as the yarn-carrying device completes its advance motion, and means operative automatically, when the yarn-carrying device reaches the transfer position, to unlock said toggle and thereby permit the jaws to open.

34. The combination according to claim 32, comprising means for opening said jaws when the device is in fully retracted position in readiness to receive a yarn between them, and means for closing said jaws immediately before said yarn-carrying device begins its advance toward the transfer position.

35. In a shuttleless weaving loom of the kind which comprises a yarn-carrying device operative to carry an end of a filling pick part of the way, only, across the shed to a transfer point, and a second yarn-carrying device operative to take said end at the transfer point and complete the travel of said end across the shed, wherein the second-named of said devices has a yarn-receiving orifice, further characterized in having means operative to induce the inflow of air at said orifice as said second device arrives at the transfer point thereby to draw the yarn end into said orifice, and further characterized in having a movable closure for said yarn-receiving orifice, and means whereby, as said yarn-carrying device begins to retreat from the transfer point, said closure is actuated to close the port and thereby grip a yarn end which has been drawn into the port.

36. In a shuttleless weaving loom of the kind which comprises a yarn-carrying device operative to carry an end of a filling pick part of the way, only, across the shed to a transfer point, and a second yarn-carrying device operative to take said end at the transfer point and complete the travel of said end across the shed, wherein the second-named of said devices has a yarn-receiving orifice, further characterized in having means operative to induce the inflow of air at said orifice as said second device arrives at the transfer point thereby to drawn the yarn end into said orifice, and wherein, for closing the yarn-receiving orifice, there is a plug which is normally urged toward open position by a spring, and wherein the means for moving said plug toward port-closing position comprises a toggle linkage operative positively to hold said plug in orifice-closing position while the yarn-carrying device is completing its retracting stroke.

37. The combination according to claim 32, wherein the first of said yarn-carrying devices is guided, in moving toward or from the transfer position, by relatively movable elements, one of which is a piston working in a cylinder, said elements being so constructed and arranged that, as the first-named yarn-carrying device moves toward the transfer point, the piston compresses air within the cylinder, and means for discharging the air thus compressed as a jet from the yarn-carrying end of said device.

38. The combination according to claim 32, wherein the second of said yarn-carrying devices is guided, in moving toward or from the transfer position, by relatively movable elements, one of which is a piston working in a cylinder, said elements being so constructed and arranged that, as said second yarn-carrying device advances toward the transfer position, the piston acts to create subatmospheric pressure within the cylinder such as, by suction, to drawn a yarn end, presented by the first of said devices, into operative engagement with the second of said devices.

39. A needle loom of the kind wherein two axially aligned needles are moved toward and from each other once for each weaving cycle, one needle carrying one end of a single strand of filling yarn from one selvage to a transfer point and the other needle taking said end of filling yarn at the transfer point and carrying it to the opposite selvage, characterized in that each needle has a hollow blunt nose having an orifice at its tip, yarn-clamping means housed within the nose of each needle, said clamping means comprising at least one movable jaw and a part with which said jaw cooperates for gripping the yarn, means within each needle for locking said movable jaw in closed position thereby positively to grip the yarn, means for so simultaneously moving the needles toward each other that, at their nearest point of approach, the

tips of their noses are spaced apart a distance not substantially exceeding ¼ inch, and means operative to move a yarn end, released from the clamping means of the first-named needle, across the space between said tips and to place said yarn end within the field of action of the movable jaw of the other of said needles.

40. A needle loom according to claim **39**, wherein for moving the yarn end from one needle nose to the other the first needle comprises means for delivering a jet of compressed air from its nose while the second needle comprises means for creating suction at the yarn-receiving orifice of its nose.

41. In a shuttleless weaving loom of the kind which comprises a yarn-carrying device comprising mechanical, yarn-gripping means operative to grip and carry the end of a pick of soft, limp filling part of the way, only, across the shed to a transfer point and then to release said end, and a second yarn-carrying device comprising mechanical, yarn-gripping means operative to grip and take said end at the transfer point and complete the travel of said end across the shed, and means operative to move the mechanical, yarn-gripping means of the respective yarn-carrying devices into close but spaced relationship at the transfer point, in combination, pneumatic means operative to transfer said end from the first of said devices to the second of said devices while said devices dwell at the transfer point.

42. The combination according to claim **41**, further characterized in having means operative to deliver a jet of air as said devices arrive at the transfer point, so directed as to urge the end of the yarn, released from the mechanical, yarn-gripping means of the first of said devices, toward the second of said devices.

43. In a shuttleless weaving loom of the kind which comprises a yarn-carrying device having mechanical, yarn-gripping means operative to carrying the end of a filling pick part of the way, only, across the shed to a transfer point, and then to release said end, and a second yarn-carrying device having mechanical, yarn-gripping means operative to take said end at the transfer point and complete the travel of said end across the shed, wherein the second-named of said devices has a yarn-receiving orifice, further characterized in having means operative to induce the inflow of air at said orifice as said second device arrives at the transfer point thereby to draw the yarn end released from the mechanical, yarn-gripping means of the first-named yarn-carrying device into said orifice.

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ROBERT R. MACKEY, *Acting Primary Examiner.*

DONALD W. PARKER, *Examiner.*