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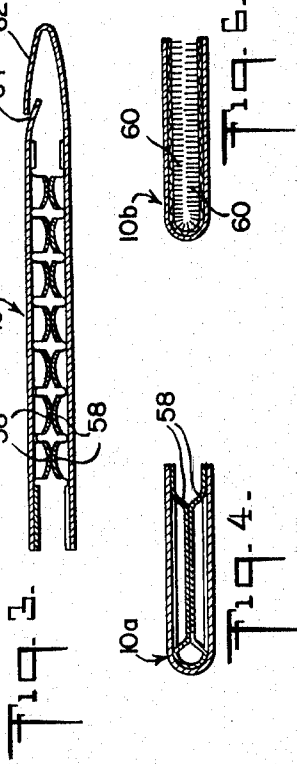
R. H. ROSSMANN

3,263,705

WEAVING METHOD AND LOOM

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11 Sheets-Sheet 1



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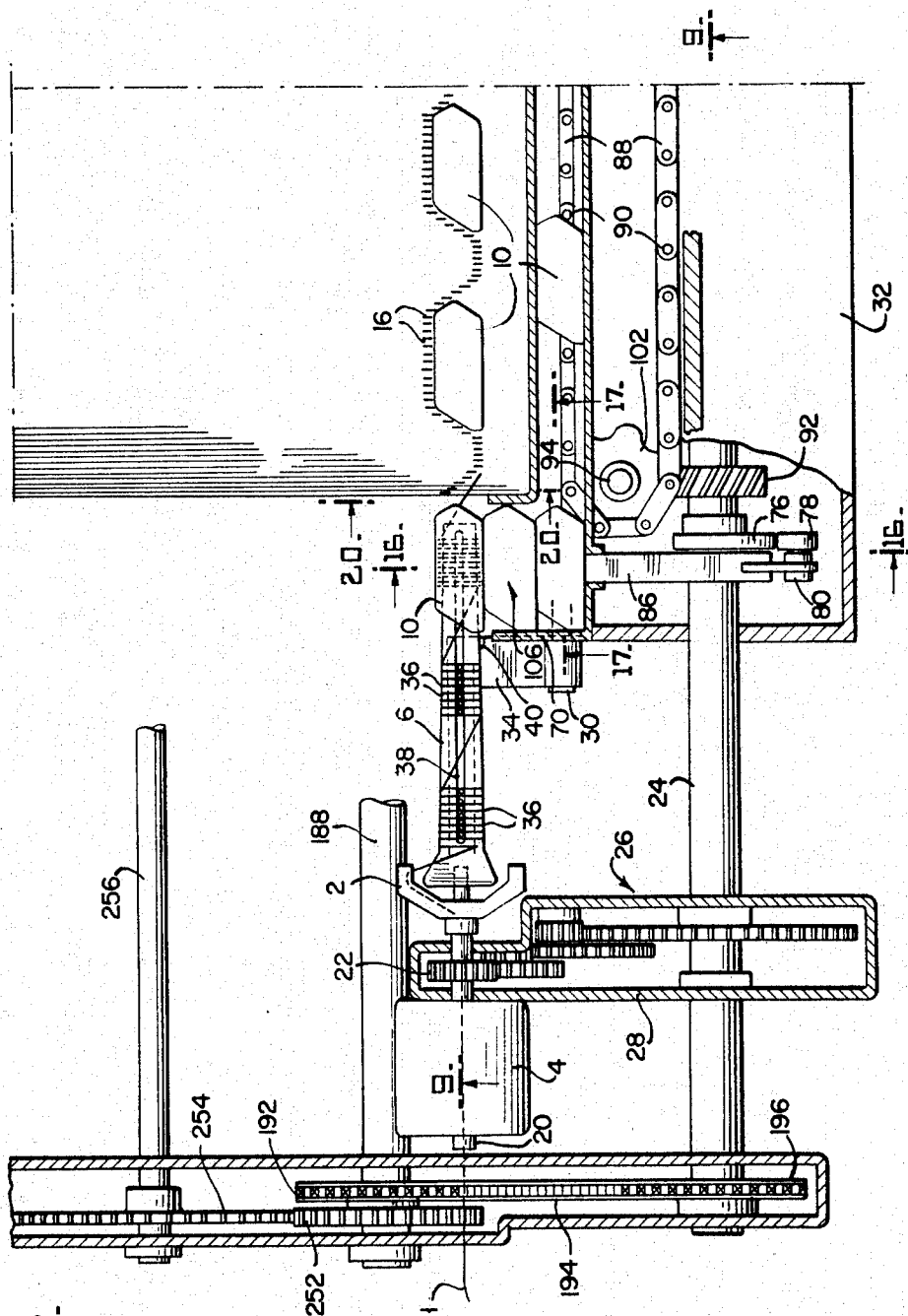
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WEAVING METHOD AND LOOM

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11 Sheets-Sheet 2



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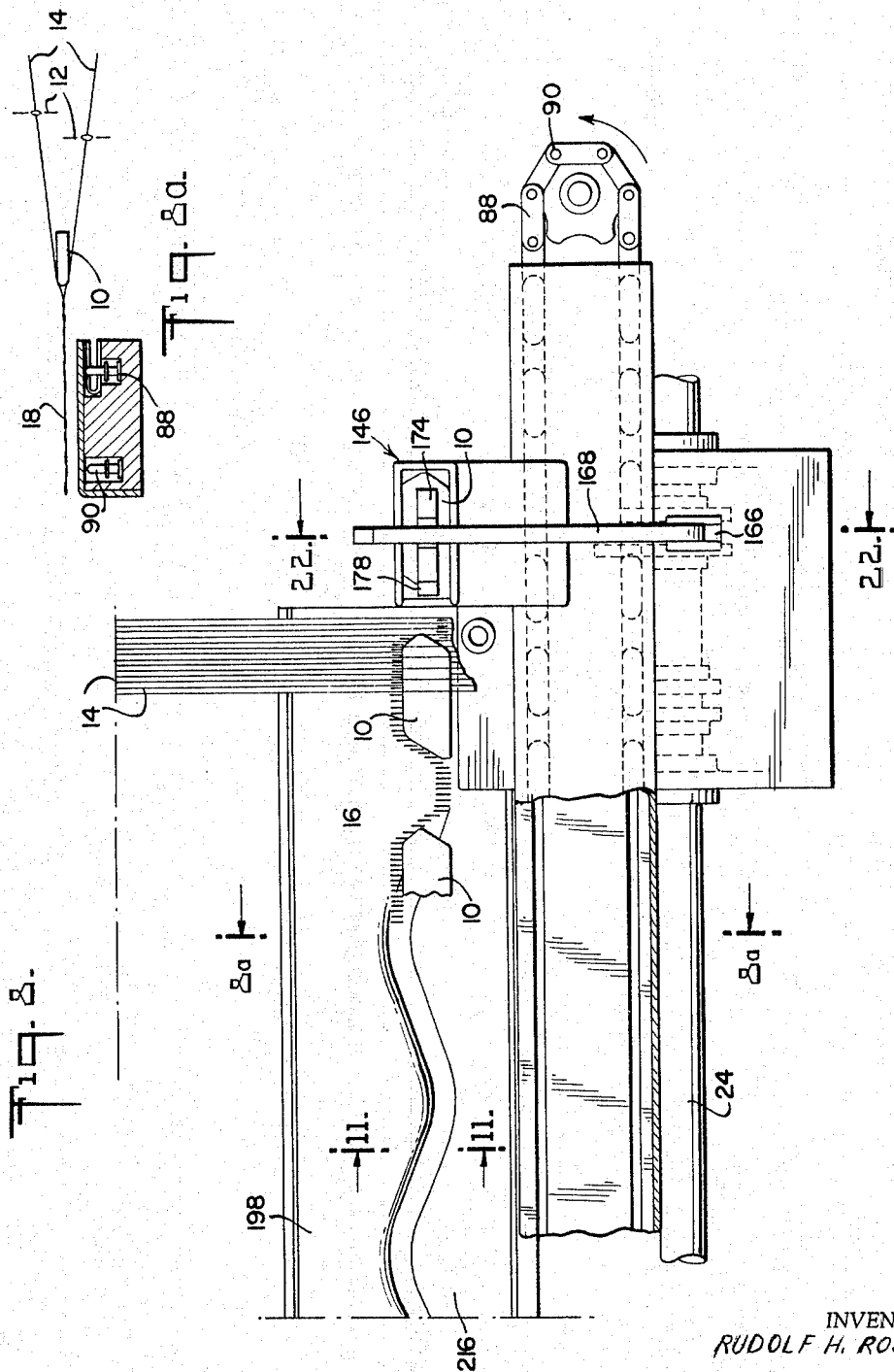
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11 Sheets-Sheet 3



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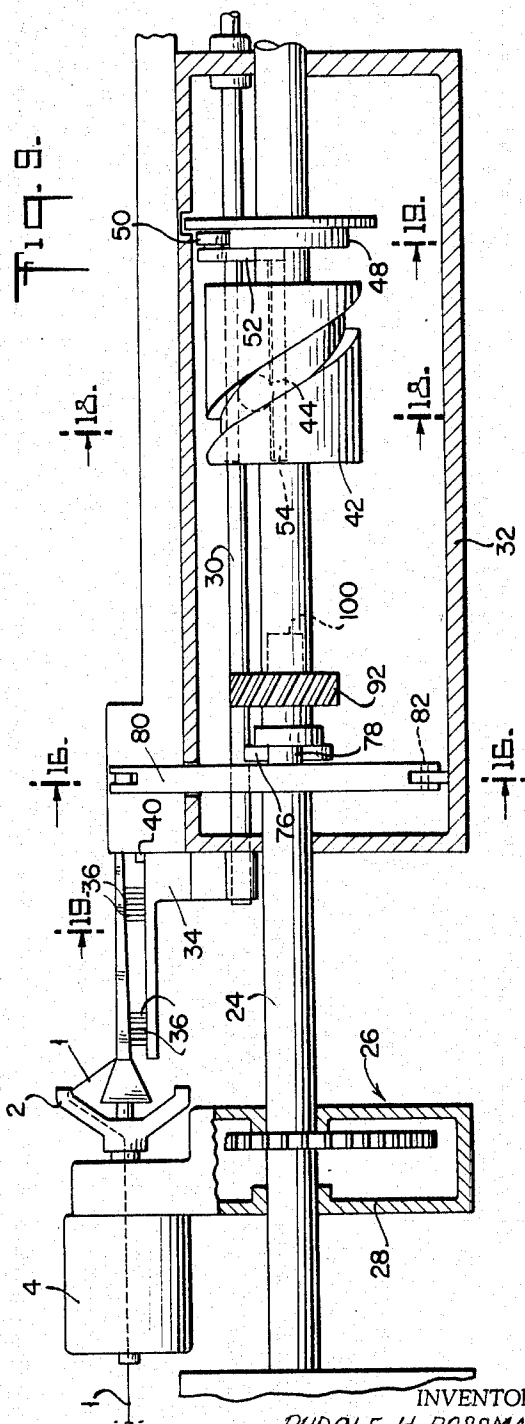
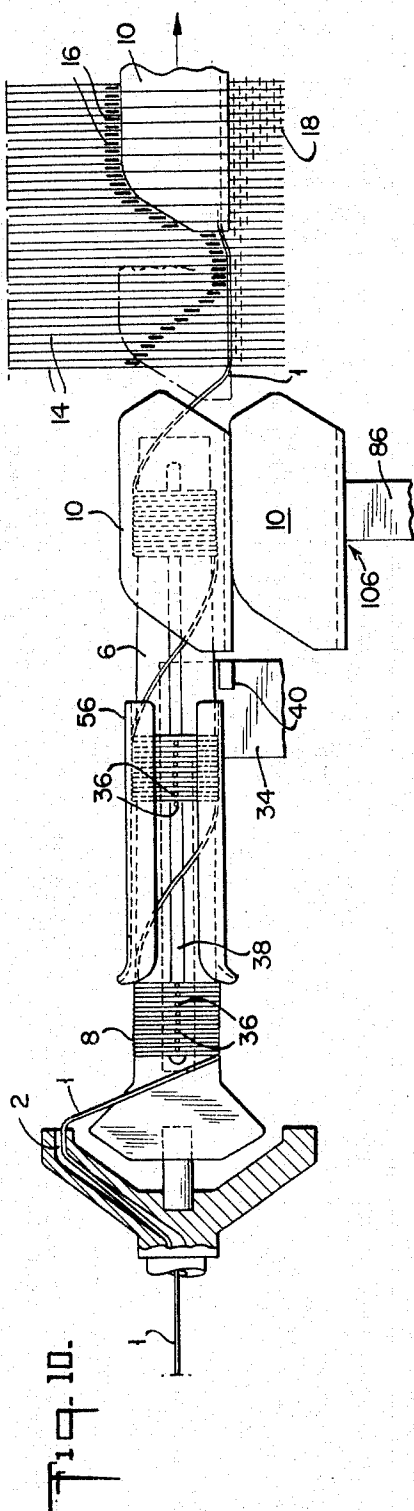
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WEAVING METHOD AND LOOM

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11 Sheets-Sheet 4



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Fig. 14.

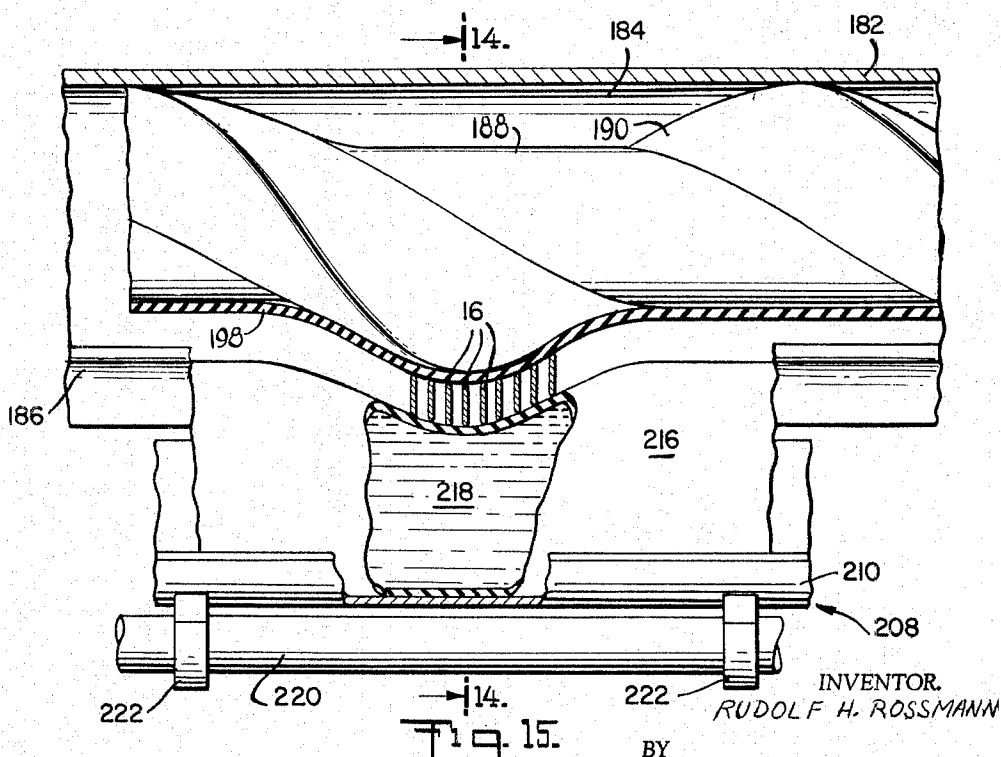
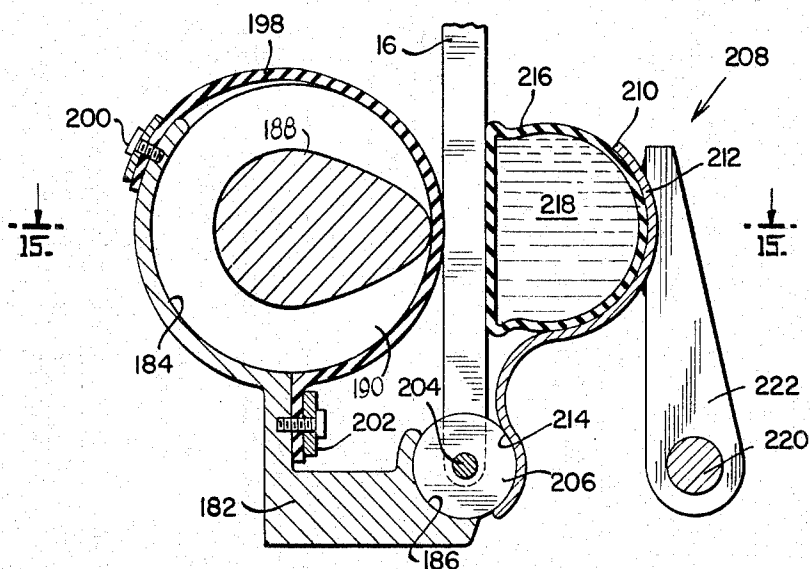


Fig. 15.

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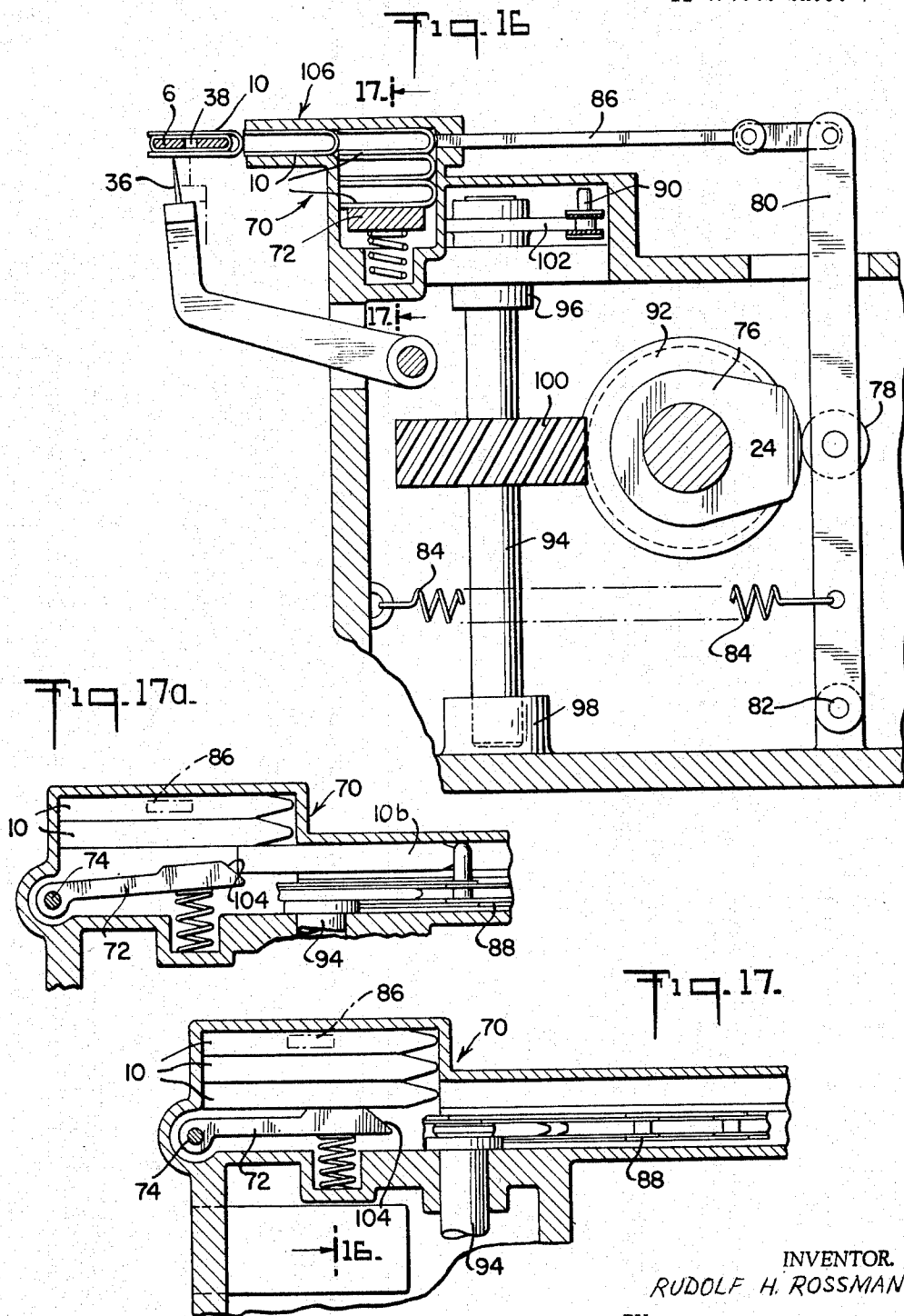
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11 Sheets-Sheet 7



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Fig. 18.

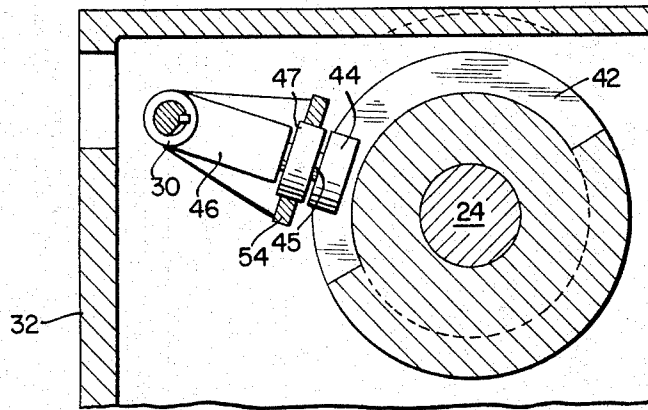


Fig. 19.

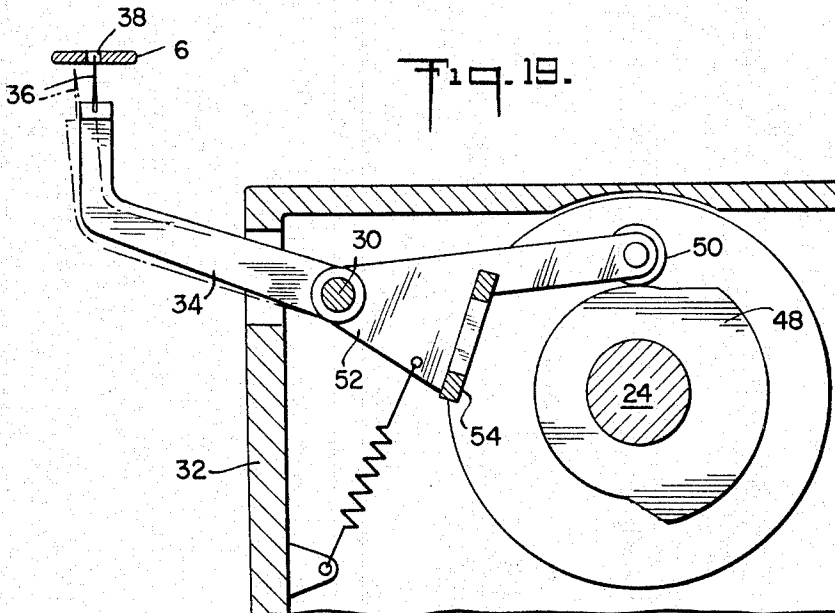


Fig. 20.

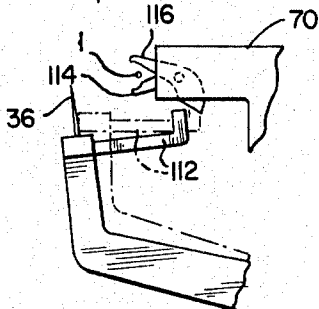
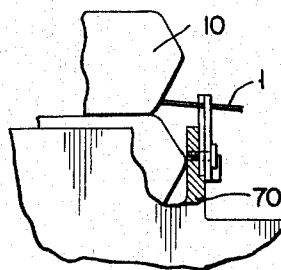


Fig. 21.



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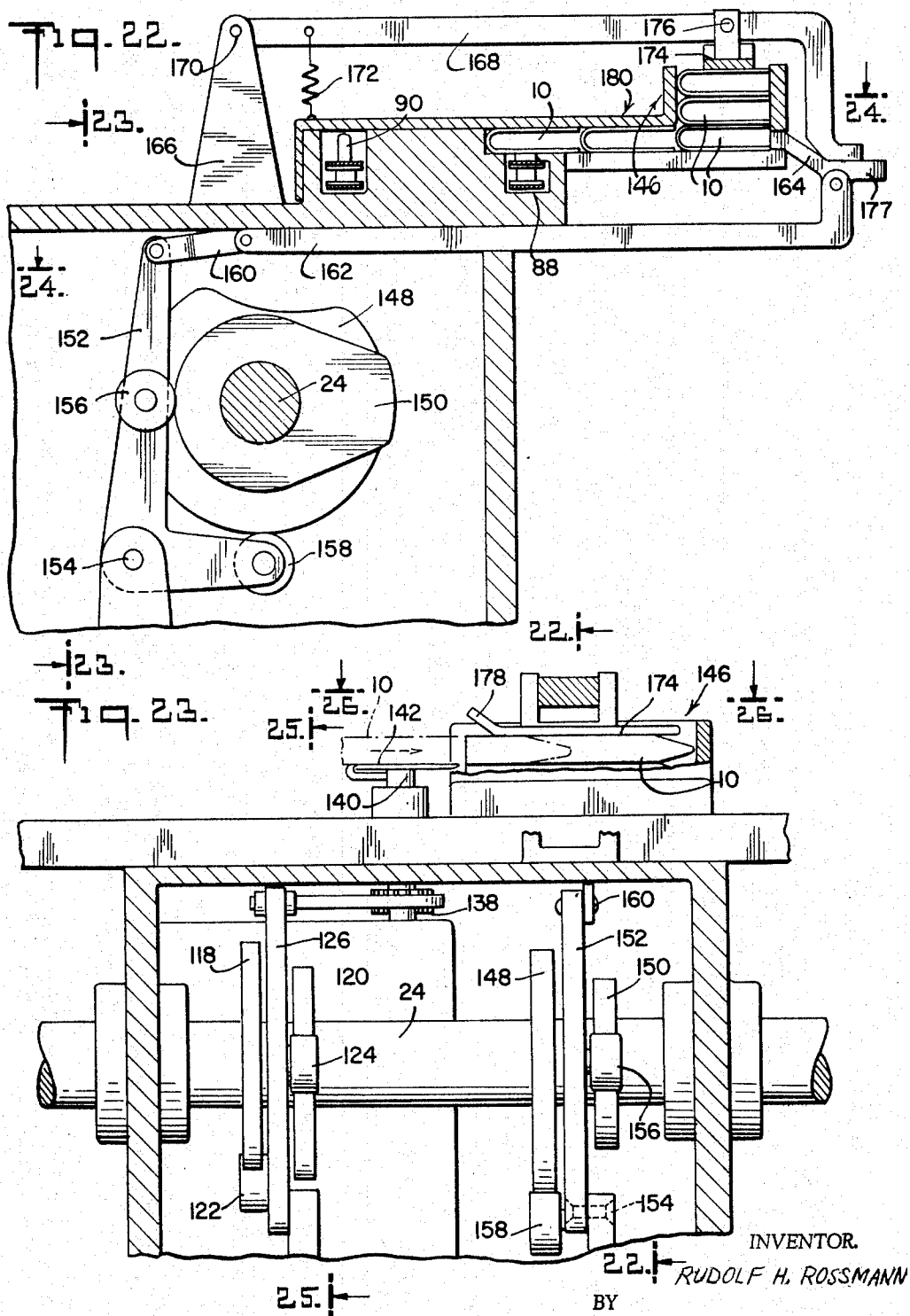
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11 Sheets-Sheet 9



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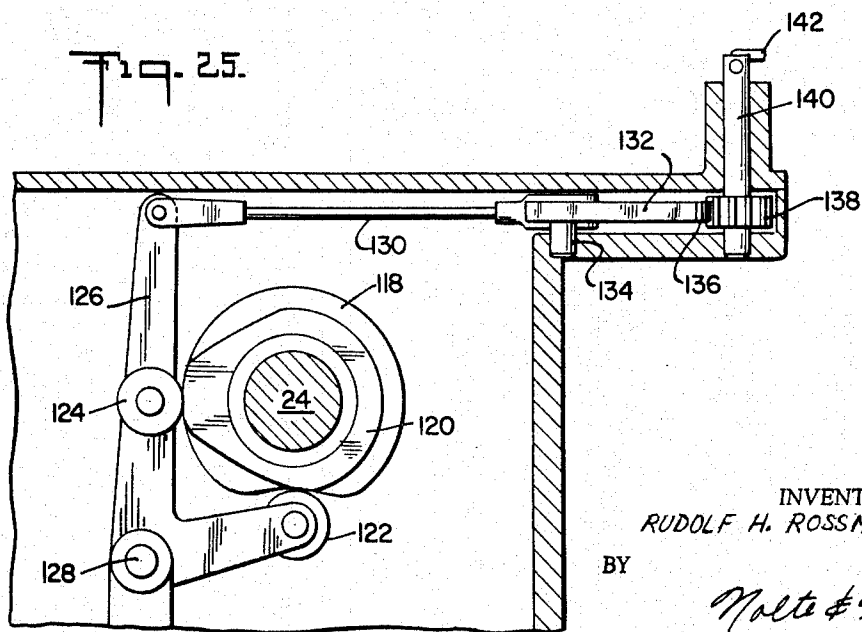
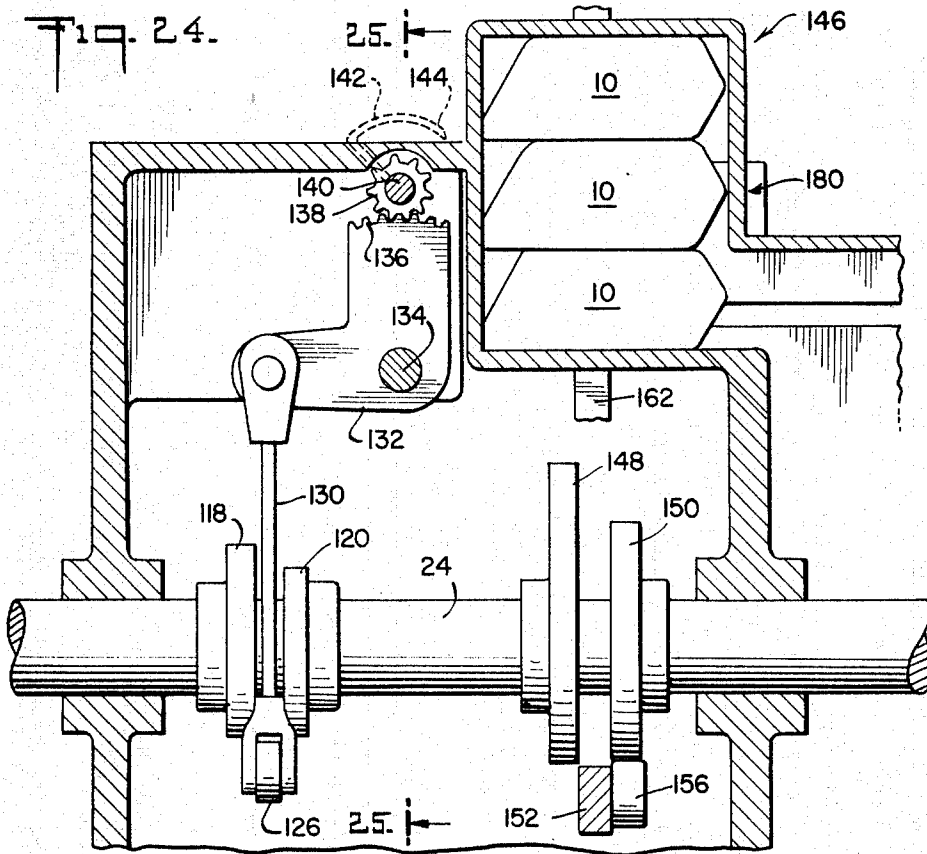
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11 Sheets-Sheet 10



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Fig. 26.

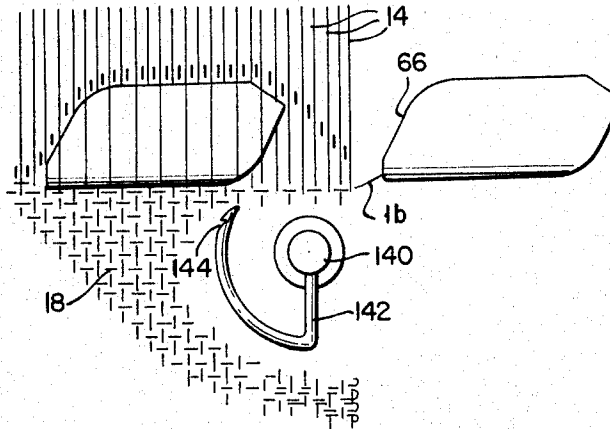


Fig. 27.

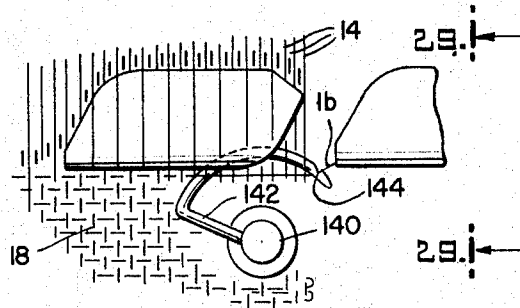


Fig. 28.

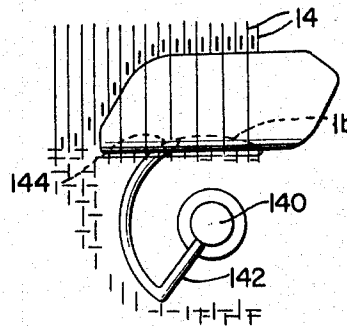
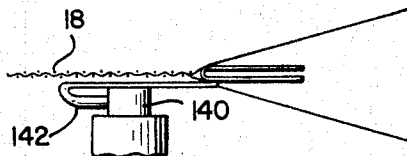


Fig. 29.



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WEAVING METHOD AND LOOM
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Filed Nov. 23, 1962, Ser. No. 239,677
33 Claims. (Cl. 139—12)

This invention relates to a new and improved method and apparatus for weaving textiles and the like, more particularly to a weaving method and apparatus wherein a plurality of shuttles are moving simultaneously through the shed. This is a continuation-in-part of copending application for U.S. Letters Patent, Serial No. 822,871, filed on June 25, 1959, now abandoned.

It has been heretofore suggested that techniques be used whereby a plurality of shuttles are sequentially and simultaneously moving through the warp threads for the picking of the weft, but such methods have not been put to practice due to a variety of difficulties. One of these difficulties is the need for charging each shuttle with short weft threads substantially corresponding to the width of the material to be woven. Another difficulty resides in the problem of driving the plurality of shuttles through a shed constantly changing between the traveling shuttles. The various heretofore proposed solutions included the provision of the shuttles with a substantial number of teeth which, upon the movement of the shuttle would catch a thread from below and insert it into the shuttle but the resulting arrangement was too complicated. For the shuttle drive it has been proposed to apply pressure through the warp threads from the outside of the shed, but this leads to warp thread breakage and similar other complications.

With the above disadvantages in view, it is an object of the present invention to provide a novel method of weaving which is more efficient than prior art weaving methods.

It is another object of the invention to provide a novel weaving method whereby a plurality of shuttles is moved simultaneously through the width of material to be woven, the shed being constantly changed between the moving shuttles.

According to another object of the invention, novel means is provided for charging each shuttle with a shuttle charge of filling thread and driving the shuttles through the shed.

According to the invention, individual shuttle charges of weft thread are formed, the length of the thread comprising each shuttle charge substantially corresponding to the width of the material to be woven. The formed shuttle charges are subsequently charged into shuttles according to the invention. The charged shuttle is subsequently pushed into the first shed opening where it starts its journey throughout the width of the material. According to the invention, furthermore, the batten reeds of the apparatus are pivoted independently of each other and are driven so as to describe a continuous traveling wave motion throughout the width of the material to be woven, whereby, beside beating up the weft thread continuously released from the plurality of shuttles traveling through the alternating sheds, the reeds also serve to drive the shuttles across the material.

As each shuttle leaves the shed at the opposite edge of the material than where it entered, the empty shuttles are automatically returned outside the fell material to the other side ready to be charged with another shuttle charge of weft yarn.

The selvage on the entrance or input side of the shuttle can be formed by severing the overhanging weft thread of the previous shuttle only after this end has been carried into the shed by a subsequent shuttle. On the output

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edge of the material the selvage can be formed by a needle adapted to pull the loose end of the weft thread picked by the shuttle just leaving the shed, pull the loose end into the shed before the weft thread from a subsequent shuttle is being beaten up against the fell.

The novel shuttle according to the invention is substantially of an elongated U-shape, open at its rear end and one side whereby it can be simply pushed onto the end of a shuttle charge forming blade, resulting in the formed shuttle charge being deposited and retained within the interior of the shuttle. The shuttle charge is retained within the shuttle in a manner whereby it can easily pay out the weft thread as the shuttle travels throughout the moving shed.

The reeds, each disposed between the warp threads, are individually but coaxially pivoted. The traveling wave-like motion for beating up the weft and forwarding the shuttle is accomplished by a novel drive, to be called the progressing cavities drive, whereby the reeds are disposed between a liquid-filled hose and a rotating shaft having a helix thereon. As the shaft with its helix is rotated, the liquid-filled hose, sealed at its ends, constantly conforms to the progressing helix of the rotating shaft, creating a complementarily progressing traveling wave-like protrusion of the liquid-filled hose bulging into the deep portions of the progressing helix. The reeds disposed between the liquid-filled hose and the rotating helix conform to the instantaneous contour of the corresponding portion of the liquid-filled hose. The shuttles are formed with a sloping rear end, so that the pressure of the constantly driven reeds against the sloping rear end of the shuttle causes same to move constantly forward paying out the weft thread into the shed.

The constant changing of the shed in conformity with the traveling wave-like motion of the reeds is accomplished by a plurality of heddles, which instead of being mounted in harness frames as on conventional weaving machines, are here individually mounted from spiraling guide-rods. The spiral of the guide-rods is formed in conformity with the helix of the reed driving shaft, so that the alternating adjacent sheds are formed substantially synchronously with the corresponding reed-and-shuttle-position.

Further features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings showing a preferred embodiment of the invention, wherein:

FIG. 1 is a diagrammatic perspective view illustrating the forming of the shuttle charges, charging the shuttles and moving same through the shed;

FIG. 2 is a plan view of one embodiment of a shuttle, with parts shown broken away;

FIG. 3 is a longitudinal sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a transverse section taken along line 4—4 of FIG. 2;

FIG. 5 is a fragmentary perspective view of the nose portion of a shuttle according to the invention;

FIG. 6 is a cross-sectional view taken across another embodiment of a shuttle according to the invention;

FIGS. 7 and 8 are plan views of the left and the right sides respectively, of a loom according to the invention, with parts broken away and parts omitted for clarity;

FIG. 8a is a schematic showing of the relative positions of the fell, warp threads and the shuttle return mechanism;

FIG. 9 is a cross-sectional view taken along the approximate broken plane 9—9 of FIG. 7;

FIG. 10 is a fragmentary, enlarged plan view of the shuttle charge forming and shuttle charging parts shown in FIG. 7;

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FIG. 11 is a fragmentary, sectional, perspective view taken approximately along the line 11—11 of FIG. 8, with parts broken away;

FIG. 12 is a cross-sectional view taken along the line 12—12 of FIG. 11, illustrating the heddles, with parts omitted for clarity;

FIG. 13 is a cross-sectional view taken along the line 13—13 of FIG. 12, showing the heddle drive;

FIG. 14 is an enlarged fragmentary sectional view taken along the line 14—14 of FIGS. 11 and 15, showing the progressing cavities drive for the reeds;

FIG. 15 is a plan sectional view taken along the line 15—15 of FIG. 14, showing the progressing cavities drive for the reeds;

FIG. 16 is a cross-sectional view, taken along the line 16—16 of FIGS. 7 and 9, showing the shuttle magazine and its charging mechanism on the input side of the shed;

FIG. 17 is a cross-sectional view, taken along the line 17—17 of FIGS. 7 and 16, showing the shuttle magazine in its loaded state;

FIG. 17a is a fragmentary view similar to that of FIG. 17, with a returning shuttle being pushed into the magazine;

FIG. 18 is a cross-sectional view taken along the line 18—18 of FIG. 9, showing the helical cam controlling the linear movement of the porter pusher needle supporting extension plate;

FIG. 19 is a cross-sectional view taken along the line 19—19 of FIG. 9, showing the cam controlling the tilting movement of the porter pusher needle supporting plate;

FIG. 20 is a side elevational view of one embodiment of an optional weft cutting mechanism taken approximately along the line 20—20 of FIG. 7;

FIG. 21 is a plan view of the mechanism shown in FIG. 20, with parts broken away;

FIG. 22 is a cross-sectional view taken along the line 22—22 of FIGS. 8 and 23, showing the shuttle removing and returning mechanism;

FIG. 23 is a cross-sectional view taken along the line 23—23 of FIG. 22;

FIG. 24 is a plan sectional view taken along the broken line 24—24 of FIG. 22, with parts broken away;

FIG. 25 is a cross-sectional view taken along the line 25—25 of FIGS. 23 and 24, showing the outlet selvage forming needle operating mechanism;

FIG. 26 is a fragmentary plan view taken along the line 26—26 of FIG. 23, with parts broken away;

FIGS. 27 and 28 show successive operating steps of the needle shown in FIG. 26; and

FIG. 29 is a fragmentary end view taken along the line 29—29 of FIG. 27, showing the position of the needle of FIGS. 26—28.

In describing the invention, like reference numerals refer to the parts throughout.

The basic principle of the weaving method according to the invention is best shown in FIG. 1, wherein a weft thread 1 is fed through an arm of a bifurcated flyer 2, which is adapted to be rotated by a driving motor 4 (FIG. 7). The flyer 2 rotates about a somewhat tapered stationary blade 6. The weft thread 1 is consequently wound around the blade 6. Individual shuttle charges 8 of the weft thread 1 are separated from each other as they are wound about the blade 6, the length of the weft thread comprising the porters substantially corresponding to the width of the material to be woven, the individual shuttle charges being gradually and periodically pushed along the blade 6 in the right hand direction along the slight taper of the blade. As a shuttle charge 8 approaches the right hand end of the blade 6, a shuttle 10 is pushed with an open end thereof onto the blade, thereby surrounding the porter 8 disposed at the right hand end of the blade.

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As heddles 12 create a shed opening in warp threads 14 adjoining the right hand end of the blade 6, the shuttle 10 containing the outermost porter 8 is pushed into the shed. A plurality of reeds 16 project between the warp threads 14, the reeds being driven in a continuous wave-like motion by means to be described in greater detail herein following. As a shuttle 10 enters the shed at the input side, in FIG. 1 at the left hand side thereof, the reeds 16 with their selectively guided motion begin to push the shuttle across the shed, while the heddles 12 create a synchronous progressing shed opening at a given shuttle position. As the shuttle 10 progresses through the material, the weft thread from the porter 8 contained therein is continuously paid out behind the shuttle, and beat up against the fell 18 by the reeds 16.

By the time a shuttle 10 has reached the output side of the material to be woven, in FIG. 1 shown at the right hand side thereof, the entire length of the shuttle charge 8 of the weft thread has been paid out and the shuttle is empty and it leaves the material, as shown in the right hand side of FIG. 1. At this point, a selvage can be formed at the edge of the fell 18. The empty shuttles 10 are then subsequently returned in the direction of the arrow and outside the fell to the other side of the loom to receive another porter 8 and start another weaving cycle as described above.

Formation of the shuttle charges

Motor 4 is adapted to drive the entire machine. The motor shaft 20 (FIG. 7) is hollow, and the flyer 2 is mounted directly at one end thereof. The weft thread 1 is threaded through the motor shaft 20 and the flyer 2, as shown by a dotted line in FIG. 7. The flyer 2 is rotated by the motor 4 at a relatively high speed. A gear 22, mounted for rotation on the shaft 20 is adapted to drive the main drive shaft 24 through a gear system 26. The motor 4 is mounted from the housing 28, in which are journaled also the components of the gear system 26 and the main drive shaft 24. As shown in FIGS. 7, 9, 10, 18 and 19, a pusher rocker shaft 30, adapted both for rocking and for movement in the axial direction, is journaled in a housing 32. An L-shaped extension 34 is made integral with or keyed onto the shaft 30, the extension 34 being provided with shuttle charge pushing needles 36, adapted to selectively protrude through an elongated opening 38 in the blade 6, and a shuttle pusher member 40. (FIGS. 7 and 10.)

As shown in FIGS. 9, and 18 a helical cam 42 is adapted to be rotated by the main drive shaft 24. A rotating cam follower 44, for contacting the helical cam 42, is journaled onto a shaft 45 of a driving arm 46 which is keyed to the pusher rocker shaft 30. Also, rotatably journaled on the shaft 45 is an idler roller 47. The driving arm 46 is keyed to the pusher rocker shaft 30, thereby providing axial motion to the shaft.

Also mounted on the main drive shaft 24 is a cam 48 (FIG. 19), the cam surface of which is contacted by a follower 50. The cam follower 50 is journaled in one end of a rocker arm 52, the other end of which is floatingly mounted on pusher rocker shaft 30. A connecting member 54 (FIGS. 18 and 19) is attached at its one end to the rocker arm 52. The connecting member 54 is bifurcated at its end facing the driving arm 46, the inside surfaces of the bifurcated arms being adapted to contact the idler roller 47. The bifurcation of the connecting member 54 is suitably long, so as to provide contact between the arms of the member and the idler 47 at all axial positions of the pusher rocker shaft 30 as driven by the helical cam 42. The rocker arm 52 remains in the same axial position relative to the cam 48, while the pusher rocker shaft 30 may slide back and forth in the floating mounting. The angular movement of the pusher rocker shaft 30, as caused by the cam 48, is transmitted to the driving arm 46 by the bifurcated connecting member 54 and the idler roller

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47 contacting it at all axial positions of the pusher rocker shaft. Through this connecting member 54, the movement of the cam follower 50 is transmitted to the pivot rocker shaft 30, thereby causing an angular, rotational displacement thereof, consequently, also a movement of the L-shaped extension 34.

In operation, as a sufficient length of the weft thread 1 is wound on the blade 6 by the rotating flyer 2, the follower 50 reaches the lower portion of the cam 48 and the rocker arm 52 imparts an angular tilting motion to the pusher rocker shaft 30 and the L-shaped extension 34 thereof, whereby it will pivot upward from the dotted line position to the solid line position shown in FIG. 19 and the shuttle charge pushing needles 36 penetrate between the turns of a shuttle charge 8 having just been wound on the blade 6 by the flyer 2. The preferred taper of the blade 6 is to assure the free movement of the porters and turns of weft thread in the desired, slightly taperingly narrowing direction. Due to the action of the helical cam 42, the pusher rocker shaft 30 and the L-shaped extension 34 with its shuttle charge pushing needles 36 starts to move in the right hand direction as shown in FIG. 9, and the needles 36 engaging a shuttle charge 8 move the porter correspondingly along the blade 6. In this manner, each shuttle charge 8 is intermittently moved along the length of the blade 6 in the right hand direction. Since the plurality of shuttle charges disposed at one time simultaneously on the blade 6 are connected to each other with a length of connecting weft thread, as shown in FIG. 10, a guard 56 may be placed at least around the edges of the blade 6 to prevent the unraveling or entanglement of the weft thread 1 forming the shuttle charges. If desired, in the alternative, the r.p.m. of the flyer 2 may be adjustably controlled to assure a greater control over the shuttle charge forming operation. Similarly, the blade 6 may be mounted so as to be replaced by other blades allowing a greater control over the size of a porter and the number of turns of weft thread comprising a porter.

Shuttle charging and return, selvage formation

The construction of the individual shuttles 10 is described in reference to FIGS. 2-6. As shown in the cross-sectional views of FIGS. 3, 4 and 6, the shuttles 10a and 10b are preferably of an elongated U-shape, to be pushed over the blade 6 and an innermost shuttle charge 8 through the open side of the shuttle. The shuttles 10 may be made of molded plastic, metal, etc. In order to retain a porter within a shuttle 10a or 10b in the originally wound thread formation of the shuttle charge as it was on the blade 6, means are provided within the shuttles to gently press the shuttle charge threads together, but at the same time, have enough resilient action to permit the weft thread of the shuttle charge to be paid out into the shed as the shuttle moves along therein. In the drawings, two typical such retaining means embodiments are shown. In FIGS. 2-4, these means comprise slanting transverse steel fingers 58 disposed on the interior walls of the shuttle 10 in an opposed aligned relationship, whereby a shuttle charge disposed between them is gently compressed to retain its shape. A shuttle of a similar embodiment may contain only one set of steel spring fingers 58, disposed along one inner shuttle wall only, the opposing shuttle wall being the other compressing surface to hold the porters within. In FIG. 6 a shuttle 10b is shown wherein the shuttle charge retaining means comprises a relatively high pile fabric lining 60 on the interior walls of the shuttle, such as velvet or a high pile synthetic material.

The front 62 of the shuttle is formed with a slight point in the direction of the shuttle movement through the shed and the material forming the sidewalls of the shuttle is bent back along one side so as to enclose the shuttle from the front, as best seen in FIGS. 2, 3 and 5. As is apparent from FIG. 2, the printed portion of the shuttle

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has a curved, blunt configuration, and, as shown in FIG. 3, the lower shuttle sidewall curves upwardly to the pointed shuttle portion, so that the shuttle will slide readily through the shed without catching on warp threads. As the bent back portion of a shuttle sidewall on the front 62 partially overlaps the front of the opposing shuttle sidewall (FIG. 5) an opening 64 is provided between the overlapping sidewall portions. As shown in FIG. 2, the trailing edge 66 of the shuttle is formed with a slanting surface so that when the shuttle is in the shed and as the reeds 16 bear down on the trailing edge, the pressure of the reeds will cause the shuttle to move forward across the shed.

On the side of the loom where the shuttles are charged with the shuttle charges, i.e., the input side, the shuttles returned from the output side are being sequentially stored in a shuttle input magazine 70 (FIGS. 7, 16, 17 and 17a) to be delivered to pick up a shuttle charge again and move into the shed. In the input shuttle magazine 70 a spring loaded pressure device 72, pivoting at 74, urges a number of shuttles 10 upward against the upper wall of the input magazine. As best shown in FIG. 16, a cam 76 is mounted on the main drive shaft 24 for rotation therewith. A cam follower 78 is rotatably mounted in a follower arm 80 which is pivoted to the base of the machine at 82 and maintained against the surface of the cam 76 by a tension spring 84, anchored against the frame of the machine. The reciprocating end of the follower lever 80 opposite the pivot 82 is pivotally connected to a shuttle pushing member 86, the opposite end of which ranges into the shuttle input magazine 70.

The shuttles are returned from the output side by means of a return transfer chain 88, having periodically protruding transport members 90 thereon. A gear 92 is mounted for rotation with the main drive shaft 24. Mounted for rotation on a journal shaft 94, which is journaled in the frame of the housing at 96 and 98, is a gear 100, meshing with the gear 92. A sprocket gear 102 is shown mounted at the upper end of the journal shaft 94 for rotation therewith. As shown in FIG. 7, the sprocket 102 serves to drive the return transport chain 88.

The end of the spring loaded pivoting pressure member 72 facing towards the return transport chain 88 is formed with a slant 104, so that when the return transport chain by means of its member 90 returns a shuttle 10 (FIG. 17a), the pressure of the chain and its member 90 transmitted by the shuttle 10b upon the surface 104 will cause the member 72 to pivot against the bias of its spring and a shuttle is admitted to the bottom of the shuttle input magazine 70.

When the cam follower 78 rides on the lower portion of the cam 76, the action of the tension spring 84 will cause the shuttle pushing member 86 to push the topmost shuttle from the shuttle input magazine 70 into a stand-by position, indicated at 106 in FIGS. 7, 10 and 16. At the same time, a shuttle 10 which has been previously in the stand-by position at 106, is pushed over the blade 6 and a shuttle charge 8 thereon.

At this point, the shuttle disposed on the blade 6 covers a part of the elongated opening 38 thereon, so that the shuttle charge pushing needles 36 cannot contact the shuttle charge 8 within the shuttle on the blade for moving it forward, therefore, the shuttle pusher 40, integral with or affixed to the L-shaped extension 34, as best shown in FIG. 10, is provided to push a shuttle and a shuttle charge therein off the blade 6 into the shed opening upon the axial movement of the pusher rocker shaft, as above described.

As the shuttle with a shuttle charge therein is pushed by the shuttle pusher 40 into the shed, the reeds 16 take over the function of transporting the shuttle therein. Since the weft thread 1 of the previous shuttle has been already beaten up by the reeds against the fell and a new shed opening was formed by the heddles 12 for the next

entering shuttle, the uninterrupted weft thread between the previous shuttle and the entering shuttle will bend around the outermost warp threads so when the next shuttle enters, a selvage is formed. After a subsequent shuttle has penetrated to at least a few warp thread depths, the weft thread at the front of the entering shuttle will become taut, enter through an opening 108 (FIGS. 2 and 5) in the overlapping portion 62 of the front part of the shuttle and glide down past the overlapping portion, at the completion of which movement the weft thread will protrude through the opening 64. The edge of the opening 64 can be formed with a knife edge 110, whereby the weft thread from the previous shuttle which has thus re-entered a different shed can be severed merely by the shuttle movement drawing the weft thread protruding through the opening against the knife edge thereof. As the thread is under tension while its individual fibers are severed, the two thread ends formed by the severing of the thread are attenuated. Instead of an edge in the form of a knife a means for cutting the thread may be provided inside the shuttle in the proximity of the opening. If desired, an alternative cutting mechanism, shown in FIGS. 20 and 21, may be employed. In this embodiment of the cutting device, a scissor actuating arm 112 is made integral with or attached to the L-shaped extension 34 of the pivot rocker shaft 30. A stationary scissor-leg 114 and a rotatable scissor leg 116 are attached to the housing of the shuttle input magazine 70. Each time the L-shaped extension 34 of the pivot rocker shaft 30 is in the upright, dotted position, as shown in FIG. 20, the scissor actuating arm 112 pushes the rotatable scissor leg 116 shut and snips the weft thread 1 between the scissor legs 114 and 116. A coil spring (not shown) can be provided to keep the scissor legs 114 and 116 normally apart. In the case of using a weft thread cutting mechanism of this type, no selvage is formed on the input side of the fell, and different sorts of woven fabric edge designs can be employed.

On the side of the loom, where an empty shuttle leaves the shed, i.e., the output side, cams 118 and 120 are mounted on the main drive shaft 24 for rotation therewith. Cam followers 122 and 124, respectively, contacting the cams 118 and 120 are mounted on a bell crank lever 126 (see FIG. 25), which is pivoted at 128 to the frame of the machine. A connecting rod 130 is pivotally connected at one end thereof to the upper end of the bell crank lever 126, and the other end of the connecting rod is pivotally attached to a toothed bell crank 132. The crank 132 is adapted to reciprocate around a pivot 134, and is provided with rack teeth 136, which mesh with a gear 138. A shaft 140 journaled within the frame of the machine carries the gear 138 mounted for rotation therewith, and a bent needle 142 having a thread hook 144 at its free end, is mounted at the other end of the shaft 140, also for rotation therewith (see FIGS. 23-29).

As the main drive shaft 24 rotates, the connecting rod 130 reciprocates due to the action of the cam followers 122 and 124 and causes the shaft 140 and the bent needle 142 to angularly reciprocate therewith. As sequentially shown in FIGS. 26-29, the needle 142 swings parallel to the fabric and as a shuttle arrives at the edge of the warp threads, the needle is swung between the last warp thread and the shuttle until the thread hook 144 protrudes beyond the fabric, swings over the projecting weft thread-end 1b of the shuttle already having left the shed, and pulls the remainder of the weft thread 1b from the shuttle back into the shed around the edgemost warp thread 14, thus forming a selvage on the output side. The loose end of the weft thread 1b thus pulled back is subsequently covered by the weft thread deposited by a subsequently arriving shuttle and beat up against the fell 18 by the reeds 16.

A shuttle arriving at the output side, delivered by the reed pressure upon the respective trailing edge 66 of the

shuttle, enters the shuttle output magazine 146, as shown in FIGS. 22, 23 and 24. Cams 148 and 150 are mounted for rotation with the main drive shaft 24. A bell crank lever 152 is pivotally anchored to the frame of the machine at 154, and carries cam followers 156 and 158 respectively, contacting the respective cam surfaces 148 and 150, to reciprocate the bell crank lever 152. The upper end of the bell crank lever is connected to a link 160, which in turn is connected to a connecting rod 162. Integrally connected to the other end of the connecting rod 162 is a shuttle pushing pawl 164. A boss 166 is protruding from the machine frame, and a shuttle retainer arm 168 is attached to the boss 166 so as to fulcrum about it at 170. A tension spring 172 is provided to pull the shuttle retainer arm downward at all times about the fulcrum 170. A pressure member 174 is pivotally attached to the shuttle retainer arm 168 at 176, and presses the shuttles 10 downward in the shuttle output magazine 146 due to the biasing action of the spring 172. As shown in FIG. 23, the end of the pressure member 174 facing the edge of the warp threads is bent upward at 178 to facilitate the entry of a shuttle 10 into the shuttle output magazine 146. The entry of a shuttle is further facilitated by a tail portion 177 of the shuttle pushing pawl 164, so that when the cam follower 156 rides on the high portion of the cam 150, the pawl 164 is pulled through a slot in the bottom of the output magazine 146 against the bottom shuttle in the magazine and pushes it forward into a standby position 180, from where a shuttle, having been in the stand-by position previously, is pushed onto the return transport chain 88; where it is returned to the shuttle input side of the machine by the chain transport member 90. While the pawl 164 is in the magazine 146, the shuttle retainer arm is not permitted to drop due to the removal of the bottom shuttle, but is held up by the tail portion 177 of the pawl 164. Thereby, room is provided on the top for a subsequently entering shuttle.

As can be seen from the description hereinabove, upon the rotation of the main drive shaft 24 the following events will happen: the pusher rocker shaft tilts upright due to the action of the cam 48, whereby the porter pushing needles 36 engage the threads of respective porters 8. Due to the action of the helical cam 42 the pivot rocker shaft moves to the right and the groups of porters are simultaneously transferred to the right on the blade 6. A shuttle 10 with a porter 8 therein is pushed by the shuttle pusher 40 into the shed, while the L-shaped extension 34 with the porter pushing needles 36 thereon tilts sideways again due to the action of cam 48 and moves back to its original position due to the returning action of the helical cam 42. A shuttle 10 is pushed from the stand-by position 106, FIGS. 10 and 16, onto a ready porter 8 due to the action of the cam 76 while the chain 88 driven by the gear 100 returns another shuttle 10 to the bottom of the shuttle input magazine 70. On the output side a shuttle is delivered from the shed into the shuttle output magazine 146, the loose end of weft thread 1b is pulled back by the hook end 144 of the bent needle 142 due to the action of the cams 118 and 120, whereupon a lowermost shuttle is pushed in a stand-by position 180 from the shuttle output magazine 146 by the shuttle pushing pawl 164. A shuttle is pushed from a stand-by position 180 onto the return transport chain 88 and the pressure member 174 is held high by the shuttle pushing pawl 164, due to the action of the cams 148 and 150.

The reed and heddle driving mechanisms

The progressing cavities drive mechanism imparting the wave-like motion to the reeds 16 for propelling a plurality of shuttles simultaneously and in succession through the shed is shown in FIGS. 11, 14 and 15. A housing 182 is formed with a larger semi-circular recessed portion 184 and a smaller semi-circular recessed portion 186. A shaft 188 having a helix 190 thereon is disposed within

the larger recessed portion 184 of the housing 182. A sprocket 192 (FIG. 7), attached for rotation to the end of the shaft 188 is connected through a chain 194 to a sprocket 196 mounted for rotation with the main drive shaft 24. A flexible covering 198 surrounds the parts of the shaft 188 and the helix 190 thereon, which are not covered by the wall of the housing 182 forming the larger recessed portion 184. The flexible cover 198 can be attached to the top and the bottom of the cavity 184, such as shown at 200 and 202 in FIG. 14. As noted from FIG. 11, a wire 204 is laced through holes in the lower ends of the reeds 16 and spacer discs 206 maintain the reeds 16 at a desired distance from each other. Also, there is additional space shown between the reeds 16 and the spacer discs 206. However, it is preferred that the spacers 206 be directly contacting adjacent reeds without any additional space along the wire 204 being available. The outside diameters of the helix 190 and the spacer discs 206 substantially correspond to the respective inside diameters of the semi-circular recesses 184 and 186.

An operational cover 208 is provided for the reed drive. Said cover comprises a contoured sheet 210 made of metal or other suitable material, the sheet defining a larger semi-circular recessed portion 212 and a smaller semi-circular recessed portion 214 parallel with the larger recess 212. A flexible hose 216 filled with a liquid 218 is disposed within the larger recessed portion 212 of the cover sheet 210, and is sealed at both ends (not shown) to prevent loss of the liquid 218 and maintain a desired pressure therein. The smaller recess 214 substantially corresponds to the diameter of the spacer discs 206 and operationally is adapted to cover the same. The cover sheet 210 comprising the operational cover 208 is supported by a shaft 220 carrying a plurality of supporting arms 222, which are attached at their upper ends to the cover sheet 210. Access to the reeds 16, the spacers 206 and other components of the reed drive can be provided by swinging the cover sheet 210 in the direction indicated by the arrow in FIG. 11, whereby maintenance of the components of the reed drive can be accomplished.

In FIGS. 11 and 12, a reed guide is shown comprising reed movement limiting rods 224 with wires 226 stretched between them. The correct disposition of the reed movement limiting rods is shown schematically in FIG. 12. However in FIG. 11, the rods are shown in an opposite incline for ease of illustration. The rods 224 limit the pivoting movement of the reeds 16 about the wire 204 and the wires 226 maintain the upper portions of the reeds apart from each other to prevent lateral entanglement.

The progressing cavities drive, described above, imparts a traveling, sinuous wave-like motion to the reeds for simultaneously driving a plurality of shuttles across the shed and to beat up the weft thread 1, picked from the shuttles, against the fell 18. The hose 216 maintains the reeds 16 tight against the flexible cover 198 and the helix 190 on the shaft 188 behind it. As the shaft 188 with helix 190 is rotated by the main drive shaft 24, the progressing helix creates correspondingly progressing cavities within the liquid-filled tube 216 pressed tightly thereagainst, thereby making it conform to the instantaneous helical configuration and producing a continuously traveling wave-like shape of the flexible hose. Since the reeds 16 are pinched between the helix, i.e. its cover 198, and the flexible hose 216, the reeds will be similarly disposed in a continuously traveling wave-like pattern. Since the drive of the shaft 188 can be timed from the main drive shaft 24, the reed motion is synchronized with the other operational steps of the machine. In the alternative, in place of the liquid-filled hose another correspondingly formed helical cam, or a suitable resilient cushion layer, may be used.

The heddle drive system is shown in FIGS. 12 and 13, while its power take-off is shown in FIG. 7. Upper heddle drive shaft 228 and lower heddle drive shaft 230 are dis-

posed within a heddle drive housing 232. The shafts 228 and 230 are contoured in a wave-like form, and journaled at their respective ends in the sidewalls of the housing 232 for rotation at 180° out of phase with each other regarding their opposing spiral contour formations. The shafts 228 and 230 are laced through elongated holes 234 and 236 of upper heddle guides 238 and lower heddle guides 240, respectively. The upper and lower heddle guides 238 and 240 are made of sheet metal and are adapted to be guided for their reciprocating motion by the inner sidewalls of the oil filled housing 232. The guides 238 and 240 range in pairs through opening 242 in the top of the housing 232, and are kept adjacent each other in pairs by sliding guide brackets 244 being attached to one of the guides comprising a pair of guides 238 and 240, and slidably surrounding the other guide of the pair. Ranging through spaced holes in the protruding part of the upper heddle guide 238, are heddle holding wires 250. Each heddle holding guide has two spaced holes for an upper and a lower heddle holding wire 248 and 250, respectively. The heddles 12a are laced at their upper ends to the top heddle holding wire 248 and at their lower ends to the bottom heddle holding wire 248. The heddles 12b, as shown only in FIG. 12, are laced similarly on the heddle holding wires 250.

Mounted on the end of the shaft 188 for rotation therewith is a gear 252 meshing with a gear 254 carried by a drive shaft 256 (FIGS. 7 and 13). The other end of the shaft 256 is connected to the upper heddle drive shaft 228 and carries a gear 258 meshing with a gear 260, which is connected to the lower heddle drive shaft 230.

As the drive shaft 256 is rotated through the gears 252, 254 and the described transmission system by the main drive shaft 24, the wave-like contoured upper and lower heddle drive shafts 228 and 230 move the parallel disposed pairs of upper and lower heddle guides 238 and 240 in a continuous traveling wave-like motion up and down, causing the heddle holding wires 248 and 250 to undulate in the shape of a traveling wave. In this manner the heddles 12a and 12b form continuously traveling and changing sheds for the plurality of shuttles being transported through the warp threads 14 by the synchronously wave-like moving reeds 16.

While a preferred weaving loom of the invention and its various drive systems were described in view of specific and preferred embodiments thereof, it is to be noted that various changes and modifications may be made without departing from the full scope of the invention as interpreted from the appended claims.

What I claim is:

1. In a weaving process, wherein a plurality of shuttles are simultaneously used for picking the weft thread, the improvement comprising winding weft thread into groups of turns, said groups being spaced from each other and each group including a succession of turns of weft thread outside of a shuttle, charging a shuttle with a number of said turns of weft thread substantially corresponding in length to the width of a material to be woven while maintaining the configuration of said turns of weft thread substantially unchanged, each of said groups including said number of said turns of weft thread, introducing the charged shuttle into a shed formed by warp threads of the material to be woven, cutting the weft thread between said groups of turns thereof, said step of cutting being made at some point after said step of charging, sequentially changing the shed throughout the width of said material, simultaneously with said step of changing the shed driving said charged shuttle through the changing shed, all of said shuttles being driven in the same direction through said shed, and beating up the weft thread paid out by the moving shuttle against a fell.

2. In a weaving process, wherein a plurality of shuttles are simultaneously used for picking the weft thread, the improvement comprising winding a succession of turns of weft thread, charging a shuttle with a number of turns

of weft thread substantially corresponding in length to the width of a material to be woven, introducing the charged shuttle into a shed formed by warp threads of the material to be woven, cutting the weft thread between a given number of successive turns thereof, said step of cutting being made at some point after said step of charging, sequentially changing the shed throughout the width of said material, simultaneously with said step of changing the shed driving said charged shuttle through the changing shed, beating up the weft thread paid out by the moving shuttle against a fell, successively retaining a connection between the weft thread trailing out from one shuttle and weft thread from a leading end of a following shuttle, and severing said connection after said following shuttle has entered the shed, so as to form a separated end extending around an outermost warp thread to form a selvage.

3. In the method of claim 2, after a shuttle starts to leave a shed at one side of the material opposite to another side where it entered, the improvement further comprising the steps of pulling a loose end of the weft thread in said shuttle out from said shuttle and around an outermost warp thread, and introducing it in a shed different from the shed a remaining length of said weft thread is placed, whereby a selvage is formed at said one side of said material.

4. In a loom, a process for continuously inserting individual weft threads inbetween warp threads running perpendicular to the weft threads to be inserted, wherein the weft threads are inserted by a plurality of shuttles advancing in succession within moving sheds, comprising the steps of pulling weft thread off a supply bobbin, winding the thus-pulled weft thread in flat turns, one turn lying behind the other, successively introducing groups of said flat turns into a plurality of shuttles; and separating a weft thread which protrudes from the front end of a shuttle and which is still connected to a weft thread of the previously advanced shuttle.

5. A weaving process comprising the steps of:

- (a) winding a continuous weft thread onto a carrier;
- (b) forming individual shuttle charges of weft thread on said carrier, said shuttle charges substantially corresponding in thread length to the width of a material to be woven;
- (c) disposing a first shuttle about a shuttle charge on said carrier;
- (d) removing said first shuttle from said carrier with said shuttle charge retained within said shuttle;
- (e) forming a first shed from the warp threads of the material to be woven, said first shed being slightly larger in length than said first shuttle;
- (f) introducing said first shuttle into said first shed at one edge of the material to be woven;
- (g) disposing said first shed in a continuously moving sequence towards an opposite edge of the material to be woven;
- (h) moving said first shuttle along within said moving first shed, wherein the weft thread comprising said shuttle charge in said first shuttle is paid out from said first shuttle into the moving shed;
- (i) disposing a second shuttle about a shuttle charge on said carrier;
- (j) forming a second shed;
- (k) severing a connection between the weft thread comprising the shuttle charge within said first shuttle and the weft thread comprising the shuttle charge within said second shuttle; and
- (l) disposing said second shed in a continuously moving sequence subsequent to said first shed.

6. A loom for picking a plurality of weft threads simultaneously in sheds formed in warp threads, comprising means for forming a plurality of shuttle charges of weft thread, said means for forming the shuttle charges comprising an elongated member adapted to accommodate successive turns of continuous weft thread thereon,

and a flyer adapted to wind said successive turns onto said elongated member, shuttle means including a plurality of shuttles for respectively receiving said shuttle charges and for transporting said shuttle charges through the sheds and paying out weft thread into the sheds, means for severing the weft thread between the shuttle charges, heddle means for forming a plurality of moving sheds in the warp threads, and reed means for propelling a plurality of shuttles along with the moving sheds and for beating up the weft threads paid out by said shuttles.

7. A loom according to claim 6, wherein said reed means comprises a plurality of reed members disposed in a parallel spaced relationship between said warp threads, said reed members being mounted at one end thereof in a coaxial relationship, a helical cam disposed on one side of said reed members, said reed members being disposed perpendicularly to the axis of said helical cam, and a pressure member disposed parallel to said helical cam on the other side of said reed members, whereby said pressure member presses the reed members against said helical cam causing said reed members to follow the contour of said helical cam.

8. A loom according to claim 7, wherein said pressure member comprises a liquid-filled hose.

9. A loom according to claim 6 further including charging means for disposing a shuttle charge of weft thread in a shuttle, and selvage forming means for disposing a loose end of a weft thread within a shed different from the shed which accommodates the largest part of the same weft thread.

10. A loom according to claim 6, wherein said charging means further includes a shuttle magazine adapted to contain a plurality of empty shuttles in a stacked relationship, and a shuttle magazine pusher member adapted to push the topmost one of said stacked shuttles from said magazine onto a porter disposed on said elongated member.

11. A loom according to claim 6, wherein said heddle means includes a plurality of heddles adapted to have a warp thread each threaded through each of said heddles, a plurality of flexible heddle holders, said heddles being mounted from said heddle holders, and heddle guides disposed in a parallel spaced relationship and adapted to be reciprocated in a phasing delayed from one heddle guide to an adjacent one, said heddle holders being mounted from said heddle guides.

12. A loom according to claim 11, further including heddle guide reciprocating means.

13. A loom according to claim 12, wherein said heddle guide reciprocating means comprises at least one spiral shaft, said heddle guides being mounted for reciprocation from said spiral shaft, and drive means attached to the spiral shaft for rotating the same.

14. A loom according to claim 13, further including a housing, said spiral and a part of said heddle guides being disposed within said housing, said housing being adapted to be at least partially filled with a lubricant.

15. A loom according to claim 6, wherein said elongated member is tapered to provide for a loosening of the turns of weft thread and for the transportation of said turns of weft thread on said elongated member in the narrowing tapered direction thereof.

16. A loom according to claim 6, including a shuttle charge transporting member adapted to forward turns of weft threads along the taper of said elongated member.

17. A loom according to claim 16 wherein said charging means includes a shuttle charge pusher disposed for movement together with said shuttle charge transporting member and adapted to push a shuttle charged with a shuttle charge into a shed.

18. A loom according to claim 6, further including shuttle return means for returning an empty shuttle from one side of the loom to the other side thereof, where said shuttle can again be charged by a shuttle charge.

19. A loom according to claim 18, wherein said shuttle return means comprises an endless chain disposed paral-

lel to the weft threads between said warp threads and outside said warp threads, the chain being adapted to transport empty shuttles from the side of said loom opposite the side where said charging means are disposed to said charging means.

20. A loom according to claim 19, wherein said shuttle return means further includes a stacker adapted to sequentially deposit empty shuttles leaving the shed onto said endless chain.

21. A loom according to claim 9, wherein said selvage forming means includes a reciprocable member disposed adjacent to the outermost warp threads on one side of the loom opposite to another side where the shuttles enter the shed, said reciprocable member being adapted to pull the end of a weft thread from a shuttle leaving the shed, and deposit said end in a shed different from the shed left by said shuttle.

22. A loom according to claim 9, wherein said severing means comprises a cutting edge disposed adjacent the edge of each shuttle by which edge each shuttle enters a shed, whereby the connection between the weft thread within the shuttle just having entered a shed and a shuttle having previously entered a shed is severed upon the tightening of the weft thread connection.

23. A loom according to claim 21, wherein said severing means comprises a cutting edge disposed adjacent the edge of each shuttle by which edge each shuttle enters a shed, whereby the connection between the weft thread within the shuttle just having entered a shed and a shuttle having previously entered a shed is severed upon the tightening of the weft thread connection.

24. Heddle means for the forming of a plurality of sheds moving transversely between a plurality of warp threads in a loom, comprising a plurality of heddles adapted to have a warp thread each threaded through each of said heddles, a plurality of pairs of unitary flexible wire heddle holders, adjacent ones of said heddles being mounted from a different pair of said plurality of pairs of heddle holders, and a plurality of pairs of heddle guides disposed in a parallel spaced relationship, the heddle guides in each pair supporting a different one of said pairs of heddle holders and each guide of a respective pair of heddle guides being adapted to be reciprocated in a phasing opposite with respect to the other guide of that pair.

25. Heddle means according to claim 24, further including heddle guide reciprocating means.

26. Heddle means according to claim 24, wherein said heddle guide reciprocating means comprises a pair of spiral shafts, said heddle guides in each pair being mounted for reciprocation from a different one of said spiral shafts, and drive means attached to said pair of the spiral shafts for rotating the same.

27. Heddle means according to claim 26, further including a housing having a top wall through which said heddle guides project, said spiral shafts and a part of said heddle guides being disposed within said housing, said housing being adapted to be at least partially filled with a lubricant.

28. A process for inserting individual weft threads in a loom wherein a weft thread is inserted by a shuttle advancing through a shed, comprising, pulling a weft thread off a stationary bobbin, placing the weft thread in flat windings lying one behind the other, introducing a group of flat windings corresponding to a length of a weft thread into said shuttle; and separating an end of the weft thread, which protrudes from a front end of the shuttle.

29. The process according to claim 28, wherein the end of the weft thread which is connected with a previously beaten up weft thread and which emerges at the front end of a shuttle is cut off after the shuttle

enters the shed whereby the end of the thread is bent back, and further comprising the step of introducing the short thread end which is still connected to the shuttle after the shuttle leaves the shed into the next shed.

30. In a loom, means for forming a group of weft threads, a shuttle having a substantially U-shaped body, a blunt forward portion and a sloping rearward portion, and means to advance said shuttle through said warp shed by continually applying a forward moving wave-like pressure to the sloping rearward portion of said shuttle.

31. In a loom, a flat blade member having an elongated slot and tapering sides, a rotatable bifurcated flyer adapted to feed thread about said blade to form shuttle charges, means for moving said shuttle charges along said blade member, charging means for disposing said shuttle charges in shuttles, respectively, and means for directing the shuttles through a warp shed while the shuttle charges are respectively paid out of said shuttles and for then returning and shuttles to said charging means to again receive shuttle charges, respectively.

32. A method of weaving including the step of pulling a weft thread off a stationary bobbin, placing the weft thread in windings lying one behind the other, introducing a group of such windings substantially corresponding to a length of a weft thread into a shuttle, separating an end of the weft thread which protrudes from a front end of the shuttle, retaining a trailing end of said group while causing travel of said shuttle through the warp threads by applying a constant forwardly moving pressure to said shuttle throughout the travel thereof through said warp threads, and positioning said shuttle adjacent the fell during its movement through said warp threads.

33. A method of weaving as claimed in claim 32, wherein said shuttle comprises an inclined trailing end, said constant forwardly moving pressure being applied to said trailing end of said shuttle.

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