July 14, 1964 E. F. CLARK 3,140,592

APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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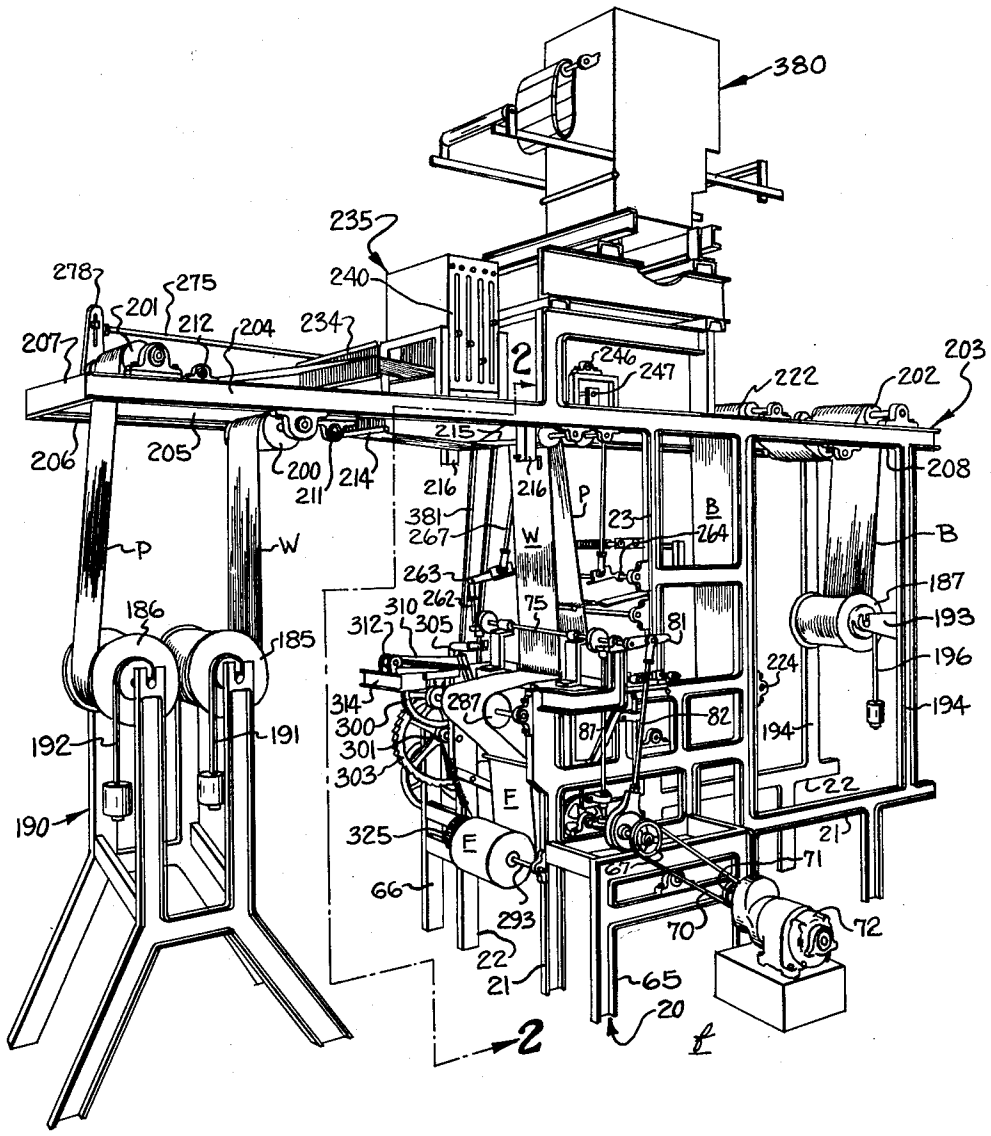

Fig-1

INVENTOR:
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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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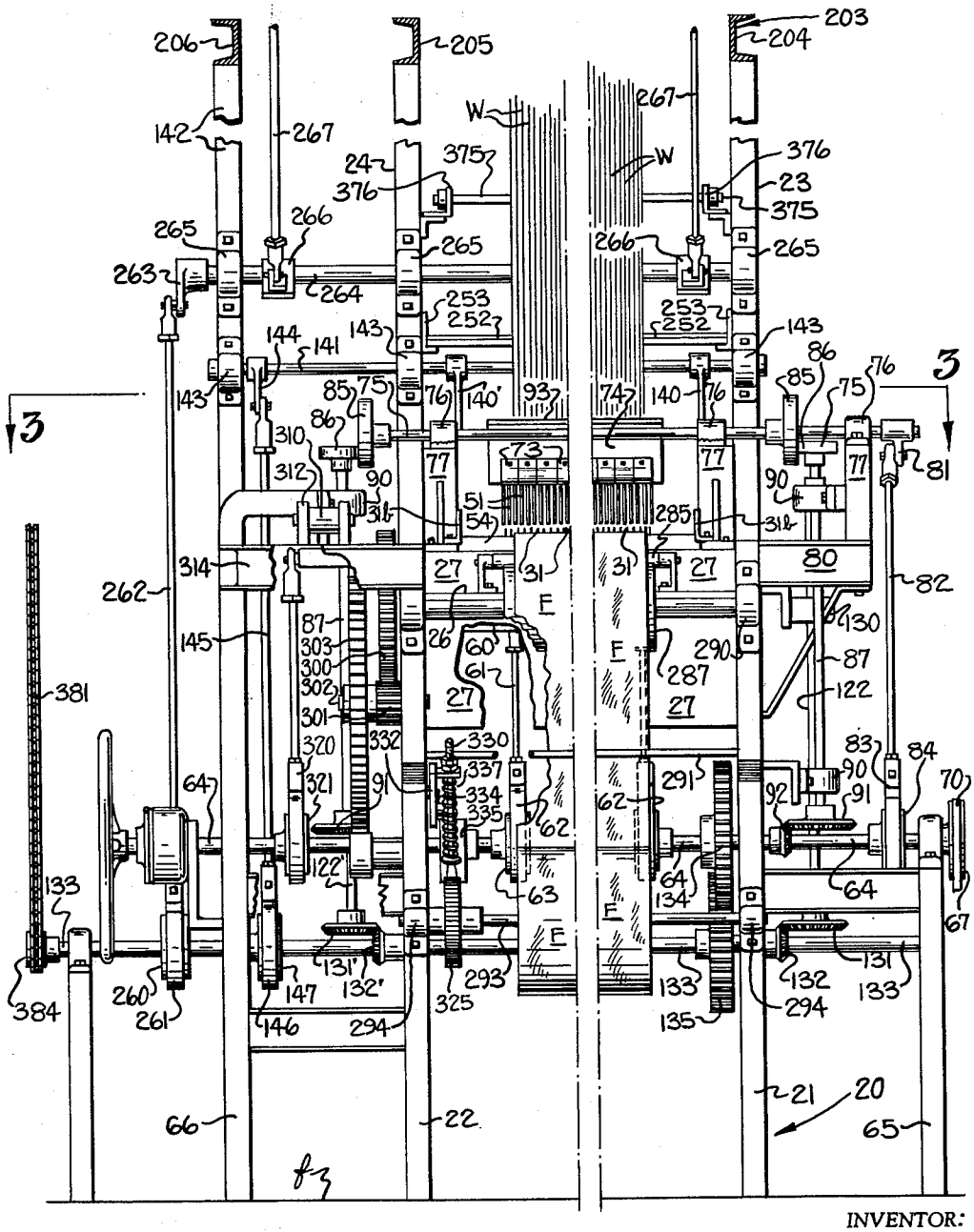

Fig-2

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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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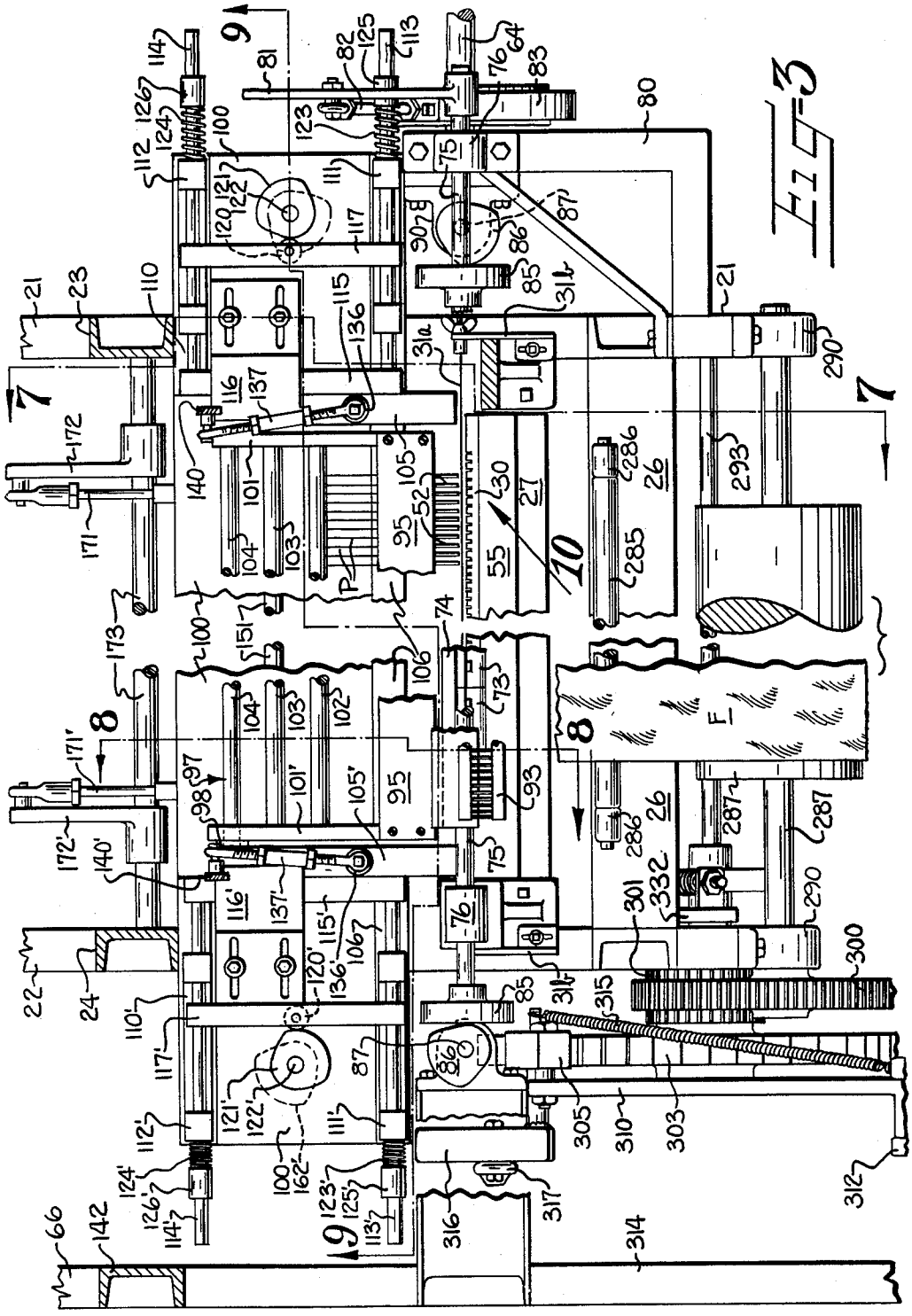

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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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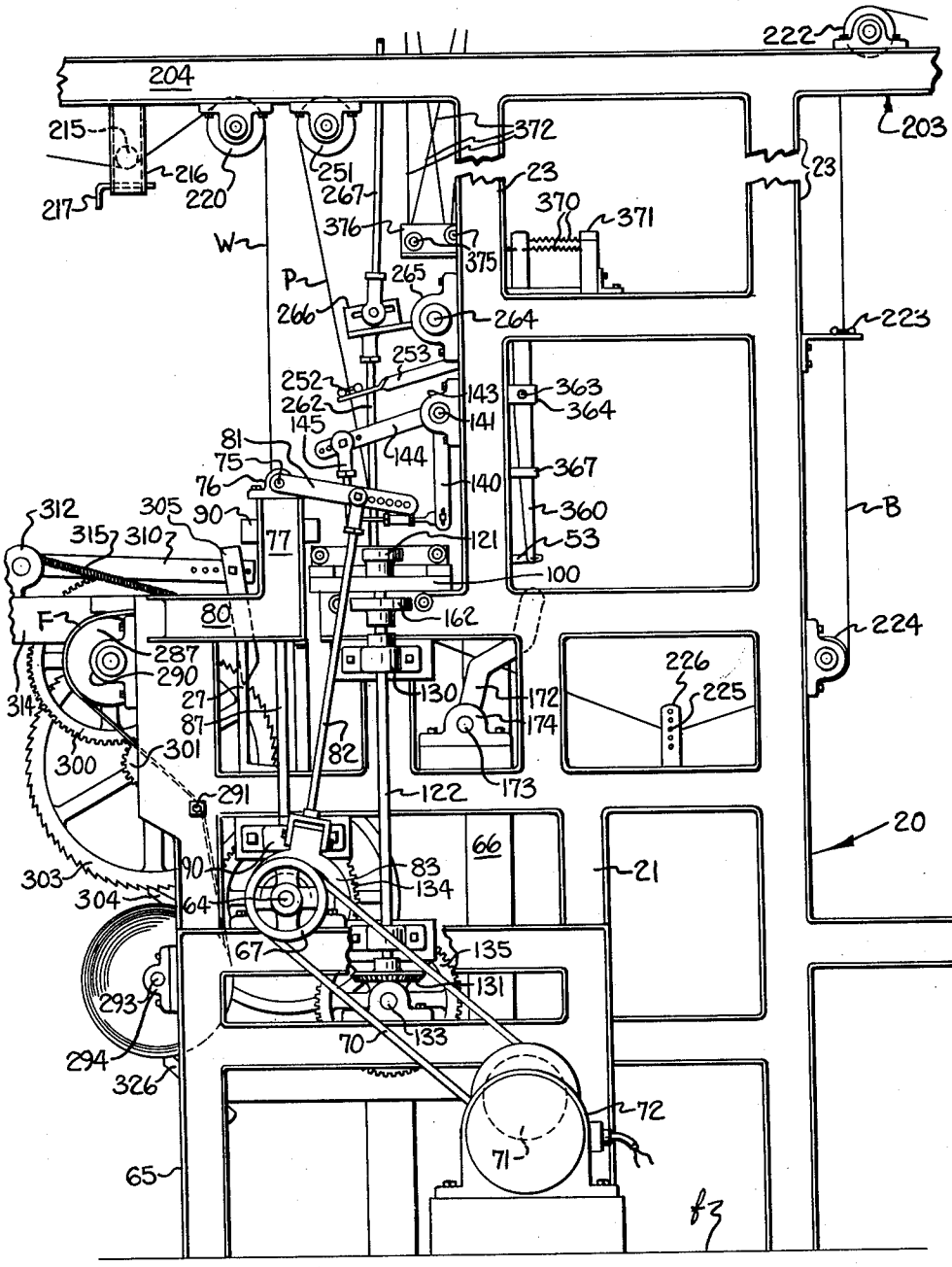

Fig. 4

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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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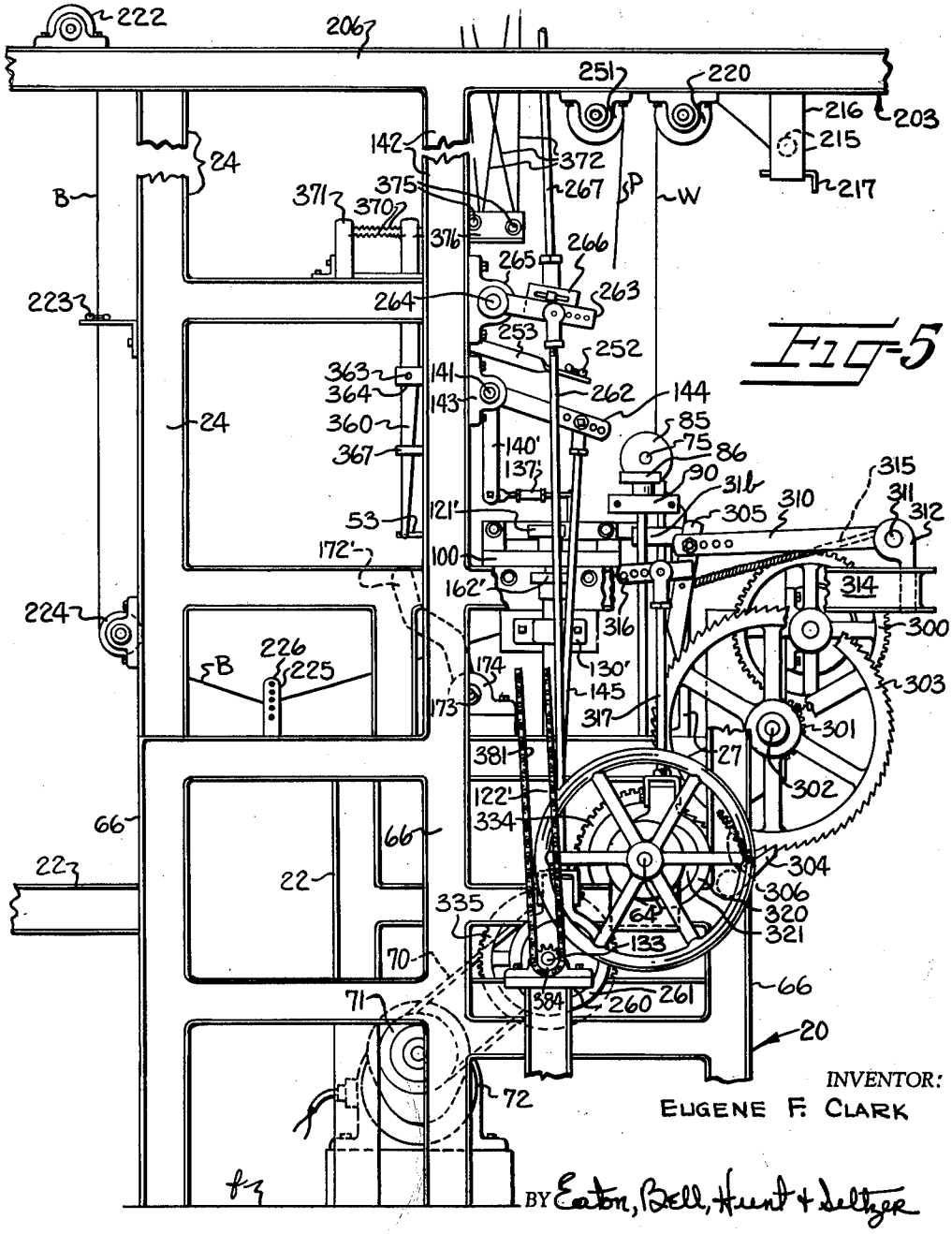

Fig-5

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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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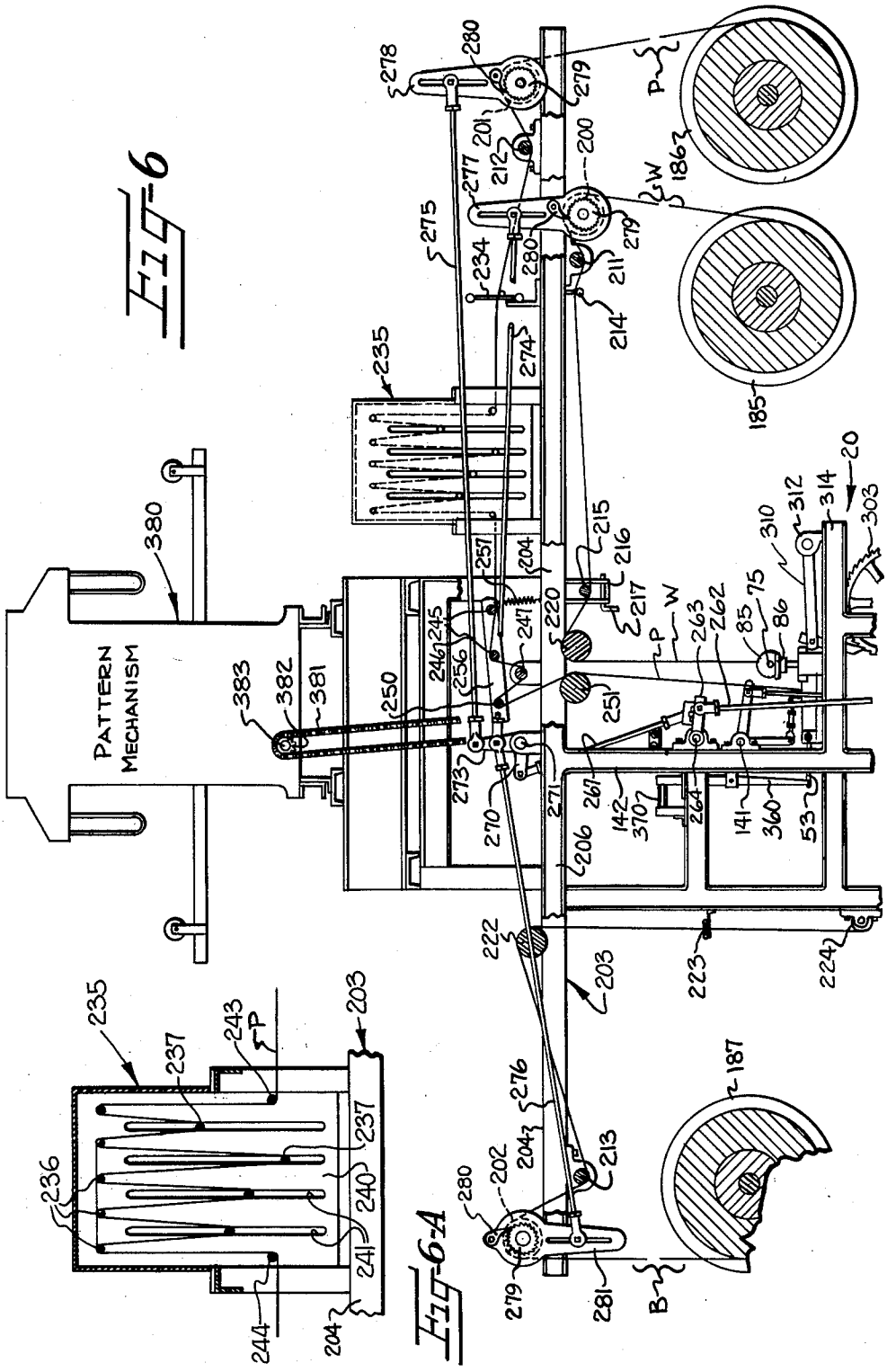

FIG-6

FIG-6A

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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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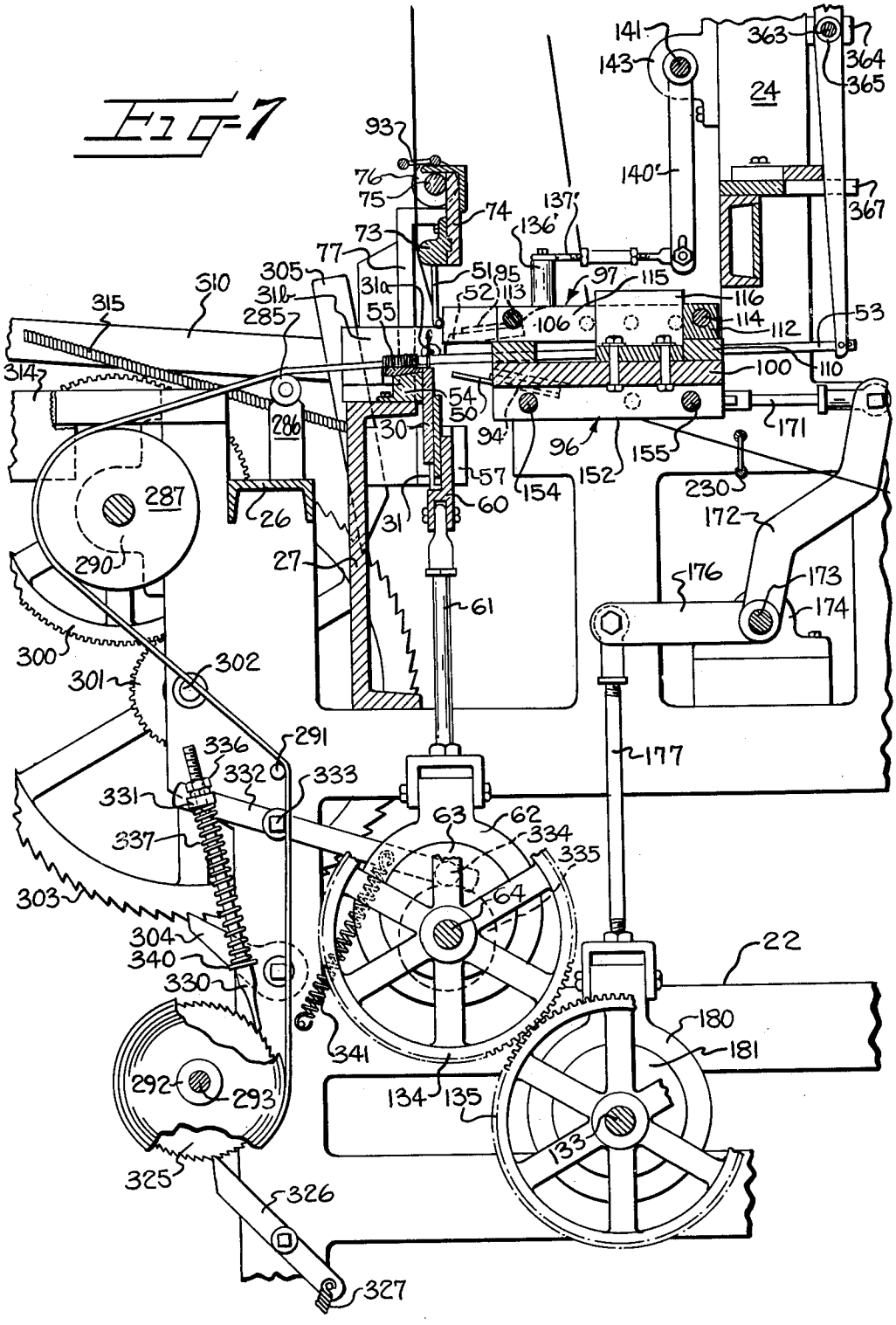
Fig-7



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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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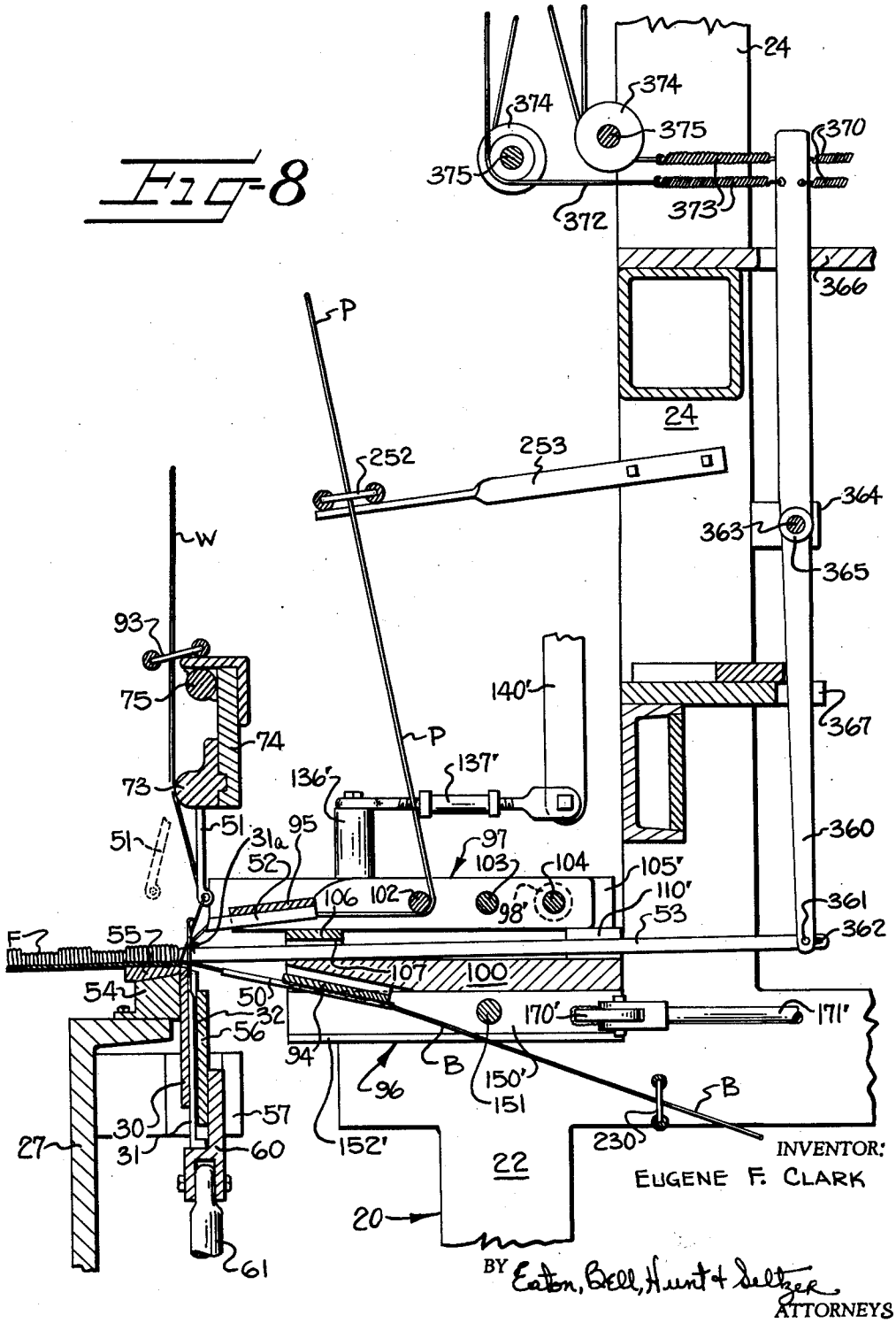
Fig-8



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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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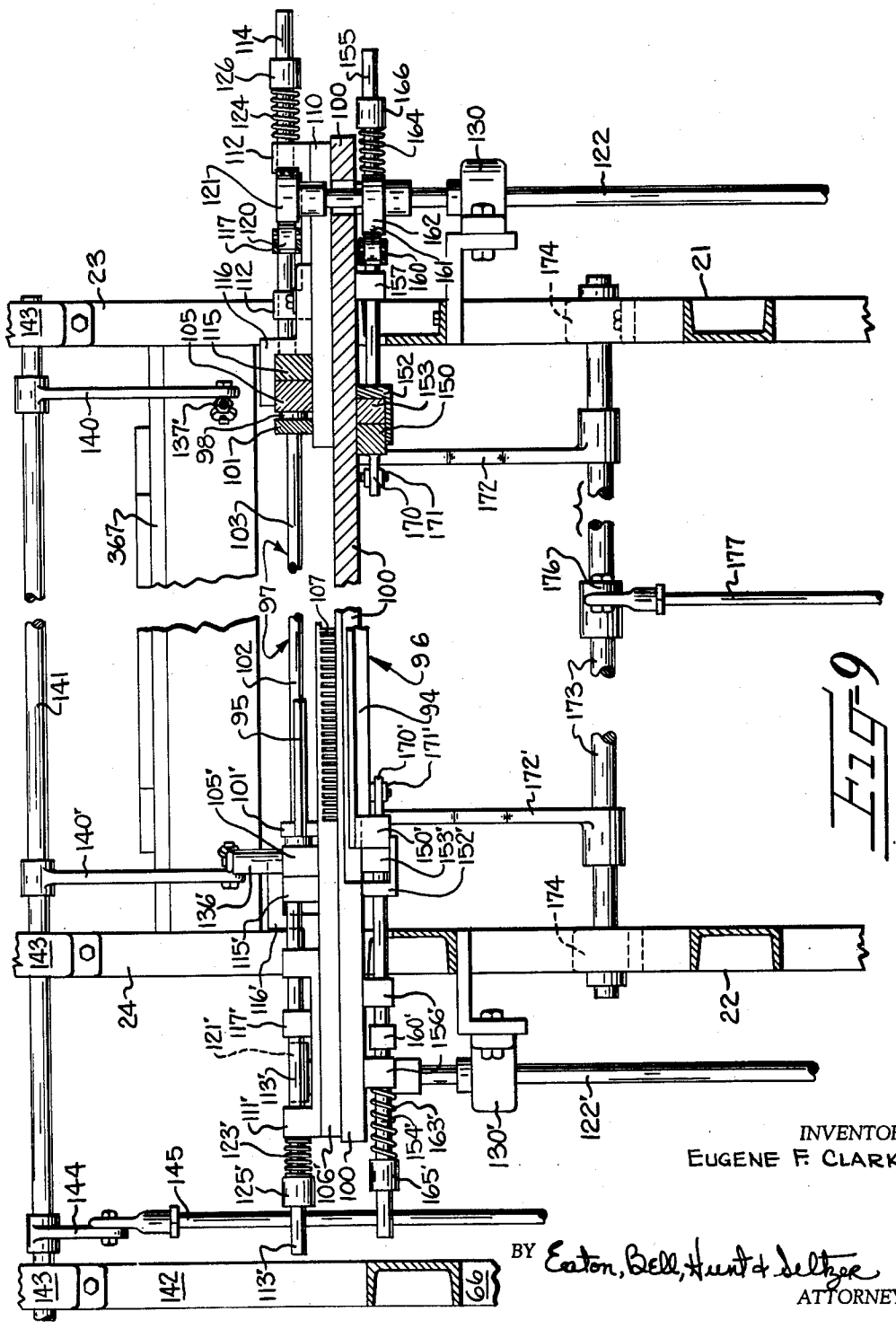

FIG 9

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July 14, 1964 E. F. CLARK 3,140,592

APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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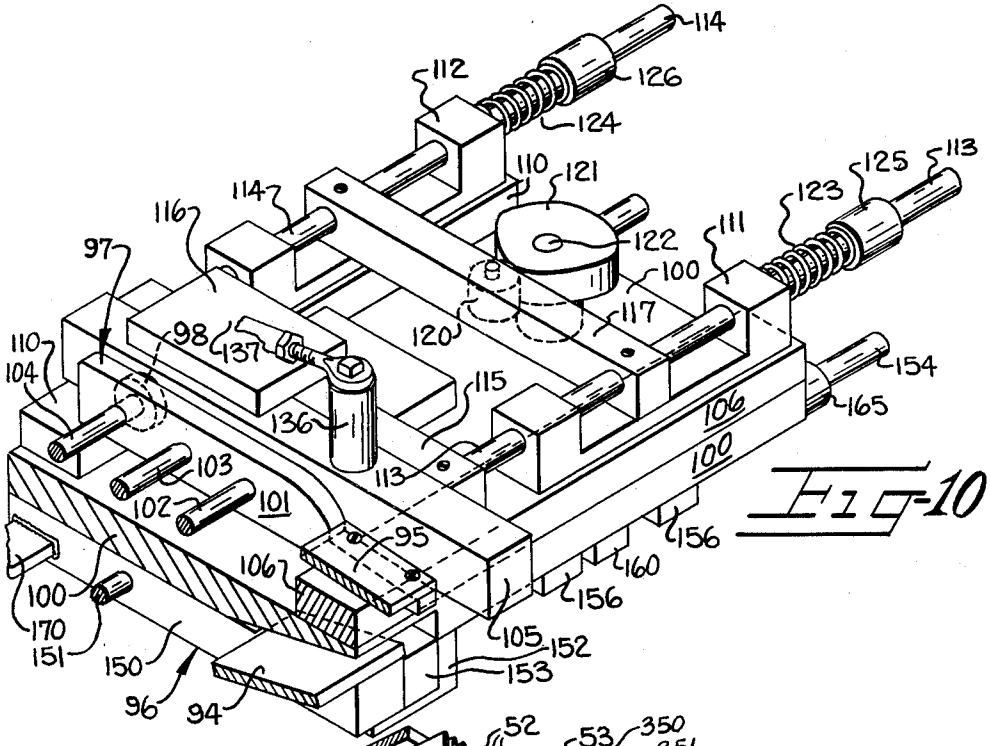

Fig-10

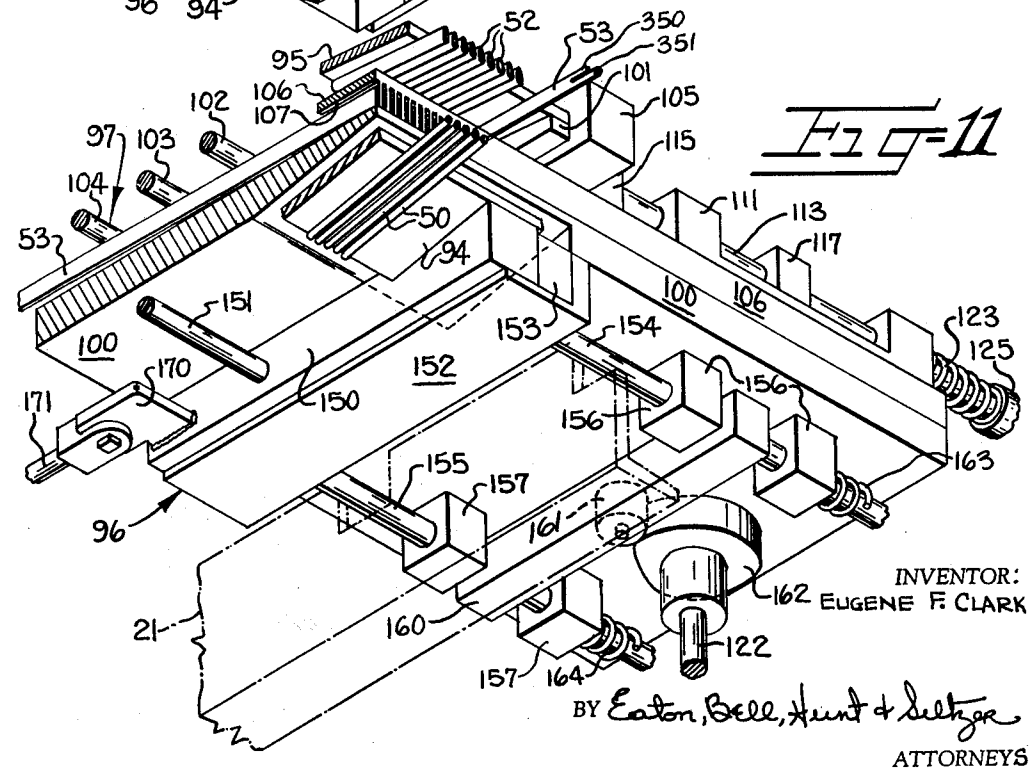

Fig-11

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July 14, 1964 E. F. CLARK 3,140,592

APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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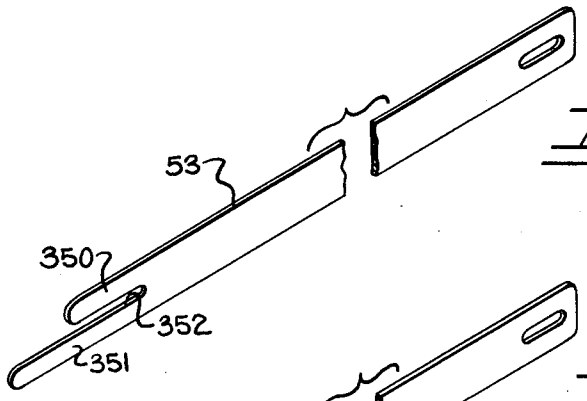

Fig. 12

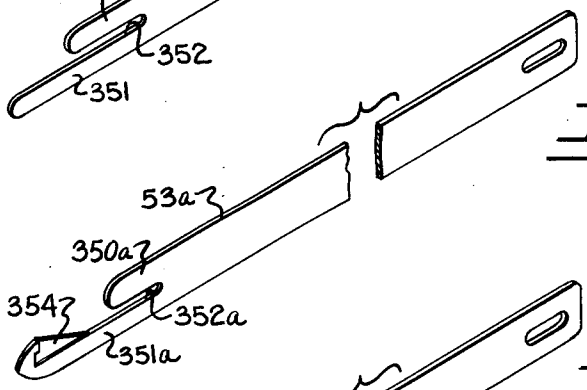

Fig. 13

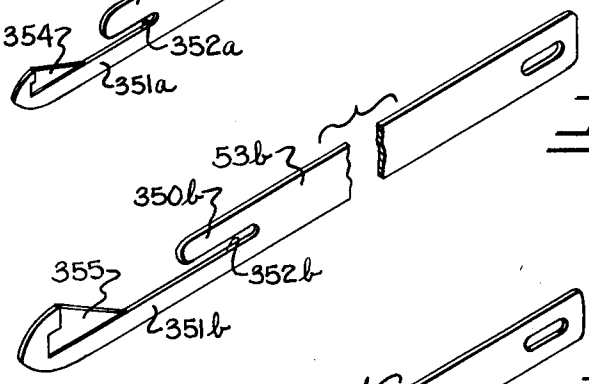

Fig. 14

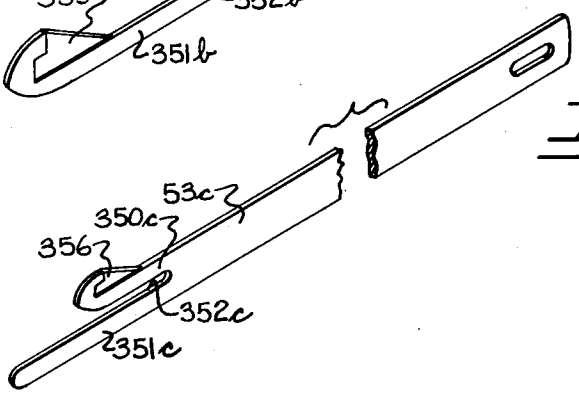

Fig. 15

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APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

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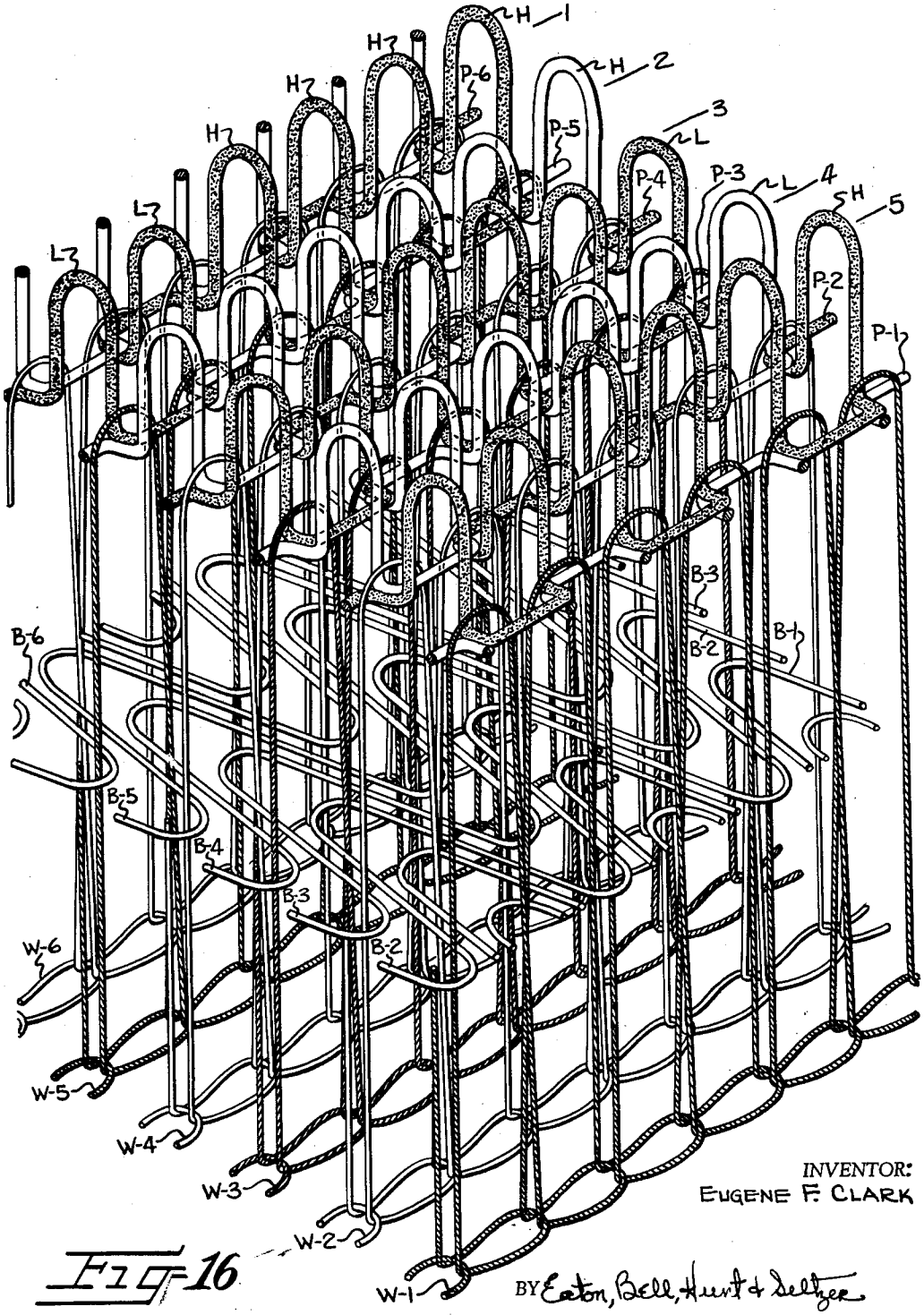

Fig-16

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United States Patent Office 3,140,592 Patented July 14, 1964

3,140,592

APPARATUS FOR KNITTING VARIANT HEIGHT PILE FABRICS

Eugene F. Clark, Leaksville, N.C., assignor to Fieldcrest Mills, Inc., Spray, N.C., a corporation of Delaware

Filed Nov. 2, 1960, Ser. No. 66,856
5 Claims. (Cl. 66—85)

This invention relates to the art of knitting pile fabrics, such as rugs, carpets and the like, and it is a primary object of this invention to provide a novel apparatus and method for knitting pile fabrics having warpwise rows of raised pile tufts of at least two different heights arranged in any predetermined order, and wherein the tufts of each row are located between two immediately adjacent lines of chain stitches and are bound at their base by the two adjacent lines of chain stitches.

The terms "coursewise" and "weftwise" are used herein to identify a plane transverse of the knitted fabric, and the terms "walewise" and "warpwise" are used herein to identify a plane longitudinally of the fabric.

Various methods and apparatuses have been devised fro knitting pile fabrics on flat bed or warp knitting machines in which warp yarn guides and weft yarn guides cooperate with needles for forming a base of warpwise chains bounded together by sinuous weft yarns, and wherein pile yarn guides also cooperate with the needles in the forming of pile tufts in the form of loop pile or cut pile. In some instances, stationary pile wires or loop formers have been used for supporting the pile yarns in raised position above the base during formation of the pile tufts. However, the use of stationary pile wires has required that all pile tufts be of the same height throughout the length of the fabric.

One type of knitted pile fabric of which I am aware includes a base of chain stitches wherein adjacent rows of chain stitches are interconnected by backing yarns or weft yarns in the manner described above. Loops of two different heights are formed from pile yarns bound to the rows of chain stitches. However, the pile tufts of the latter fabric were formed by the use of hooks pulling the pile yarn upwardly between adjacent rows of chain stitches with the pile yarns advancing coursewise and diagonally from one chain stitch to the next chain stitch of each of the chain stitch warps. To my knowledge, the heights of the pile tufts could not be varied in each warpwise row, nor could they be varied according to any predetermined pattern. Also, the pile yarns, in each instance, embraced a greater number of chain warps than was embraced by the individual backing yarns so that selected warpwise loop rows could not be of a distinctive color or texture throughout with respect to adjacent rows.

In order to produce a knitted pile fabric having pile tufts of at least two different heights arranged in any predetermined sequence both weftwise and warpwise of a knitted fabric, and in which the pile yarns need not embrace more than two adjacent rows of chain stitches, it is a more specific object of this invention to provide a method and apparatus utilizing warpwise shiftable pile wires having loop forming stages of at least two different heights, in combination with knitting instrumentalities including warp yarn feed guides, weft yarn feed guides and needles, wherein the warp yarn feed guides, weft yarn feed guides and needles cooperate in the forming of a base fabric of substantially the character heretofore described, and pile yarn feed guides also cooperate with the knitting instrumentalities to bind the pile yarn to the base and shog the pile yarn over the loop forming stages, the loop forming stages being selectively presented to the knitting zone according to a predetermined pattern to thus form loops of different heights over the respective stages of different heights on the pile wires.

I have also provided novel means for imparting transverse shogging and longitudinal motion to the pile yarn guides, for imparting the warpwise movement to the pile wires under control of a pattern mechanism, and for controlling the feeding of the various yarns to the knitting and pile forming instrumentalities.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

FIGURE 1 is a perspective view of my improved carpet knitting machine with some parts being omitted, because of the small scale of the drawing;

FIGURE 2 is an enlarged front elevation looking substantially along line 2—2 in FIGURE 1, with parts broken away and other parts being omitted for purposes of clarity;

FIGURE 3 is a top plan view of the central portion of the machine taken substantially along line 3—3 of FIGURE 2, with parts broken away;

FIGURE 4 is a right-hand side elevation of the central portion of the machine looking at the right-hand side of FIGURE 2 and also looking at the side of the machine shown in FIGURE 1;

FIGURE 5 is a left-hand side elevation of the central portion of the machine looking at the opposite side thereof from that shown in FIGURE 4;

FIGURE 6 is a somewhat schematic left-hand side elevation of the upper portion of the machine, partially in section, and looking at the opposite side of the machine from that shown in FIGURE 1;

FIGURE 6–A is an enlarged schematic view of the pile yarn tension control shown in the central portion of FIGURE 6;

FIGURE 7 is an enlarged fragmentary longitudinal vertical sectional view taken substantially along line 7—7 in FIGURE 3, showing the fabric take-up mechanism and some of the mechanism for operating the knitting and pile forming instrumentalities;

FIGURE 8 is a somewhat schematic fragmentary longitudinal and vertical section view through the knitting and pile forming instrumentalities, taken substantially along line 8—8 in FIGURE 3;

FIGURE 9 is a fragmentary vertical sectional view taken substantially along line 9—9 in FIGURE 3, showing parts of the mechanism for supporting and imparting longitudinal and transverse movement to the pile yarn and weft yarn feed guides;

FIGURE 10 is a fragmentary isometric view looking at the top and front surfaces of the mechanism shown in the right-hand central portion of FIGURE 9 and being taken looking in the general direction of the arrow 10 of FIGURE 3;

FIGURE 11 is a view similar to FIGURE 10, but showing the bottom and front surfaces of the structure of FIGURE 10;

FIGURES 12 through 15 are isometric views of four different types of pile wires which may be used, separately or combined, on the present machine;

FIGURE 16 is an exploded isometric view of one embodiment of a knit pile fabric which may be produced on the present knitting machine.

Generally, the method of the present invention comprises knitting a base fabric of warpwise rows of chain stitches interconnected by wefts extending across groups of the chain stitch rows, concurrently with which pile tufts of varying heights are formed from respective pile yarns bound to and shogged to and fro between adjacent pairs of chain stitch rows. The different heights of pile tufts are arranged, both weftwise and warpwise, according to a predetermined pattern.

Referring more specifically to the drawings, the knitting machine for carrying out the present method comprises a main frame broadly designated at **20**, and including a pair of spaced main upright side frames **21**, **22** whose rear portions have respective upright extension frames **23**, **24** thereon (FIGURES 4 and 5). The front upper portions of the main side frames **21**, **22** support a transverse frame member **26**, rearwardly of which a transverse frame member **27** is located (FIGURES 2, 7 and 8).

Transverse frame member **27** carries a transverse needle bed plate **30** (FIGURES 7 and 8) having vertically extending grooves therein in which conventional latch needles **31** are mounted. Latch needles **31** are arranged in a row of series transversely of the machine. It will be observed in FIGURE 8 that needles **31** are held in the grooves of needle bed plate **30** by a bar **32** (FIGURE 8) which extends lengthwise of bed plate **30** and intersects the grooves in bed plate **30**.

The needles **31** are reciprocated in unison by means to be later described, and cooperate with backing yarn or weft yarn feed guides **50**, chain warp yarn feed guides **51**, pile yarn feed guides **52** and pile wires or loop forming fingers **53** in the knitting of a pile fabric F, as will be later described. The yarn feed guides **50**, **51**, **52** are also arranged in respective series and complement needles **31**, although said guides are shifted both longitudinally and laterally with respect to the direction in which the fabric F is taken up. The feed guides **50**, **52** for the weft yarns and pile yarns are shown in the form of tubes, and the warp yarn feed guides **51** are shown in the form of fingers of stems having eyes in the free ends thereof although other types of yarn feed guides may be used. Guides **50**, **51**, **52** have respective backing or weft yarns B, chain warp yarns W and pile yarns P extending therethough to the fell of the fabric F being knit.

In order that the mechanism for operating the knitting and pile forming instrumentalities may be understood during the course of their description, a cycle in the operation of the knitting and pile forming instrumentalities will now be given, which is as follows:

(1) Upon completion of each course of the fabric F, assume that needles **31** (FIGURE 8) occupy lowered position, the chain warp feed guides **51** occupy the broken line position; i.e., forwardly of and above the level of the needles **31**, and the pile and weft yarn feed guides **52**, **50** occupy rearward position substantially as shown in FIGURE 8.

(2) Weft yarn feed guides **50** move laterally and forwardly in one direction beneath the pile wires, but above and across approximately three needles **31**, while each pile yarn feed guide **52** moves laterally in the opposite direction from guides **50**, across and above a single pile wire **53**, and past the two respective warp feed guides **51**, thus laying weft yarn B and pile yarn P across and above stitches then looped about the shanks of the respective needles **31**.

(3) Needles **31** move to raised position shown in FIGURE 8, during which their latches are opened by a latch opening trip wire **31***a*.

(4) Chain warp yarn feed guides **51** move rearwardly, then laterally in one direction and then forwardly to place chain warp yarn W through the hooks of the needles **31**, while weft and pile yarn feed guides **50**, **52** also move rearwardly.

(*a*) This positions the backing yarn B and pile yarn P against the front surfaces of respective needles **31**, opposite from the latches thereof, and positions a warp yarn W above respective weft yarns B and pile yarns P.

(5) As warp yarn feed guides **51** return to the broken line position of FIGURE 8, needles **31** return to lowered position, during which they draw stitches through previously formed base loops and said previously formed base loops are shed from the needles **31**. When the needles are lowered, the warp yarn traverses over the respective

weft yarn and pile yarn to bind the wefts and pile loops to the respective chains formed of the chain warps.

(6) While the needles **31** occupy lowered position, or during their downward movement, one or more of the pile wires **53** may be shifted forwardly or rearwardly to present different heights of loop forming stages to the loop forming zone, thus completing one-half of a cycle in the operation of the knitting and loop forming instrumentalities.

(7) The above steps are then repeated, but the lateral movements of the yarn feed guides **50**, **51**, **52** are in the opposite direction from those of the first half of the cycle, thus completing the cycle.

The fabric F is taken up a predetermined amount during the operation of the knitting and loop forming instrumentalities, since a course or weftwise row of chain stitches and pile tufts is completed with each said half-cycle.

Main Drive and Operating Mechanisms for Needles and Warp Yarn Feed Guides

As heretofore described, the needles **31** are lowered and raised in timed relation to movement of the yarn feed guides **50–52**, and the needles **31** are guided for substantially vertical movement in needle bed plate **30**. Bed plate **30** is carried by blocks **54** fixed to transverse frame member **27** (FIGURES 7 and 8). Blocks **54** also support a transverse breast plate **55** for supporting the fabric F as it is formed.

In order to import vertical movement to needles **31**, a needle guide plate **56** (FIGURES 7 and 8) is guided for vertical movement in guides **57** on the bed plate **30**. A shouldered plate **60**, secured to the rear face of guide plate **56**, projects beneath guide plate **56** for supporting the butts or lower ends of needles **31**. The upper ends of a pair of links **61** are universally connected to shouldered plate **60** (FIGURES 2 and 7) and their lower ends are connected to respective cam followers **62** which engage or are mounted on respective eccentric cams **63**.

Cams **63** are fixed on a common drive shaft **64** journaled on the main side frames **21**, **22** and on a right-hand outrigger frame **65**. Drive shaft **64** is also journaled on and extends outwardly beyond a left-hand outrigger side frame member **66** (FIGURES 1 and 2). The right-hand end of drive shaft **64** in FIGURE 2 has a pulley **67** fixed thereon which, as shown in FIGURES 1 and 5, has an endless belt **70** mounted thereon. Belt **70** is also mounted on a pulley **71** driven by an electric motor **72** supported upon the floor *f* upon which the machine rests.

It is thus seen that drive shaft **64** rotates continuously during operation of the machine, thus rotating cams **63** and imparting vertical reciprocatory movement to needles **31**.

The latch opening means for the needles comprises the taut trip wire or cable **31***a* located above pile wires **53** and closely adjacent to the rear surfaces of needles **31** (FIGURES 3, 7 and 8). Latch-opening cable **31***a* extends across the series of pile wires **53** and opposed ends thereof are anchored to fixed anchor blocks **31***b* carried by respective bearing stands **77** on the transverse frame member **27**.

The chain warp feed guides **51** are fixed, at their upper ends, in brackets **73** suitably secured to a rocker plate **74**. Rocker plate **74** is suitably secured to and depends from a transverse rocker shaft **75** journaled in bearings **76** fixed upon respective bearing stands **77**. Three such bearing stands **77** are shown in FIGURES 2, 3, 5 and 7, two of which are fixed to transverse frame member or girt **27**, as stated above, and the other of which is formed integral with a cantilever frame **80** (FIGURES 3 and 5) connected to the front upper portion of main right-hand side frame **21**.

In order to rock rocker shaft **75**, rocker plate **74**, brackets **73** and chain warp feed guides **51** in proper timed relation to vertical reciprocation of needles **31**, one end of rocker shaft **75** has a crank **81** fixed thereon (FIGURES 2, 3 and 5) to which the upper end of a link or connecting

rod 82 is adjustably and universally connected. The lower end of connecting rod 82 has an annular follower 83 connected thereto which encircles an eccentric cam 84 fixed on main drive shaft 64 (see right-hand portion of FIGURE 2). Since drive shaft 64 rotates continuously during operation of the machine, it is apparent that cam 84 imparts vertical reciprocation to rod 82 and crank 81, thus oscillating rocker shaft 75, rocker plate 74, brackets 73 and chain warp feed guides 51 (FIGURES 7 and 8).

As heretofore stated, each time chain warp feed guides 51 move rearwardly with respect to needles 31, they must move laterally in one direction or the other. Accordingly, as best shown in FIGURES 2 and 3, opposed end portions of rocker shaft 75 have respective follower wheels or disks 85 thereon which engage peripheral surfaces of respective oppositely arranged cams 86.

Each cam 86 is fixed on the upper end of a vertical shaft 87 journaled in bearings 90 carried by the respective main side frames 21, 22. The lower end of each shaft 87 has a bevel gear 91 fixed thereon which engages a bevel gear 92 fixed on the drive shaft 64. The gears 91, 92 should be of such relative size that the cams 86 rotate one-half revolution with each revolution of drive shaft 64. It will be observed in FIGURE 3 that cams 86 are so arranged that each cam maintains the follower associated with the other cam in engagement with the other cam. Since drive shaft 64 rotates continuously, the shafts 87 and cams 86 are also rotated continuously to impart reciprocatory movement to the rocker shaft 75 longitudinally of its own axis.

Rocker shaft 75 also preferably carries a suitable yarn guiding means shown in the form of a reed 93 through which chain warp yarns W pass in their course to the eyes of the chain warp feed guides 51 (FIGURE 8). The means directing chain warp yarns W to reed 93 and feed guides 51 will be later described.

Operating Mechanisms for Pile Yarn and Weft Yarn Feed Guides

As heretofore stated, the feed guides 50, 52 for the weft yarn and pile yarn are moved forwardly, rearwardly and laterally in timed relation to vertical reciprocation of the needles 31. To this end, the weft yarn and pile yarn feed guides 50, 52 are in the form of respective weftwise series of tubes suitably secured to respective carrier bars 94, 95 (FIGURES 3, 7 and 8) which are parts of respective feed guide carriages 96, 97 supported by a transverse frame or platform 100 (FIGURES 3, 4, 5, and 7–11) bridging, and being suitably secured to, main side frames 21, 22 on a level approximating that at which the fabric F is formed.

The upper carriage 97, which may also be termed as a pile yarn feed guide carriage, comprises a pair of end plates 101, 101', to the front relatively narrow portions of which opposed ends of inclined carrier bar 95 are suitably secured. Plates 101, 101' are also interconnected by three rods or shafts 102, 103, 104, the front rod 102 of which serves as a guide bar for pile yarns P (FIGURE 8) in their course to tubular pile yarn feeding guides 52.

Opposed ends of the rear shaft 104 extend beyond the end plates 101, 101' of carriage 97 and are journaled or pivotally supported in a pair of elongate transmission bars 105, 105' which extend longitudinally of the machine, but transversely of the platform 100 (FIGURES 9 and 10). Suitable spacers 98 may be mounted on shaft 104 between plates 101, 101' and bars 105, 105'.

Transmission bars 105, 105' rest and move freely upon a front guide bar 106 which extends throughout substantially the entire length of platform 100 and is suitably secured to platform 100. The central portion of guide bar 106 is provided with a plurality of slots extending substantially horizontally therethrough and indicated at 107. Slots 107 are provided for guiding and maintaining pile wires 53 in proper alinement with the spaces between adjacent needles 31.

The rear portion of plate 100 is provided with a pair of rear guide bars 110, 110' (FIGURES 10 and 8, respectively) which are relatively short and upon which the rear portions of transmission bars 105, 105' are supported for freedom of movement relative to the respective rear guide bars 110, 110'.

Opposed ends of the front guide bar 106 support respective bearing blocks 111, 111', and the rear guide blocks 110, 110' support similar bearing blocks 112, 112' (FIGURES 3, 8 and 10). Since the operating mechanism adjacent the right-hand end of upper yarn guide carriage 97 is identical to the operating mechanism adjacent the left-hand end of the carriage 97, except being opposite hand, only the remaining structure adjacent the right-hand end of the upper yarn guide carriage 97 will be described in detail and like parts associated with the operating mechanism adjacent the left-hand end of carriage 97 will bear the same reference characters with the prime notation added, in order to avoid repetitive description.

As best shown in FIGURES 3, 9 and 10, bearing blocks 111, 112 have respective thrust or tappet rods 113, 114 mounted for longitudinal sliding movement therein weftwise of the machine. The inner ends of tappet rods 113, 114 have opposed ends of a tappet element or tappet head 115 suitably secured thereto which bears in sliding engagement against the outer surface of the transmission bar 105. Transmission bar 105 and tappet head 115 are maintained in sliding engagement with guide bars 106, 110 by a substantially Z-shaped bracket 116 suitably secured to the upper surface of platform 100.

Medial portions of bearing blocks 111, 112 are recessed to accommodate opposite end portions of a tappet bridge bar 117, which may also be termed as a tappet follower bar, and which is suitably secured to tappet rods 113, 114. A medial portion of tappet bridge bar 117 is recessed for reception of a cam follower 120 in engagement with the periphery of a tappet cam wheel 121 fixed on the upper end of a substantially vertical shaft 122. Cam follower 120 is maintained in engagement with the periphery of cam wheel 121, by any suitable means such as compression springs 123, 124 surrounding outer portions of respective tappet rods 113, 114, and engaging the outer surfaces of bearing blocks 111, 112. The outer ends of compression springs 123, 124 engage respective collars 125, 126 suitably adjustably secured to the outer portions of tappet rods 113, 114.

It will be observed in FIGURE 3 that the tappet cam wheels 121, 121' are oppositely arranged so that, when either of the cam wheels 121, 121' is moving the respective tappet head inwardly to impart a shogging or weftwise movement to the carriage 97 in one direction, the other of the tappet cams permits the corresponding tappet head to move outwardly, and vice versa. The tappet cam shafts 122, 122' are journaled in respective bearings 130, 130' (FIGURES 4, 5 and 9) carried by the respective main upright side frames 21, 22.

The lower ends of shafts 122, 122' have respective bevel gears 131, 131' fixed thereon (FIGURE 2) which engage respective bevel gears 132, 132' fixed on an auxiliary drive shaft 133. Tappet cam shafts 122, 122' rotate one-half a revolution with each revolution of drive shafts 64, 133. Like the main drive shaft 64, auxiliary drive shaft 133 is journaled in the main upright side frames 21, 22 and the outrigger side frames 65, 66. As best shown in FIGURE 7, auxiliary drive shaft 133 is driven at substantially the same speed as, but in the opposite direction from, the main drive shaft 64, by means of intermeshing gears 134, 135 fixed on the respective shafts 64, 133.

From the foregoing, it is apparent that the upper yarn guide carriage 97 and respective yarn feed guides 52 are shifted laterally of the machine in timed relation to vertical reciprocation of needles 31.

As heretofore stated, shaft 104 serves to connect car-

riage 97 to the transmission bars 105, 105'. It might be stated that, since shaft 104 is journaled in the transmission bars 105, 105', the pile yarn feed guides 52 may be readily raised to facilitate threading the pile yarns P and weft yarns B through the respective tubular feeding guides 52, 50.

Now, in order to impart forward and rearward movement to the upper carriage 97 and its pile yarn feed guides 95, it will be observed in FIGURES 3, 4, 5, 7, 8, 9 and 10 that the transmission bars 105, 105' have respective posts or bosses 136, 136' thereon to which front ends of respective links 137, 137' are pivotally connected. The rear ends of links 137, 137' are pivotally connected to the lower ends of respective cranks 140, 140' (FIGURES 7 and 9) fixed on a common rocker shaft 141 journaled on the front portions of the main extension frames 23, 24 and on a post 142 extending upwardly from the left-hand outrigger frame 66 (FIGURE 5), by means of bearing blocks 143.

A crank 144, suitably secured to and extending forwardly from rocker shaft 141, has the upper end of a link 145 pivotally and adjustably secured thereto (FIGURES 2, 5 and 9). Link 145 serves as a connecting rod, since its lower end is connected to a circular follower 146 which encircles an eccentric cam 147 (see lower left-hand portion of FIGURE 2) fixed on auxiliary drive shaft 133. Thus, cam 147 imparts vertical reciprocatory movement to connecting rod 145 and crank 144, thus imparting oscillatory movement to rocker shaft 141, cranks 140, 140', links 137, 137' and transmission bars 105, 105'.

Since carriage 97 is connected to transmission bars 105, 105', it is apparent that the movement imparted thereto by cranks 140, 140' and the intervening links 137, 137' is also imparted to carriage 97 and its pile yarn feed guides 52. This completes the description of the function and construction of the upper carriage 97.

The lower carriage 96 is constructed in a manner quite similar to that of the upper carriage 97. The lower carriage 96 comprises end plates 150, 150' which serve as transmission bars and are interconnected by the weft yarn feed guide carrier bar 94 and a rod 151. The end plates 150, 150' are guided for lateral and longitudinal movement with respect to the machine between the platform 100 and respective slide supports 152, 152'. The slide supports 152, 152' are substantially L-shaped in cross-section and their upwardly extending portions are suitably secured to the lower surface of platform 100, as best shown in FIGURES 9, 10 and 11. The slide supports 152, 152' also support respective tappet head bars 153, 153' for sliding movement thereon. Since the parts associated with tappet head bars 153, 153' may be identical, only the parts associated with tappet head bar 153 will be described in detail and like parts associated with tappet head bar 153' will bear the same reference characters with the prime notation added, in order to avoid repetitive description.

As shown in the right-hand portion of FIGURE 9 and in FIGURE 11, the inner ends of a pair of spaced tappet rods 154, 155 are suitably secured to tappet head bar 153 and extend outwardly therefrom, slidably penetrating the vertical portion of the substantially L-shaped slide 152. The rods 154, 155 are also guided for longitudinal sliding movement, weftwise of the machine, in respective bearing blocks 156, 157 (FIGURES 9 and 11) suitably secured to the lower surface of platform 100. Opposed end portions of a tappet bridge bar or follower bar 160 are suitably secured to tappet rods 154, 155. A medial portion of tappet bridge bar 160 is recessed and has a cam follower 161 journaled therein, which is engaged by a cam wheel 162 fixed on the vertical tappet cam shaft 122.

Follower 161 is maintained in engagement with the periphery of cam 162 by any suitable means, such as a pair of compression springs 163, 164 which loosely surround the respective tappet rods 154, 155, and bear against the outer bearing blocks 156, 157. The outer ends of compression springs 163, 164 bear against respectively collars 165, 166 (FIGURES 10 and 9, respectively) fixed on the outer portions of tappet rods 154, 155.

It is thus seen that the cam wheels 162 impart lateral movement to the weft feed guides 50 in substantially the same manner in which the cam wheels 121, 121' impart lateral movement to the pile yarn feed guides 52. However, it should be noted that the high points or lobes of the tappet cam wheels 162, 162' are higher than, and extend in the opposite directions from, the lobes of the upper tappet cam wheels 121, 121'. This is desirable so that the weft yarn feed guides 50 move in the opposite direction from the pile yarn feed guides 52 and move a distance slightly greater than the distance embraced by three needles 31, while the pile yarn guides 52 each moves a distance slightly greater than the distance from one needle to the next adjacent needle 31.

Forward and rearward movement is imparted to the weft yarn feed guides 50 in a manner quite similar to that in which forward and rearward movement is imparted to the pile yarn feed guides 52. However, in this instance, the end plates or bars 150, 150' of the lower carriage 96 serve substantially the same purpose as the transmission bars 105, 105' of the upper carriage 97.

To this end, it will be noted that the end bars 150, 150' of lower carriage 96 have respective inwardly projecting portions 170, 170' thereon (FIGURES 8, 9 and 11) to which the front ends of respective links 171, 171' are pivotally connected. The rear ends of links 171, 171' are pivotally connected to respective cranks 172, 172' (FIGURES 3, 4, 5, 7 and 9) whose lower portions are fixed on a common rocker shaft 173. Rocker shaft 173 is journaled in bearings 174 carried by the main upright side frames 21, 22.

Referring to FIGURES 7 and 9, the central portion of rocker shaft 173 has a crank 176 fixed thereon and extending forwardly therefrom, and to which the upper end of a connecting rod 177 is pivotally connected. The lower end of connecting rod 177 is connected to a circular follower 180 which encircles an eccentric cam 181 fixed on the auxiliary drive shaft 133.

It is apparent that, since auxiliary drive shaft 133 rotates continuously during operation of the machine, cam 181 imparts vertical reciprocatory movement to connecting rod 177 and the corresponding end of crank 176. This, in turn, oscillates rocker shaft 173, cranks 172, 172' and links 171, 171' to thus impart forward and rearward reciprocatory movement to the lower carriage 96 and the weft yarn feed guides 50.

Yarn Supply Let-Off and Tension Control

Referring to FIGURES 1 and 6, the chain warps W, pile yarns P and weft yarns B are drawn from respective warp beams 185, 186, 187. Beams 185, 186 are journaled on a front beam frame 190 and are equipped with suitable braking or friction let-off devices 191, 192. The weft yarn warp beam 187 is journaled upon brackets 193 carried by and projecting forwardly from a pair of upright frame members 194 spaced rearwardly from, and suitably connected to, the main side frames 21, 22. Weft yarn warp beam 187 is also provided with a suitable braking device or friction let-off device 196. The braking devices 191, 192, 196 may be of well-known construction such as is indicated at 76–82 in FIGURE 1 of U.S. Patent No. 1,665,274 granted to C. E. Neisler, Jr. on April 10, 1928.

The yarns W, P, B pass upwardly from the respective warp beams 185–187 and then pass over respective let-off rolls or friction rolls 200, 201, 202 suitably journaled in an elongate substantially horizontal overhead frame broadly designated at 203. Overhead frame 203 comprises three laterally spaced longitudinally extending frame members 204, 205, 206 (FIGURES 1, 2, 4, 5 and 6), the ends of which are interconnected by transverse frame members 207, 208. Frame members 204, 205

of overhead frame 203 are supported on the upper ends of the respective extension frames 23, 24, and frame member 206 is supported on the upper end of post 142 (FIGURES 5 and 6) of the outrigger frame 66.

The yarns W, P, B pass inwardly toward the center of the machine, and downwardly beneath respective guide rolls 211–213 journaled in overhead frame 203. Chain warps W then pass through a suitable fixed reed 214 (FIGURE 6) carried by overhead frame 203, from whence chain warps W pass beneath a dancing roll 215 guided for vertical movement between the flanges of a pair of vertical channel members 216 depending from the respective longitudinal side frame members 204, 205 (FIGURES 3, 4, 5 and 6). A removable pin 217 may be positioned through, and span the distance between, the flanges of the channel members 216 to limit downward movement of dancing roll 215.

From the dancing roll 215, chain warps W pass upwardly and rearwardly, at an angle, over an idler roll 220 journaled on overhead frame 203. Chain warps W then pass downwardly through reed 93 and to the chain warp feed guides 51, in the manner heretofore described.

As shown in FIGURES 4, 5 and 6, the backing or weft yarns B pass upwardly and forwardly from idler roll 213, over an idler roll 222 journaled on overhead frame 203, then downwardly through a reed 223 carried by extension frames 23, 24, then beneath and forwardly from an idler guide roll 224 journaled on the rear portions of main side frames 21, 22, and then forwardly and downwardly to and beneath a guide rod 225. It will be observed in FIGURES 4 and 5 that guide 225 is adjustably mounted in a pair of upright brackets 226 carried by the main side frames 21, 22. If so desired, brackets 226 may support a suitable drop-wire type of stop motion of conventional or other construction, for stopping the machine upon any one of the weft yarns being parted. The weft yarns extend upwardly and forwardly from between brackets 226 through a suitable reed 230 (FIGURES 7 and 8) and thence, through the tubular weft yarn feed guides 50.

Since the primary purpose of the present machine is to knit a fabric having warpwise rows of pile tufts of varying height, it is apparent that the amount of each pile yarn P used for forming successive warpwise loops must vary and, therefore, the amounts that certain pile yarns are taken up by the fabric vary with the formation of certain courses or weftwise rows of pile tufts. Accordingly, it will be observed in FIGURES 6 and 6–A that the pile yarns P pass upwardly and rearwardly through a suitable reed 234 to a pile yarn tension control device broadly designated at 235.

Various types of pile yarn tension control devices may be used on the present machine. In this instance, the pile yarn tension control device 235 is in the form of an open-bottomed frame supported on overhead frame 203 and including an upper group of fixed, horizontally spaced and substantially parallel rods 236 (FIGURES 6 and 6–A) beneath which a group of vertically movable, horizontally spaced and substantially parallel dancing rods or rolls 237 are positioned. It will be noted that the frame of tension control device 235 includes a pair of side plates 240 provided with a series of horizontally spaced, vertically extending slots 241 therein within which opposed ends of the respective dancing rods 237 are loosely mounted and, thus, guided for vertical movement relative to the group of fixed rods 236.

The frame of device 235 also supports a pair of horizontally spaced fixed guide rods 243, 244 which straddle the lower group of dancing rods 237 and the slots 241. Thus, the pile yarns P pass rearwardly from reed 234 beneath guide rod 243 of the tension control device 235, then upwardly and over upper rods 236. The pile yarns P pass beneath the dancing rolls 237 and are thus split into several groups of pile yarn, respective groups of which pass upwardly from the dancing rods 237 and over respective upper fixed rods 236. From the rearmost fixed rod 236, the pile yarns P pass downwardly beneath guide rod 244 to an accumulative tension device to be presently described.

It is thus seen that the dancing rods 237 rest upon respective groups of pile yarns to maintain tension therein and as relatively long loops are formed in the fabric from the pile yarns in any one group shown in FIGURE 6–A, it is apparent that respective dancing rod 237 moves upwardly and will return toward the lowered position with the subsequent movement of the let-off or friction roll 201 (FIGURE 6), thus embodying means for maintaining each group of pile yarns under tension even though the sizes of successive pile tufts formed therefrom are varied from time to time during knitting.

The pile yarns P pass forwardly from the yarn tension control device 235, between a pair of lease rods 245, 246 of an accumulative tension device. Yarns P then pass beneath an idler roll 247 carried by overhead frame 203, and over another lease or guide rod 250. From the guide rod 250, pile yarns P pass downwardly and forwardly into engagement with an idler roll 251 journaled on overhead frame 203, from whence the pile yarns pass downwardly through a reed 252 carried by fixed brackets 253 (FIGURES 4, 5 and 8) which extend rearwardly and are suitably secured to the upright extensions 23, 24 of the respective main side frames 21, 22.

It will be observed in FIGURE 8 that pile yarns P pass downwardly from reed 252, partially around the rod 102 of upper carriage 97 and thence through pile yarn feed guides 52 to the fabric F.

It will be observed in the central portion of FIGURE 6 that opposed ends of rod 246 are fixed to overhead frame 203 and rod 246 has a pair of levers 256 oscillatably mounted thereon, only one of which is shown. The levers 256 have opposite ends of the lease rods 245, 250 mounted therein astraddle the lease rod 245. The ends of the levers 246 in which the lease rod 245 is mounted have respective tension springs 257 connected thereto and extending downwardly to where they are connected to the overhead frame 203. Thus, the front lease rod 245 yieldably bears against the upper surfaces of the pile yarns P and cooperates with the tension device 235 in maintaining the pile yarns P under uniform tension.

In order to let off the yarns W, P, B predetermined amounts while knitting each course of stitches, auxiliary drive shaft 133 has another eccentric cam 260 fixed thereon (FIGURES 2 and 5) on which a circular cam follower 261 is mounted. Cam follower 261 has the lower end of a connecting rod or link 262 pivotally connected thereto whose upper end is pivotally and adjustably connected to a crank 263 (FIGURES 2, 5 and 6) fixed on a rocker shaft 264. Rocker shaft 264 is journaled in bearings 265 carried by post 142 and upper extension frames 23, 24.

Rocker shaft 264 has a pair of rocker arms 266 fixed thereon (FIGURE 2), to which the lower ends of respective links 267 are pivotally and adjustably secured (FIGURES 2, 4, 5 and 6). The upper end of each link 267 is pivotally connected to a crank arm 270 fixed on a shaft 271 (FIGURE 6) journaled on the central portion of the overhead frame 203.

Shaft 271 has a crank 273 fixed thereon and projecting upwardly therefrom to which the proximal ends of links 274, 275, 276 are pivotally connected. Links 274, 275 extend forwardly and are pivotally and adjustably connected to respective clutch crank arms 277, 278 mounted on reduced corresponding ends of the respective friction rolls 200, 201. Link 276 extends rearwardly from crank arm 273 and is pivotally and adjustably connected to a clutch crank arm 281 depending from and being mounted on a reduced corresponding end of the friction roll 202.

Clutch crank arms 277, 278, 281 may be connected

to friction rolls 200–202 by any suitable clutch or ratchet mechanism of types such as are shown in FIGURES 9 and 10 of U.S. Patent No. 2,645,250 granted to Ivar O. Moberg or FIGURE 12 of U.S. Patent No. 1,739,192 granted to Walter H. Wakefield. Each such ratchet mechanism is shown in the form of a ratchet wheel 279 fixed on the reduced end of the respective friction roll and engaged by a pawl 280 pivoted on the respective crank arm. If desired, suitable brake means, such as is disclosed in said Neisler patent, may be provided to prevent reverse movement of rolls 200–202 during reverse or inactive strokes of crank arms 277, 278, 281.

It is thus seen that, each time connecting rod 262 (FIGURES 2 and 6) is moved downwardly by cam 260, downward movement is also imparted to link 267 and crank 270 to impart a counterclockwise movement to crank arm 273. In so doing, links 274, 275, 276 are moved from right to left to impart counterclockwise movement to friction rolls 200, 201 and clockwise movement to friction roll 202, thus drawing a predetermined amount of yarn from each of the warp beams 185–187. It should be noted that the amount of yarn drawn off of each of the warp beams 185–187 may be determined, not only by the throw of cam 260 (FIGURE 2) but it may also be determined by adjusting the corresponding ends of links 274–276 relative to the respective crank arms 277, 278, 281.

Fabric Take-Up Mechanism

As heretofore stated, the fabric being knit is supported adjacent the needles 31 by breast plate 55 (FIGURES 7 and 8). The fabric F passes forwardly from breast plate 55 over an idler roll 285 journaled in bearings 286 (FIGURE 7) carried by the front transverse frame member 26. The fabric F then passes forwardly, downwardly at an angle and partially around a take-up roll or sand roll 287 journaled in bearings 290 suitably secured to the front upper portions of main side frames 21, 22.

The fabric F passes downwardly and rearwardly from sand roll 287, over a guide rod 291 suitably secured to the main side frames 21, 22 and then downwardly, and is wound about a fabric wind-up roll 292. Wind-up roll 292 is mounted on a shaft 293 journaled in bearings 294 carried by the main side frames 21, 22 (FIGURES 2 and 7). The friction take-up roll 287 and fabric wind-up roll 292 are driven intermittently in a step-by-step manner to be presently described.

As best shown in FIGURES 3, 5 and 7, one reduced end of friction take-up roll 287 has a gear 300 fixed thereon which meshes with a pinion 301 rotable upon a stub shaft 302 carried by left-hand main side frame 22. Pinion 301 is suitably secured to, or formed integral with, a ratchet wheel 303 engaged by a hold-back pawl 304 (FIGURE 5) and a feed pawl 305.

Hold-back pawl 304 is pivotally mounted on one side of the left-hand main side frame 22 and is held in engagement with ratchet wheel 303 by any suitable means, such as a tension spring 306 (FIGURE 5). The feed pawl 305 is pivotally connected to a pawl-carrying arm 310 which extends forwardly and is pivotally mounted on a stub shaft 311 carried by a frame member 314 (FIGURES 2 and 5) on the left-hand outrigger frame 66 and which may be secured in fixed relation to any adjacent part of the main frame 20.

Feed pawl 305 is maintained in engagement with the teeth of ratchet wheel 303 by a tension spring 315, one end of which may be connected to bracket 312 and the other end of which may be connected to a medial portion of pawl 305. Pawl 305 has an operating lever 316 fixedly connected thereto and to which the upper end of a connecting rod 317 is adjustably and pivotally secured. Connecting rod 317 has a circular cam follower 320 on its lower end (FIGURES 2 and 5) which is mounted on an eccentric cam 321 fixed on the main drive shaft 64.

The fabric wind-up roll 292 is rotated only to the extent required in order to maintain the fabric F under adequate tension and to produce a cloth roll of the desired compactness, while the friction take-up roll 287 is driven a predetermined amount in accordance with the length of stitches formed by needles 31 and chain warp feed guides 51. It will be observed in FIGURE 7 that the fabric wind-up roll 292 has a ratchet wheel 325 fixed on the supporting shaft 293 thereof, a portion of which is engaged by a hold-back pawl 326, pivoted on the inner surface of main side frame 22, and which is urged into engagement with ratchet wheel 325 by any suitable means, such as a tension spring 327.

A yieldable feed pawl 330 also engages the ratchet wheel 325, this pawl being in the form of an elongated rod having its threaded upper end loosely penetrating a cuff 331 pivotally mounted on the front portion of a follower lever 332. Follower lever 332 is oscillatably mounted intermediate its ends, as at 333, on the inner surface of left-hand main side frame 22. The rear end of follower lever 332 has a cam follower 334 thereon which rides against the periphery of an irregularly shaped cam 335 fixed on the main drive shaft 64.

The outer end of the shank of feed pawl 330 has an abutment 336 thereon, which is shown in the form of a pair of nuts threaded on the shank of feed pawl 330. A compression spring 337 surrounds the shank of feed pawl 330 and its upper end bears against cuff 331 while its lower end bears against a collar 340 fixed on the lower portion of the shank of feed pawl 330.

It is thus seen that, each time a high point of cam 335 (FIGURE 7) moves into engagement with follower 334 to impart counterclockwise movement to lever 332, cuff 331 is moved downwardly against compression spring 337 to thus impart downward movement to feed pawl 330 under yieldable pressure; that is, until the tension in the fabric is such as to overcome the pressure of spring 337, whereupon cuff 331 may continue to move downwardly, but feed pawl 330 will remain stationary.

During part of the movement of cam 335 past follower 334, spring 337 assists in maintaining follower 334 against cam 335. However, as a low surface of cam 335 moves into registration with follower 334, a tension spring 341 maintains follower 334 in engagement with cam 335 so as to move cuff 331 in engagement with nuts 336 and thus move feed pawl 330 upwardly sufficiently to engage a succeeding tooth or teeth in the periphery of ratchet wheel 325. Thus, another stroke in movement is imparted to ratchet wheel 325 and the fabric wind-up roll 292 when the next succeeding high point of cam 335 engages follower 334, thus completing the description of the fabric take-up mechanism.

Pile Wires and Their Operating Mechanism

As heretofore stated, the pile wires 53 are arranged in a row or series across the machine, are alternately arranged with respect to the needles 31, and the shanks of the pile wires are guided for longitudinal movement in the slots 107 (FIGURE 11) provided in the front guide bar 106 which supports the front portion of the pile yarn guide carriage 97. Various types of pile wires may be used for producing pile tufts of at least two different heights, a few forms of such pile wires being shown in FIGURES 12–15.

The type of pile wire shown in FIGURE 11 is indicated at 53 and the other forms of pile wires are indicated at 53*a*, 53*b*, 53*c*. All the different forms of pile wires are similar to the extent that each form of pile wire has at least two upper surface portions or loop forming stages of different heights, the upper stages being formed by respective forwardly projecting prongs or projections 350, 350*a*, 350*b*, 350*c* and the lower loop forming stages being formed by respective nose portions, prongs or projections 351, 351*a*, 351*b*, 351*c* which project forwardly beyond the upper projections 350, 350*a*,

350*b*, 350*c*. The prongs 350–350*c* and 351–351*c* are preferably spaced apart to form respective slots 352–352*c* therebetween for receiving any uncut pile loop tufts over which the upper prongs may ride when respective pile wires are advanced following the formation of relatively short pile loops over the lower prongs 351–351*c*. The upper surfaces of upper prongs 350–350*c* are shown to be of the same height as the shanks of respective wires 53–53*c*. However, they may be of greater or lesser height than the shanks, if desired.

Pile wire 53*a* differs from pile wire 53 in that the free end of the lower prong 351*a* thereof is provided with a cutting blade 354 in its upper portion which is of sufficient height to cut any loops formed over the corresponding lower prong 351*a*, but which is of lesser height than the upper surface of the corresponding upper prong 350*a*, so as to sever only the relatively short pile tufts while the relatively long pile tufts remain in the form of uncut pile loops.

Pile wire 53*b* of FIGURE 14 is quite similar to pile wire 53*a* of FIGURE 13 with the exception that a cutting blade 355 is provided on the free end of the lower prong 351*b* which is of sufficient height to sever both the short and long pile tufts formed on the respective prongs 351*b*, 350*b* of the pile wire 53*b*.

Pile wire 53*c* differs from pile wire 53 in that the upper prong 350*c* of pile wire 53*c* is provided with an upwardly forwardly inclined cutting blade 356 on its free end while the lower prong 351*c* of pile wire 53*c* is devoid of any cutting blade. Thus, any pile tufts formed over the lower prong 351*c* remain in the form of uncut pile loops while the relatively high pile tufts formed over the upper prong 350*c* are severed by the blade 356.

The pile wires are shifted walewise or warpwise by a pattern mechanism. To this end, the rear end of the shank of each pile wire 53 is pivotally connected to the lower end of an operating lever 360 (FIGURE 8) preferably by means of a pin 361 carried by the respective lever 360 and penetrating a slot 362 formed in the rear end of the corresponding pile wire 53. All the levers 360 are oscillatably mounted intermediate their ends on a transverse shaft 363. Adjacent operating levers 360 are maintained in spaced relationship by suitable collars or spacer sleeves 365 mounted on the shaft 363. Shaft 363 is fixed in a pair of brackets 364 carried by the extension frames 23, 24 of the respective main side frames 21, 22.

Upper and lower portions of the operating levers 360 may be guided in suitable comb plates 366, 367 (FIGURES 7 and 8) extending between and being suitably secured to the front portions of the extension frames 23, 24. It will be observed in FIGURES 5 and 8 that the upper end of each wire-operating lever 360 has a tension spring 370 connected thereto, which extends rearwardly and has its other end connected to a transverse bar 371 carried by the upper extension frames 23, 24. These springs 370 normally urge the pile wires forwardly so that their upper pile forming stages are presented to the loop forming zone between adjacent needles.

The upper end of each wire-operating lever 360 also has a pattern control cord 372 connected thereto, preferably by means of a tension spring 373. The cords 372 engage corresponding rollers 374, there being two sets of such rollers shown in FIGURE 8. Each set of rollers 374 is rotatably mounted on a shaft 375. It will be observed in FIGURES 4 and 5 that shafts 375 are mounted in brackets 376 projecting forwardly from and being suitably secured to the extension frames 23, 24.

From the rollers 374, cords 372 extend upwardly to a suitable pattern mechanism generally designated at 380 (FIGURES 1 and 6) which is preferably in the form of a jacquard mechanism, although a dobby head or other type of pattern mechanism may be used. Since jacquard pattern mechanisms are well known, a detailed description thereof is deemed unnecessary. An example of one type of jacquard mechanism which may be used is disclosed in U.S. Patent No. 802,938, dated October 24, 1905.

The jacquard pattern mechanism 380 is suitably supported upon the overhead frame 203 and may be driven by a sprocket chain 381 mounted on a sprocket wheel 382 (FIGURE 6) fixed on a shaft 383 projecting from the jacquard mechanism 380. The sprocket chain 383 is also mounted on a sprocket wheel 384 (FIGURES 2 and 5) fixed on auxiliary drive shaft 133.

It is thus seen that the position of each pile wire 53 is determined by the pattern mechanism 380, since each individual cord 372 may be pulled upwardly by the pattern mechanism during the knitting of selected courses, thus imparting counterclockwise movement to the respective levers 360 (FIGURE 8) to present the low prongs of the respective pile wires 53 to the loop forming zone. On the other hand, when any of the cords 372 are released by the pattern mechanism 380, springs 370 move the respective operating levers 360 in a clockwise direction in FIGURE 8, thus shifting forwardly respective pile wires 53 to present the relatively high loop forming stages thereof, defined by the upper prongs 350, to the loop forming zone.

Thus, the pile wires 53 are selectively controlled to present either of the loop forming stages thereof to the loop forming zone in accordance with a predetermined pattern to form pile tufts in loop form of at least two different heights in any predetermined order throughout the length and width of the fabric being knitted. It is apparent that pile wires 53*a*, 53*b* and 53*c* may be combined with pile wires 53 so that all the low loops in selected rows would be cut while the high loops in such rows would be uncut, certain other rows could have both the high and low loops cut and still other rows could have only the high loops cut. On the other hand, any one of the three types of wires 53*a*, 53*c* may be substituted for pile wires 53.

The Fabric

One type of knit pile fabric is shown in FIGURE 16 in which the strands of the chain warp yarn extending from each loop to the next succeeding loop are exaggerated in length in order to show the bights of the chain stitches, the strands of weft yarn and the pile tufts in exploded, spaced relationship, for purposes of clarity. The fabric of FIGURE 16 is knit with the machine equipped with pile wires 53 so that all the pile tufts are in the form of loops. The pile yarns in the portion of the fabric shown in FIGURE 16 are indicated at P–1 through P–6; the backing or weft yarns are indicated at B–1 through B–6 and the chain warp yarns are indicated at W–1 through W–6.

It will be noted that each chain or row of chain stitches is made from a respective chain warp yarn and each warpwise row of pile tufts includes relatively high pile loops H and relatively low pile loops L with respective pile yarns being bound in the fabric by two adjacent lines of chain stitches. The bases of the loops formed from each pile yarn span two chain stitches of one row at one side of each row of loops, then cross over the space between adjacent rows of chain stitches, whereby the pile yarns are raised according to the height of the loop forming stages heretofore described, and then are bound in the fabric at the next adjacent row of chain stitches and also span two stitches, subsequent to which this procedure is repeated to complete a cycle in the formation of the loops.

Of course, the weft yarns B–1 through B–6 are laid across a plurality of three warps in this instance so that two overlapping weft yarns are provided in the space between adjacent warp chains or rows of chain stitches, as is desirable. However, the weft yarns may be made to

cross a greater number of chain warps, without departing from the spirit of the invention.

Now, by selecting the positions of the pile wires, such as wires 53, it will be noted that the first pile tuft row 1 includes a group of four successive relatively high loops H and two subsequent relatively low loops L, while the second pile tuft row 2 includes a single relatively high loop and a group of five relatively low loops. The third pile tuft row 3 includes two relatively low loops L, two relatively high loops H and two relatively low loops L in that order. Tuft row 4 includes six loops, all of which are low loops, and row 5 includes a group of four high loops H and two low loops L. It is thus seen that pile tufts of at least two different heights are formed both warpwise and weftwise of the fabric, according to the desired pattern.

From the foregoing, it is apparent that many different variant-height pile tuft patterns may be knit according to my method and wherein the pile tufts of one or more heights may be cut or uncut during the knitting. The higher pile tuft loops may be cut, independently of lower loops, during knitting or after the fabric is removed from the machine, as desired.

It is thus seen that I have provided a novel method and apparatus for knitting a base fabric of chain stitches inlaid with wefts and pile yarns, wherein each of the pile yarns may be bound to two adjacent rows of chain stitches with the pile yarns being moved across variant-height stages of pattern controlled pile wires between the chain stitch rows so the pile yarns form tufts of different heights, cut or uncut, according to any preconceived pattern.

Of particular importance is my novel arrangement of the feed guides for the weft and pile yarns and the pile wires, wherein the pile wires 53 are guided for longitudinal movement between and independently of the weft and pile yarn feed guides 50, 52 so that these two series of feed guides may move transversely relative to each other and relative to pile wires located between the two series of feed guides. This arrangement permits selective longitudinal shifting of the pile wires relative to the needles and the laying of weft yarns across the chain of stitches beneath the pile wires, while pile yarns are laid across adjacent chains and over the pile wires.

In the drawings and specification, there have been set forth preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. In a warp knitting machine having a transverse row of spaced knitting needles and first chain warp feed guides for guiding chain warps about said needles to knit chains therefrom, and drive means for said needles and said feed guides; the combination of a fixed platform spaced rearwardly of said needles, lower and upper carriages mounted beneath and upon said platform, respectively, a second series of weft yarn feed guides on said lower carriage and a third series of pile yarn feed guides on said upper carriage and through which respective weft yarns and pile yarns pass to the fabric being knit, a plurality of longitudinal pile wires having free front ends between adjacent needles and being carried by said platform, means for imparting transverse reciprocatory movement to said lower and upper carriages in timed relation to the operation of said needles and said first feed guides comprising at least one shaft adjacent a corresponding end of said platform and being connected to said drive means, a pair of cams fixed on said shaft, follower means movable in substantially fixed relation to said carriages and being engageable by the respective cams, means urging said follower means into engagement with said cams, and the throw of said cams being such that reciprocation of said carriages causes the respective weft and pile yarns to be shogged across at least certain of said needles, and whereby said carriages reciprocate relative to and transversely of the pile wires.

2. In a warp knitting machine having a transverse row of spaced knitting needles and first chain warp feed guides for guiding chain warps about said needles to knit chains therefrom, and drive means for said needles and said feed guides; the combination of a fixed frame spaced rearwardly of said needles, lower and upper carriages mounted beneath and upon said frame, respectively, a second series of weft yarn feed guides on said lower carriage and a third series of pile yarn feed guides on said upper carriage and through which respective weft yarns and pile yarns pass to the fabric being knit, a plurality of longitudinal pile wires having free front ends movable between adjacent needles and being guided for movement in said frame and between said second and third series of feed guides, means for imparting transverse reciprocatory movement to said lower and upper carriages in timed relation to the operation of said needles and said first feed guides whereby said carriages reciprocate transversely of the pile wires, the extent of reciprocation of said carriages being such that respective weft and pile yarns are each shogged across at least two of said chains as the pile yarns pass above the pile wires, means for selectively shifting individual pile wires longitudinally relative to said needles, said means for imparting movement to said carriages comprising at least one shaft adjacent a corresponding end of said frame and being connected to said drive means, a pair of cams fixed on said shaft, means movable with each of said carriages and being engageable by one of said cams, and means urging said last-named movable means into engagement with the respective cams.

3. A structure according to claim 2 in which said means movable with each carriage includes a transmission bar on the corresponding end of each carriage, means guiding each transmission bar for transverse and longitudinal movement on said frame with respect to the longitudinal axis of said machine, and means operatively connected to said drive means for imparting forward and rearward reciprocatory movement to said transmission bars and thus to the respective carriages in timed relation to transverse reciprocation thereof.

4. A structure according to claim 2 in which the cam associated with said lower carriage is provided with a relatively higher surface than the cam associated with said upper carriage whereby the extent of transverse reciprocation of said lower carriage is greater than that of said upper carriage.

5. A structure according to claim 2 wherein each of said cams is provided with substantially diametrically opposed high and low surfaces thereon, and wherein the high surface of one of the cams is substantially oppositely arranged with respect to the high surface of the other cam.

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