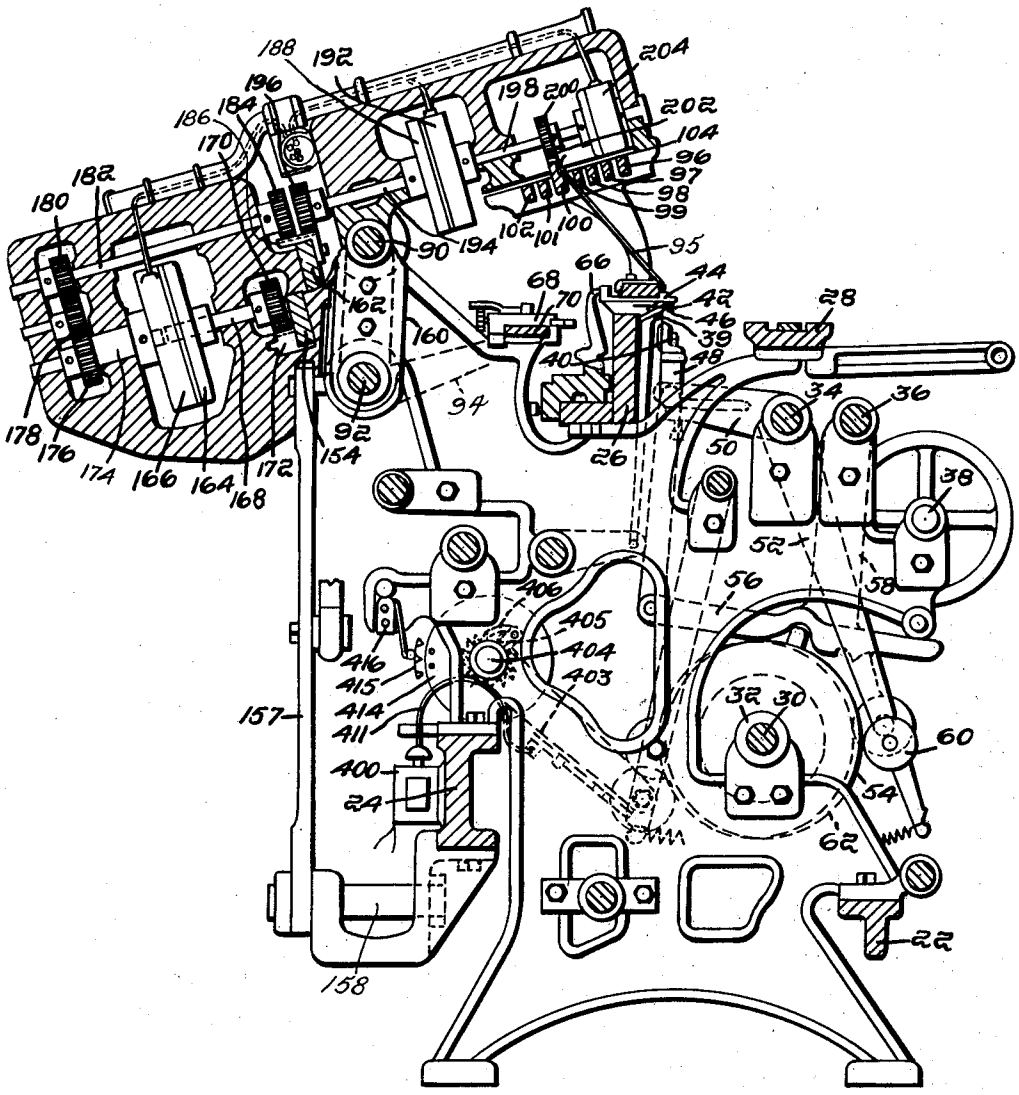
Nov. 17, 1959 A. J. COBERT 2,912,840

YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

Filed June 10, 1955 8 Sheets-Sheet 1

Fig. 1.



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YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

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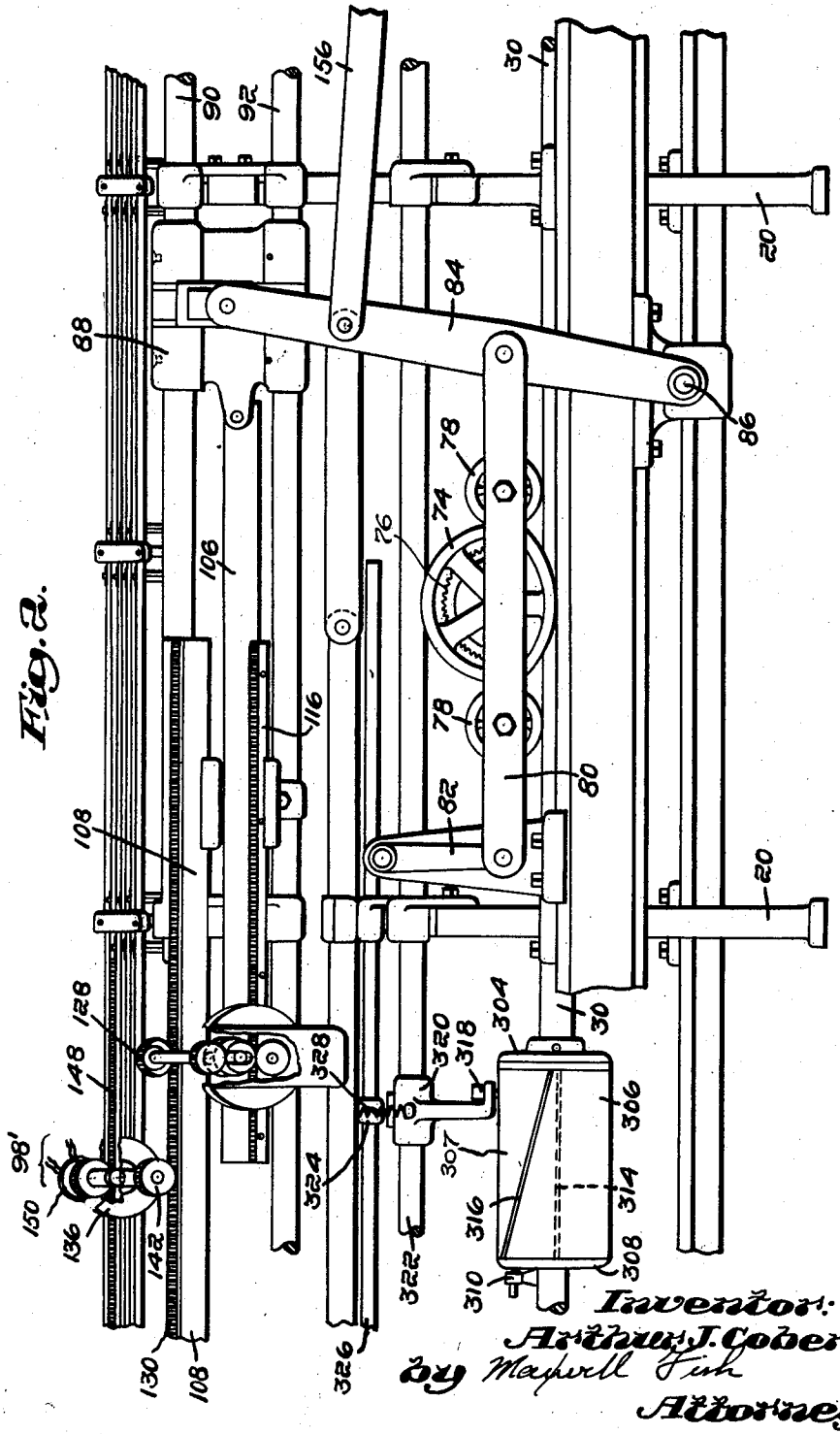

Fig. 2.

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YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

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Fig. 3.

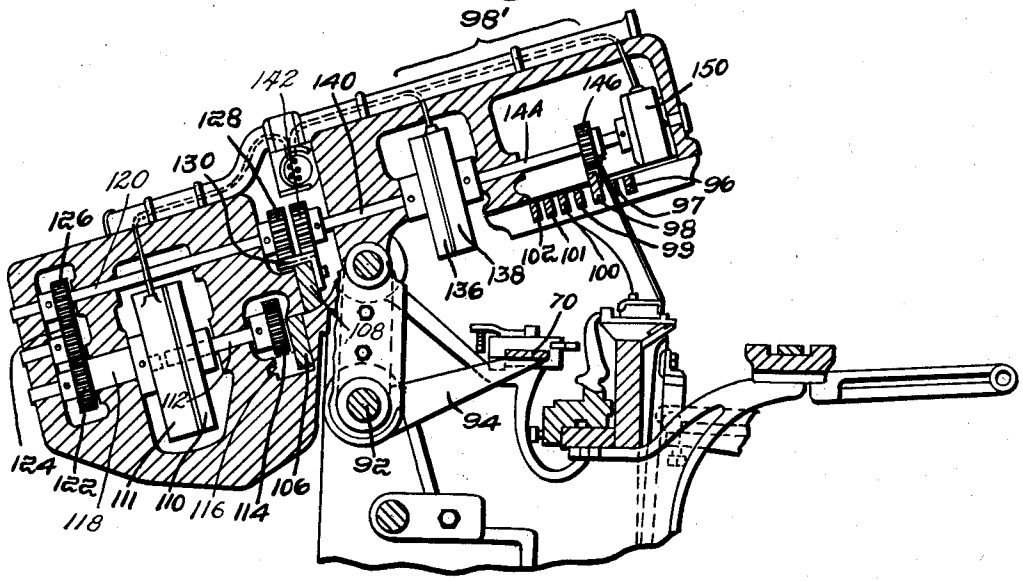


Fig. 4.

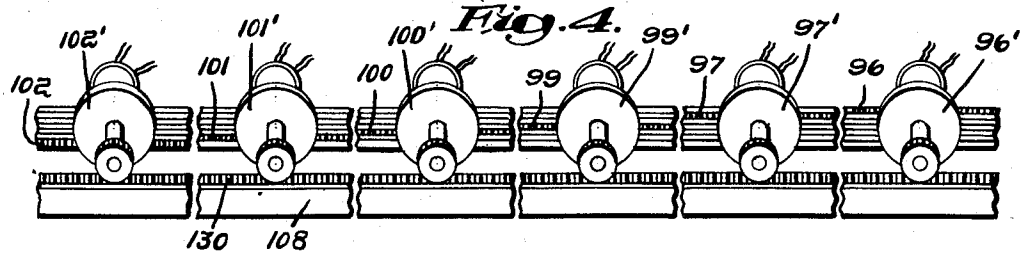
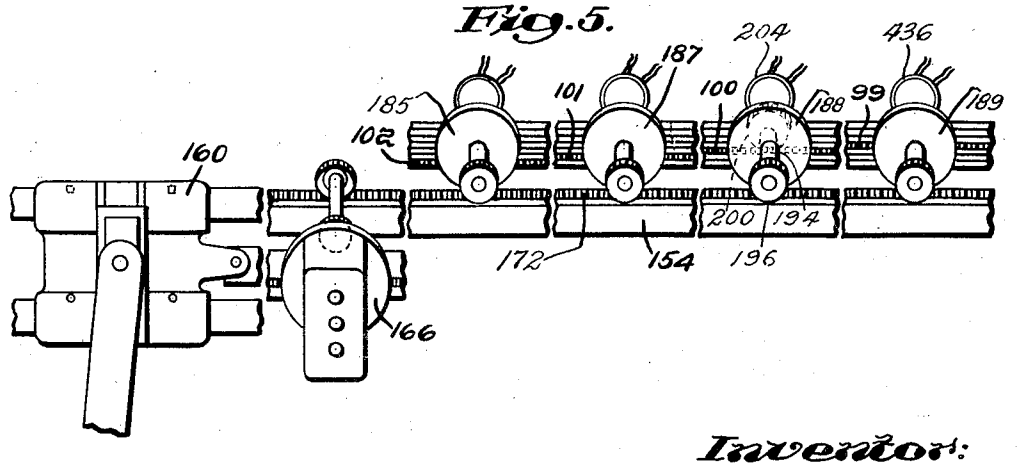


Fig. 5.



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YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

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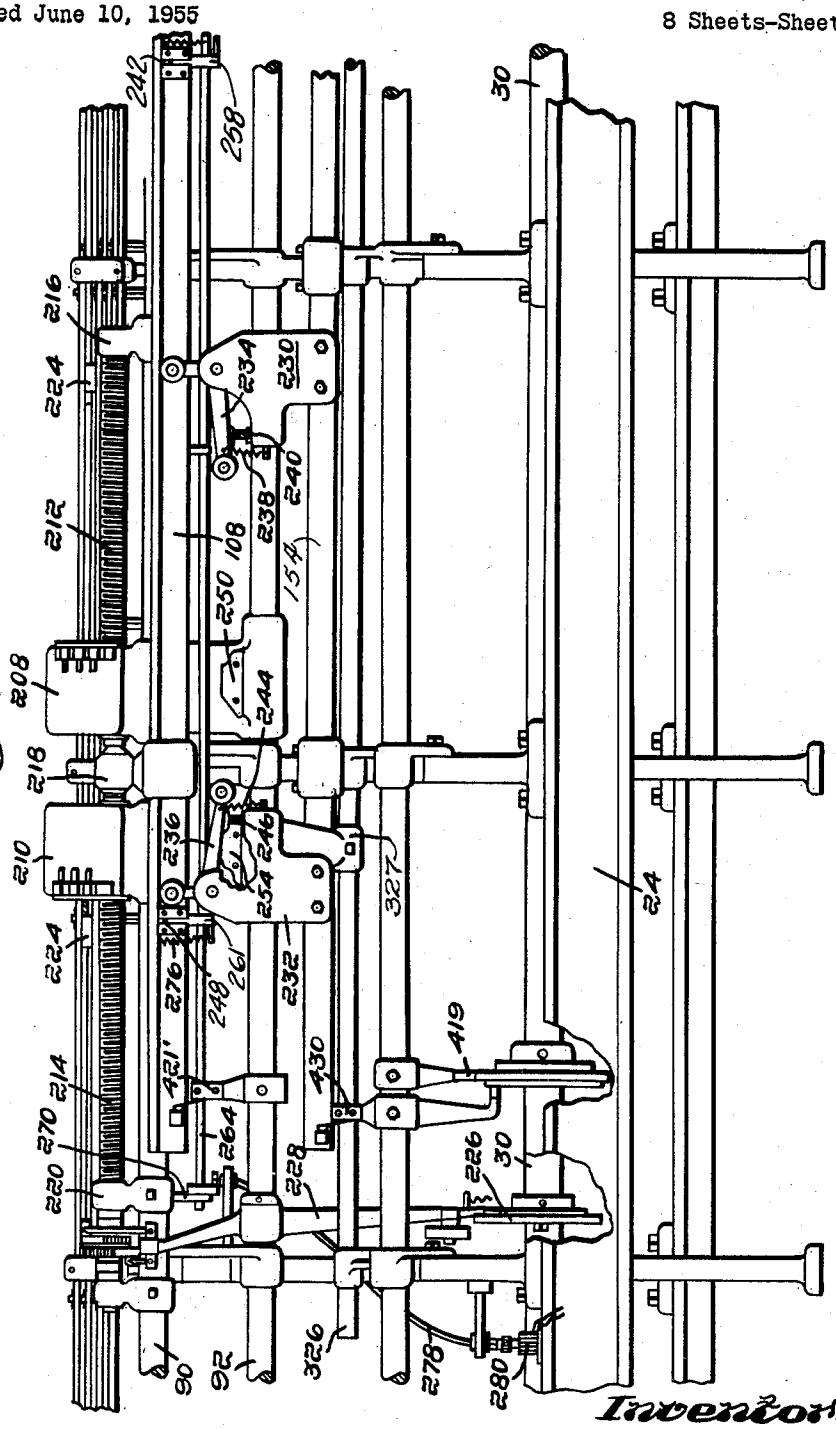

Fig. 6.

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YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

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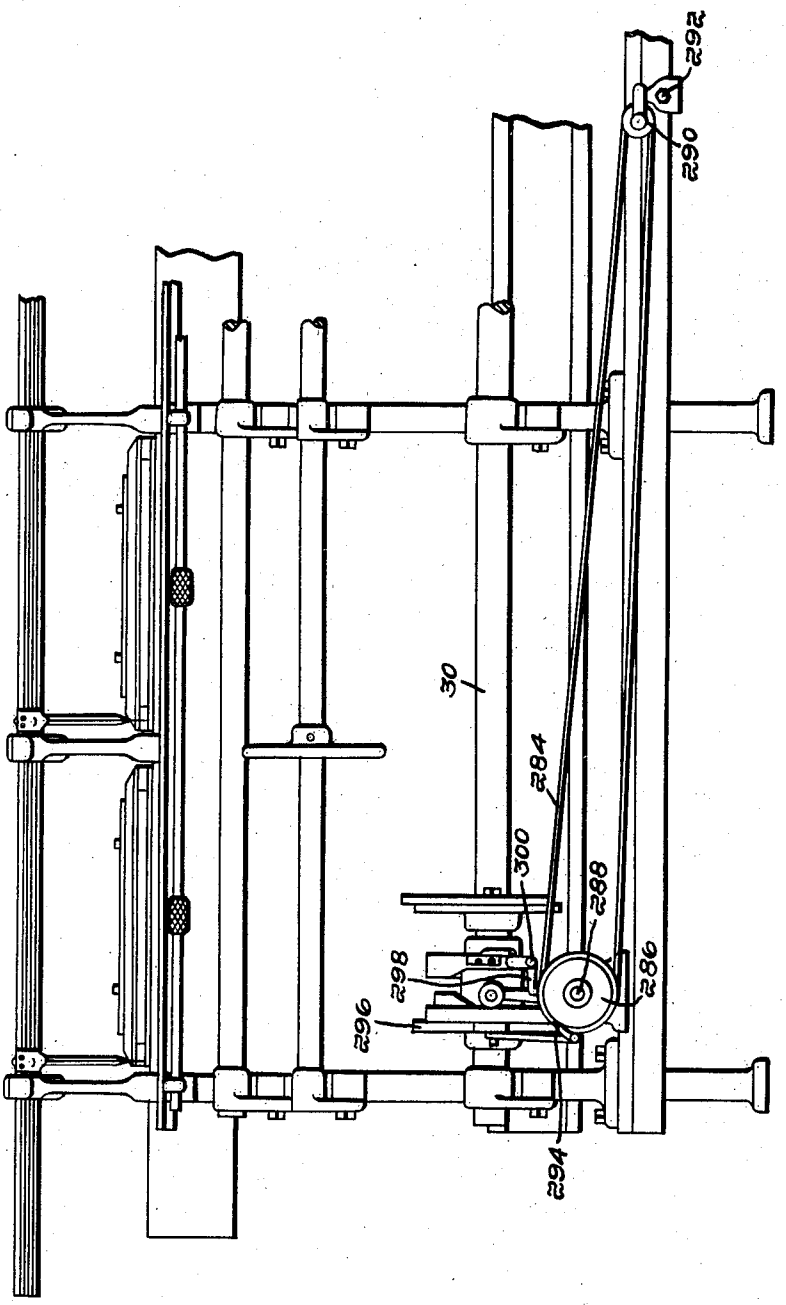
Fig. 2.



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YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

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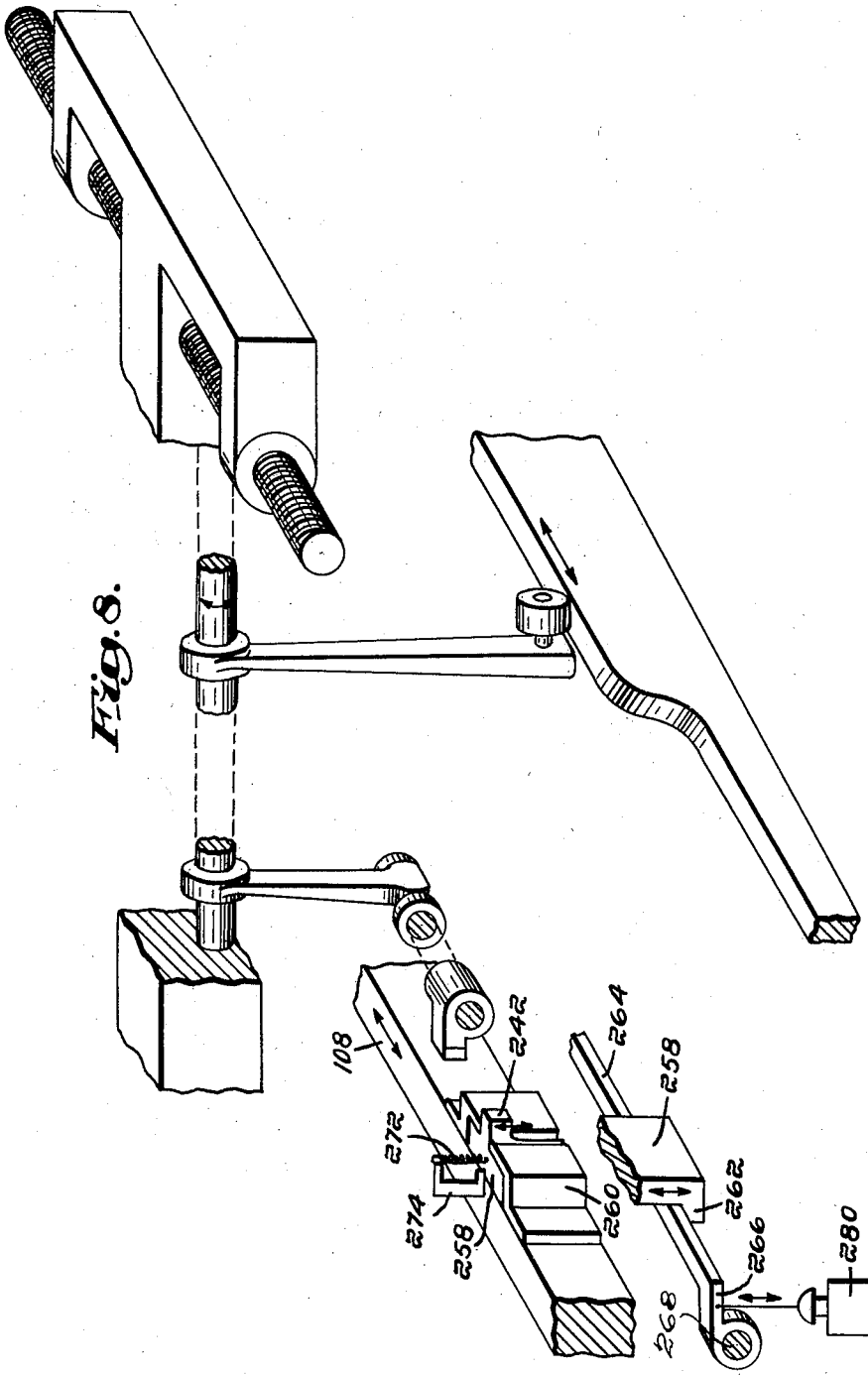

Fig. 8.

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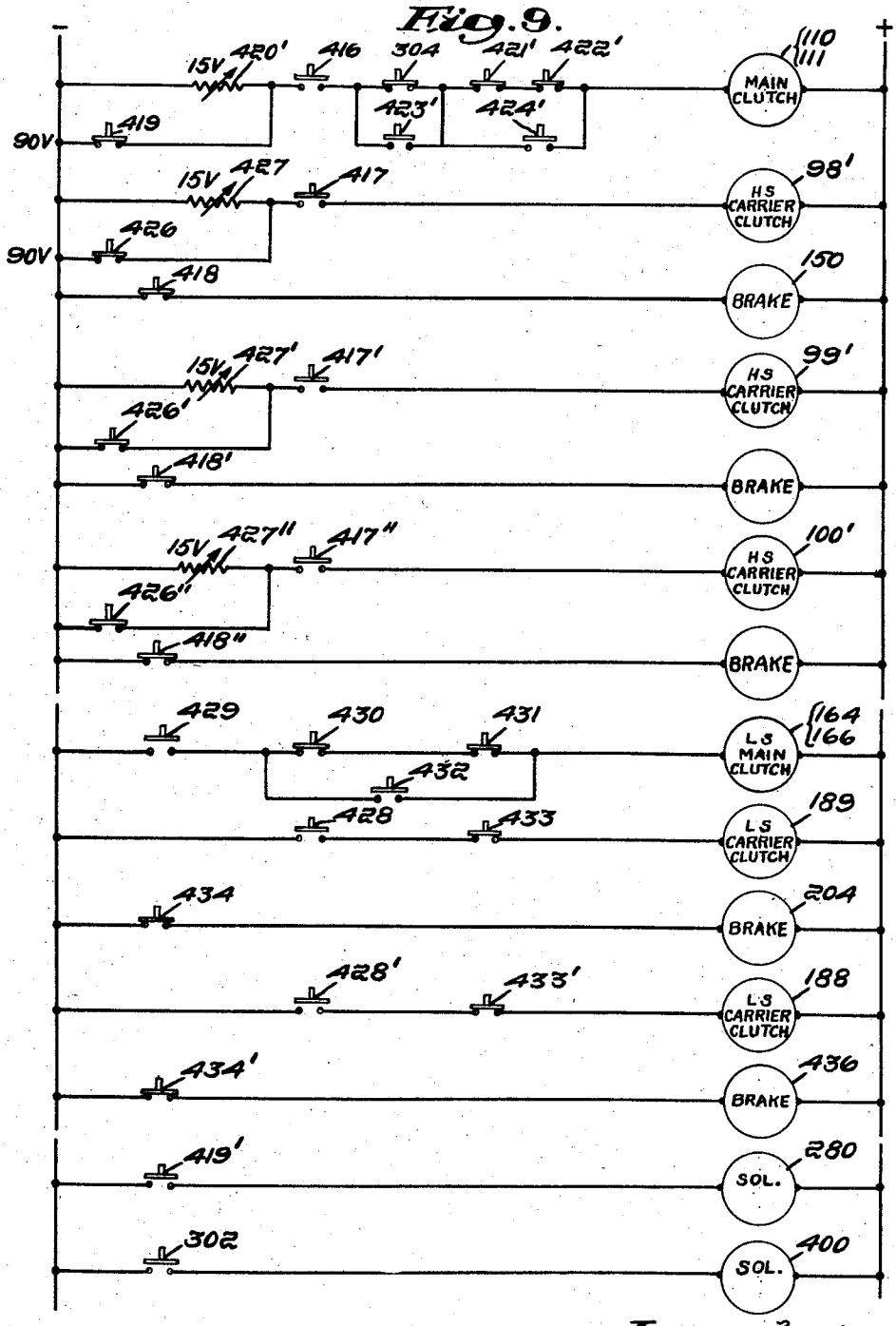
Fig. 9.



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YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

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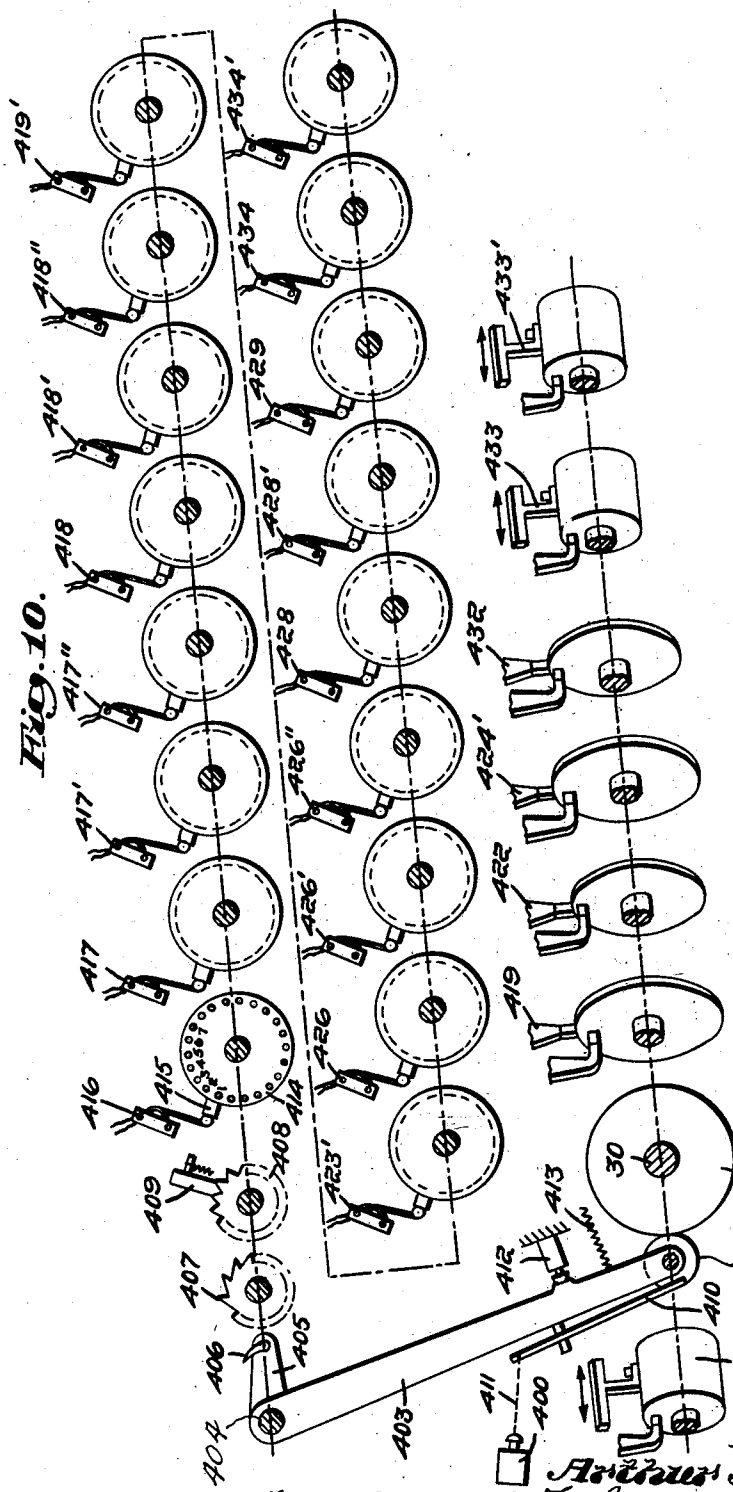

Fig. 10.

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United States Patent Office 2,912,840 Patented Nov. 17, 1959

2,912,840

YARN CARRIER MECHANISM FOR FLAT KNITTING MACHINES

Arthur J. Cobert, Chattanooga, Tenn., assignor of fifty percent to Beautiful Bryans, Incorporated, Chattanooga, Tenn., a corporation of Tennessee

Application June 10, 1955, Serial No. 514,625

21 Claims. (Cl. 66—127)

The present invention relates to an improved yarn carrier drive mechanism for flat knitting machines.

It is a principal object of the present invention to provide a novel electrical driving and control system for driving the several carrier rods from the coulier mechanism for a multiple section full-fashioned knitting machine which is of relatively simple construction, and at the same time well adapted to operate with a maximum degree of efficiency and precision at the high speeds demanded of such machines.

In accordance with the invention an electrical driving control system is provided which includes a main driver which is positively driven from the coulier motion of the machine, a main carrier slide bar, a rotary electromagnetic clutch through which the slide bar is driven from the driver, a plurality of individual rotary electromagnetic clutch and braking units for driving the individual carrier bars from the main slide bar, and control means whereby said clutches and braking units are operated to maintain an efficient and selective control of the several carriers.

It is a further object of the invention to provide a novel construction and arrangement of the shock absorbing mechanism for the active carrier rods which is simple and at the same time most effective in operation whereby the individual carriers are caused to slow down and stop with the degree of precision required for very high speed operation.

In accordance with this object a novel and improved mechanical slow down mechanism is provided including a slow speed driver which operates in combination with slow down cam and follower elements of a shock absorbing mechanism to control the movement of a main carrier slide bar and thereby to effect the desired operation and control of the individual carrier rods.

It is still another object of the invention to provide an improved mechanical construction of the carrier drive mechanism including a slow speed driver which is well adapted for the operation, particularly of certain short course carriers at a substantially reduced speed while the machine as a whole continues to operate at the higher rate.

It is still another object of the invention to provide a novel and effective combination of a mechanical shock absorbing mechanism and an electro-magnetic clutch drive for the slide bars and several carrier rods which provide for a more efficient and versatile operation of the carrier mechanism.

With these and other objects in view as may hereinafter appear, the several features of the invention consist also in the devices, combinations and arrangements of parts hereinafter described and claimed, which together with the advantages to be obtained thereby will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a sectional view of the machine illustrating

particularly the slur bar, and the slow speed drive connections for certain carrier rods;

Fig. 2 is a view in rear elevation of a portion of a machine illustrating particularly the coulier drive, one of the high speed driving units for a carrier bar, and an electrical control device for controlling the operation of the rotary electro-magnetic clutch for the main carrier slide bar;

Fig. 3 is a sectional detail view of one of the high speed driving units for driving one of the carrier bars from the coulier mechanism of the machine, the rotary electromagnetic clutch and drive connections shown being substantially those illustrated in Fig. 2;

Fig. 4 is a fragmentary view in rear elevation showing the six secondary rotary electro-magnetic clutch and braking devices driven from the main carrier slide bar 108 for driving six of the seven carrier rods;

Fig. 5 is a fragmentary view looking from the rear of the machine showing each of the four secondary rotary electrical clutch and braking units driven from the slow speed driver for actuating short course carriers of the machine;

Fig. 6 is a view in rear elevation of a portion of the machine illustrating the main carrier stop blocks and the shock absorbing mechanism for controlling the operation of the several carrier rods;

Fig. 7 is a view in front elevation of the left hand end of the machine illustrating particularly the pattern chain by means of which the several automatic motions of the machine are controlled;

Fig. 8 is a somewhat diagrammatic isometric view illustrating particularly the stop devices associated with the main carrier slide bar forming part of the shock absorbing mechanism and the controlling mechanism for rendering the shock absorber mechanism inoperative to arrest the movement of the main carrier slide bar;

Fig. 9 is a diagram of the electrical connections for the carrier drive mechanism of the machine; and

Fig. 10 is a diagrammatic view of the elements of the electrical control system of the machine including the electrical control shaft and switch actuating devices mounted on the main cam shaft.

The invention is herein disclosed as embodied in a multiple section flat full-fashioned knitting machine which may be of ordinary description comprising a series of cross frames 20 spaced apart each two knitting sections along the length of the machine and tied together by lower front and rear bars 22, 24, sinker rail 26 and table 28. A main cam shaft 30 mounted in bearings 32 provided in each of the frames 20 extends along the length of the machine in the base. Other operating shafts include the needle vertical and horizontal motion rock shafts 34, 36 and a hand wheel shaft 38. The knitting instrumentalities associated with each knitting section as indicated in Fig. 1 include a series of spring beard needles 39 movable as a unit on a needle bar 40, a press edge formed by the leading edges of a sinker support bar 42, a series of alternating sinkers and dividers 44, and a series of knock-over bits 46. The needle bar 40 is mounted on vertical arms 48 which are pivoted on horizontal support arms 50 secured to the needle vertical motion rock shaft 34 which is rocked by means of depending cam levers 52 located at spaced intervals along the length of shaft 34 for engagement with identical cams 54 similarly spaced along the length of the cam shaft 30. The needle bar supporting arms 48 are connected at their lower ends by links 56 with downwardly extending levers 58 secured to the needle horizontal motion rock shaft 36. Selected levers 58 along the length of the machine are provided with follower rolls 60 for engagement with cooperating needle horizontal motion cams 62 on the main cam shaft 30.

The yarn measuring sinkers 44 are advanced in a

knitting wave to sink yarn about the needle shanks by means of a mechanism which includes the usual sinker jacks 66 and a slur box 68 for each knitting section carried on a reciprocating slur bar 70 (see Fig. 1). The slur bar, together with the yarn carriers hereinafter to be more fully described have imparted thereto reciprocating movements longitudinally of the machine by means of a coulier motion which as best shown in Fig. 2 comprises a coulier cam 74 which is supported to turn on a forward and back axis in the machine and is driven from the main cam shaft 30 through bevel gearing including a bevel gear 76 which meshes with a cooperating bevel gear not shown on the cam shaft 30. The coulier cam 74 is engaged at the opposite sides thereof by two follower wheels 78 mounted on a cross link 80 which is connected at one end to a depending lever arm 82 and at its other end to a vertically disposed coulier drive lever 84. The lever 84 is pivoted at its lower end at 86 to a fixed bracket on the machine and is connected at its upper end by means of a sliding block with a slide box 88 which rides on two fixed support bars 90 and 92. The slide box 88 is formed with a forwardly extending bracket 94 (see Figs 1 and 3) to which is secured the slur bar 70. With the arrangement shown and as above described the slur bar 70 is continuously reciprocated with the slide box 88 by means of the coulier drive lever 84.

The mechanism for feeding yarn to the needles of the several knitting sections comprises yarn carriers such as that indicated at 95 in Fig. 1 mounted on a series of carrier bars 96 to 102, inclusive which are slidably supported in frames 104 located at spaced intervals along the length of the machine. It will be understood that in accordance with the usual practice each of the seven carrier bars shown has secured thereto one yarn carrier 95 for each knitting section along the length of the machine.

In accordance with the present invention a novel and improved mechanism is provided for driving the several carrier bars from the coulier mechanism above described and for controlling the operation of the individual carrier bars under the various operating conditions encountered in the operation of the machine.

As best shown in Fig. 2 of the drawings the slide box 88 is connected to a carrier drive rod 106 which is continuously reciprocated with the slide box 88 by the coulier drive lever 84. The drive rod 106 is connected to impart reciprocating movements to a main carrier slide bar 108 through connections which include a rotary electro-magnetic clutch (see Figs. 2 and 3) having a driving element 110 and a cooperating driven element 111. The driving member 110 is mounted on a short drive shaft 112 which has secured thereto at its forward end a pinion 114 which meshes with a rack 116 secured to the driving rod 106. The driven element 111 of the electro-magnetic clutch is mounted on a driven shaft 118 which is connected to drive a parallel shaft 120 through a pinion 122 on the shaft 118, an idler pinion 124, and a pinion 126 on the shaft 120. At its forward end the shaft 120 carries a pinion 128 which meshes with a rack 130 on the main carrier slide bar 108. It will be understood that the slide bar 108 extends along a sufficient length of the machine to provide a space for connecting thereto each of the individual rotary electro-magnetic clutch and braking devices for driving each of the several carriers shown, and the adjustable carrier slow down and stop mechanism for the main carrier slide bar 108 hereinafter more fully described

In Figs. 2 and 3 there is shown a rotary electro-magnetic clutch and braking device for driving the third-from-front carrier rod, specifically designated at 98. The rotary electro-magnetic clutch consists of a driving clutch member 136 and a cooperating driven member 138 of which the driving member is mounted on one end of a shaft 140 having secured at its rear end a pinion 142 which meshes with the rack 130 on the main carrier slide bar

108. The driven element 138 is mounted on a forwardly extending shaft 144 which carries intermediate its length a pinion 146 which meshes with a rack 148 on the carrier bar 98. At its forward end the shaft 144 is connected with an electro-magnetic braking device 150 which is in turn mounted on a fixed portion of the machine frame. While the electro-magnetic clutch 136, 138 and brake unit 150 has been described for driving the one carrier rod 98 only from the main slide bar 108, it will be understood that identical rotary magnetic clutch devices indicated respectively at 96', 97', 99', 100', 101' and 102' (see Fig. 4) and associated braking devices not identified are provided which are connected with the rack 130 for driving each of the remaining carrier rods generally designated at 96, 97, 99, 100, 101 and 102.

The electrical control devices of the machine, by means of which the operation of the main rotary electro-magnetic clutch 110, 111 and of the secondary electro-magnetic clutch and brake units 97' to 102' is controlled, will be more fully set forth hereinafter in connection with the description of the electrical control devices of the machine.

In accordance with the present invention a separate slow speed driving mechanism is provided for driving from the coulier mechanism certain of the carriers, more particularly short course carriers, at a slow rate which in the embodiment shown is reduced to substantially one-half the normal rate of drive of the carrier rod. This mechanism provided to this end comprises a half-speed driver bar 154 (see Fig. 1) which is spaced along the length of the machine from the driving rod 106 and which is connected to be driven from the coulier driving lever 84 at half the rate of rod 106 by means of a driving link 156 (see Fig. 2) which is connected between the coulier driving lever 84, and a vertically disposed driving lever 157 (Fig. 1). The lever 157 is mounted to swing on a pivot shaft 158 and at its upper end is connected to a bracket 160 which is slidable on support shafts 90, 92 and is connected to drive the half-speed driving rod 154. The half-speed driving rod 154 is connected to impart corresponding reciprocatory movement to a half-speed carrier slide bar 162 by means of a rotary electro-magnetic clutch and gear driving connections which are similar to those previously described for driving the main carrier slide bar. These driving connections, as best shown in Fig. 1 comprise a half-speed electro-magnetic clutch having the driving member 164 and driven member 166, the driver being supported on a drive shaft 168 which carries a pinion 170 meshing with a rack 172 on the half-speed driving rod 154. The driven element 166 of the rotary electro-magnetic clutch is mounted on a shaft 174 which is connected by pinions 176, 178 and 180 with parallel drive shaft 182 having at its forward end a pinion 184 which meshes with a rack 186 on the half-speed carrier slide bar 162.

Selected short course carrier rods may be driven from the half-speed carrier slide bar 162 by means of individual rotary electro-magnetic clutch devices such as that illustrated generally at 188 in Fig. 1 for driving the third-from-rear carrier rod designated at 100 and the associated braking device 204. As particularly shown in Fig. 5 four carrier rods 99, 100, 101, and 102 are indicated as short course carrier rods, and are adapted to be driven from the half-speed diver 154 by means of the half-speed rotary magnetic clutch devices indicated respectively at 185, 187, 188 and 189 in Fig. 5 together with their associated braking devices, not identified. These driving connections which are identical with the driving connections above described for driving the carrier rods from the main slide carrier bar 108 consist of a rotary electro-magnetic clutch compising, for example, driving element 188 shown in Figs. 1 and 5, and a cooperating driven element 192. The driving element 188 is supported on a short drive shaft 194 which, at its rear end, carries a pinion 196 which meshes with rack 186. The driven element 192 of the electro-magnetic clutch is supported on a forwardly

extending shaft 198 which carries a pinion 200 meshing with a rack 202 on the carrier rod 100. At its forward end the shaft 198 is connected with an electro-magnetic braking device 204 which is supported on the machine.

In accordance with the invention the operation of each of the several carrier rods driven from the main carrier slide bar 108 is determined and controlled substantially by devices which determine and control the operation of the main slide bar 108. While separate stops are provided for arresting movement of the individual carrier rods in each direction, a single shock absorber device is employed which acts against the main carrier slide bar 108. Whatever slippage may be required between the positive coulier drive and the individual carrier rods is supplied by controlling the voltage of the main electro-magnetic clutch for driving the main slide bar 108. Movement of individual carrier rods to and from their inactive storage positions is effected by means of special movements imparted to the main slide bar 108. The electro-magnetic clutch devices by means of which the individual carrier rods are driven from the main carrier slide bar 108 are intended to provide a positive driving connection therebetween and bar 108 utilized to move, and associated braking devices alternatively to secure the inactive carrier rods firmly in their rest positions.

Adjustable stops are provided for arresting the travel of the carrier rods in each direction which include right and left dead stop carrier blocks 208, 210 slidably supported on rods 90, 92 and having formed therein nuts which engage respectively with oppositely threaded portions 212, 214 of a positioning screw located and supported in brackets 216, 218, 220 mounted on a supporting shaft 90. The carrier blocks 208, 210 are provided with the usual carrier stop abutments which are arranged for engagement with cooperating stops 224 on the carrier rods. The position of the adjustable dead stop carrier blocks 208, 210 is controlled by means of a pawl and ratchet control mechanism which may be of ordinary description actuated from the main cam shaft 30 of the machine. The actuating mechanism shown includes a pawl actuating cam 226 on the cam shaft, a cam follower lever 228, and a pair of oppositely disposed pawls and ratchets which are secured to the screw shaft 212, 214. The pawls, continuously actuated by the cam 226, are normally held in inoperative position and are selectively permitted to engage with their respective ratchets by means of adjustable shields supported co-axially with the ratchets and arranged to be controlled from the pattern chain of the machine to render one or the other pawl selectively operative as may be desired.

A second set of carrier stop blocks, not specifically shown, are provided in accordance with the usual practice for arresting the movement of the short course reinforcement carriers at their inner selvage edges. Inasmuch as these carrier stops are similar to those previously described and are well known in the art no specific description is needed herewith.

As the active carrier rod and the main carrier slide bar 108 approach the limit stop position a mechanically acting slow-down and shock absorbing device becomes operative to slow the movement of the main carrier slide bar 108. This mechanism comprises a pair of brackets 230, 232 (Fig. 6) which are fixedly mounted on the half-speed driver 154 and which carry respectively bell crank slow-down levers 234, 236. A tension spring 238 connected between the horizontal arm of the bell crank 234 and a pin on the bracket 230 tends to move the horizontal arm downwardly to a limit position determined by a stop screw 240 upon the bracket. The upwardly extending arm of the bell crank 234 is arranged to be engaged by a stop 242 on the main carrier slide bar 108. The slow-down bell crank lever 236 mounted on the bracket 232 is similarly held with its horizontal arm in a downward position by means of a tension spring 244 against a positioning stop 246. An upwardly extending arm of the bell crank 236 is arranged to be engaged by a stop 248 on the main slide bar 108.

With this arrangement of the parts it will be readily seen that the slow-down brackets 230, 232 with their associated slow-down bell crank levers 234, 236 will travel with the half speed driver 154 at approximately half the speed of the main slide bar 108. The brackets 230, 232 are so positioned with relation to the stops 242, 248 on the main slide bar 108 that as the slide bar approaches the limit of its movement, as for example, to the left from the position shown in Fig. 6, the stop 242 will be brought into engagement with the upwardly extending arm of the bell crank 234, thus positively slowing the main slide bar 108 to one-half its normal operating speed. As the slide bar 108 and the active carrier associated therewith approach their limit position as determined by the associated stop block 208, the horizontal arm of the bell crank 234 engages a cam 250 mounted on the lower portion of the stop block 208, thus causing the bell crank 234 to rock in a clockwise direction from the position shown in Fig. 6 to still further slow the movement of the main slide bar 108 and its associated active carrier rod. The bracket 230 and the slow-down bell crank lever 234, mounted on the positively actuated half-speed driver 154, will continue their movement to the left to an extreme position in which the horizontal arm of the bell crank 234 rides off of the cam 250. Fig. 6 shows the bracket 232 and bell crank 236 in their extreme position to the right with respect to a cooperating slow down cam 254 on the stop block 210.

In the illustrated machine means are provided for rendering the slow-down and shock absorbing mechanism above described inoperative so that the main slide bar 108 may be permitted to move to the limit of its travel in either direction as, for example, when such movement of the main slide bar is required for positioning the main slide bar to engage with and bring a new carrier rod out of the storage position. To this end the stops 242 and 248 are constructed and arranged to be moved under the control of a pattern control out of the path of movement of the upwardly extending arms respectively of the slow-down bell crank levers 234 and 236. A detail of the stop 242 and its supporting and actuating mechanism is particularly shown in Fig. 8 of the drawings. As there shown the stop 242 is formed in the upper end of a vertically movable slide member 258 carried in a guideway 260 on the main slide bar 108. The stop 248 forms part of a similar slide member 261 vertically movable on the main slide bar 108. At their lower ends the slide members 258 and 261 are provided with forwardly offset portions indicated at 262 in Fig. 8 which engage beneath a horizontally disposed control bar 264, which extends along a substantial portion of the length of the machine and is mounted on horizontally disposed arms 266 secured to a rock shaft 268 supported from depending brackets 270 (Fig. 6) on the fixed shaft 90. The control bar 264 is of sufficient length to at all times engage the offset lower ends of the slide members 258 and 261 mounted on the longitudinally reciprocating slide bar 108. As best shown in Fig. 8 a tension spring 272 connected between the upper end of the slide 258 and overhanging bracket 274 and a similar spring 276 (Fig. 6) associated with the stop 248 acts normally to maintain the stops 242, 248 in their raised operative position. The control bar 264 is depressed when it is desired to render the stops inoperative by means controlled from the pattern chain of the machine which comprises a Bowden wire 278 (Fig. 6) connected at its upper end to one of the arms 266 and at its other end to a solenoid 280 mounted on the rear rail 24 of the machine. The solenoid 280 is energized to depress the control bar 264 and thus to render the stops inoperative by means of a switch actuated from the pattern chain of the machine.

The illustrated machine is provided with a pattern con-

trol mechanism which may be of ordinary description consisting of a pattern chain 284 which rides over a drum 286 mounted on a cross shaft 288 adjacent the left hand end of the machine as seen in Fig. 7. The chain 284 is supported also by means of a take-up pulley 290 carried on a bracket 292 secured to the front lower frame 22 of the machine. The pattern chain 284 and drum 286 have imparted thereto a stepped advancing movement which is timed with the rotation of the main cam shaft 30. The driving mechanism referred to includes a ratchet and cooperating pawl indicated at 294 which receives an oscillatory movement from a cam 296 on the cam shaft 30. Inasmuch as this mechanism is well known in the art no further illustration or description thereof is believed to be necessary.

Certain abutments on the pattern chain 284 and their associated pattern levers operate switches which in turn control the solenoids, rotary electro-magnetic clutches and braking devices above described to render selected carrier rods active and inactive. In Fig. 7 there is shown a pattern lever 298 of conventional type mounted on a pivot shaft 300 and having the horizontal arm thereof positioned to be engaged and rocked by a button on the chain. A vertically extending arm of pattern lever 298 acts when rocked in a clockwise direction to close the contacts of a switch 302.

A novel feature of the electrical system of the machine consists in the provision of a rotary switch mechanism for controlling the operation of the rotary electro-magnetic clutches for the thread carrier system above described. The rotary switch referred to is driven in timed relation to the rotation of the machine cam shaft 30, and in timed relation to the longitudinal reciprocation of the carrier bars and is additionally adjustable further to vary the timing of switch operation in accordance with the setting of the carrier stops.

A rotary switch of the type referred to is specifically shown in Fig. 2 and comprises a drum 304 having two separated semi-cylindrical contact surfaces 306 and 307, and at the left hand thereof slip rings connected with the individual contact surfaces. A slip ring 308 connected with surface 306 is shown in Fig. 2 engaged by a stationary brush 310. As will be evident from an inspection of Fig. 2 the cylindrical contact surfaces 306 and 307 are insulated from one another. One line of separation between the two contact surfaces as indicated in dotted lines at 314 runs parallel to the axis of the drum. The other line of separation of the two surfaces, as shown at 316, is disposed diagonally to the axis of the drum. An electrical circuit is closed through the contact surface 306 of the switch by means of a brush 318 carried on the depending arm of a traveller 320 which is sleeved to slide and to rotate upon a longitudinally extending supporting shaft 322 of the machine. When the switch is to be used as an on and off switch the cylindrical contact surface 307 is grounded. The traveller 320 is adopted to be shifted longitudinally of the switch axis by means of a bracket 324 and a shift rod 326 to which the bracket is secured. The shift rod 326 is secured by means of a bracket 327 to the adjustable dead stop carrier block 210 (see Fig. 6), so that the position of the shift rod 326 and switch brush 318 supported thereby are adjusted automatically lengthwise of the cam cylinder 304 in accordance with the setting of the carrier stops. The traveller 320 is connected to the bracket 324 through a flange and slot connection so that the traveller 320 while connected to move longitudinally as a unit with a shift rod 326 is permitted to swing freely about its axis on the rod 322. A tension spring 328 connected between the traveller 320 and bracket 324 tends to rock the traveller 320 so that contact member 318 is held at all times against the surface contact element 306 of the drum.

The rotary switch above described provides a most effective device for energizing and deenergizing the main rotary electro-magnetic clutch 110, 111 in timed relation to the movement of the main carrier slide bar 108 in each direction.

As hereinafter more fully set forth in connection with the description of the machine operation it is contemplated that rotary switches of the type described may be employed for many purposes as, for example, in combination with one another to reduce the voltage applied to and thereafter to wholly deenergize the rotary electro-magnetic clutch at different points in the travel of the main carrier slide bar. In this combination the first rotary switch is adjusted to alter the electrical circuit to reduce the holding power of the clutch to about 10% of the required starting torque immediately after the carrier has been brought up to speed in either direction. The second rotary switch is constructed and arranged to wholly deenergize the clutch at the moment when the associated carrier rod reaches its end stop determined position. Rotary switches of the type referred to may be utilized also to effect an increase followed by a decrease in the extent of travel of a yarn carrier rod, and will be useful, for example where reinforcement carriers move outwardly at the outside of the heel, and inwardly at the inside of the heel to form the pointex or pyramidal design of the heel reinforcement.

One or more of the rotary switches as above described may be employed in combination with the mechanical carrier slow-down stop devices above described to provide for a most effective control of the operation of the main carrier slide bar 108 and of the individual carrier rods actuated thereby. With this arrangement of the mechanism the voltage would be applied to engage the electro-magnetic clutch 110, 111 at the moment when the main carrier slide bar 108 reverses its direction of travel. For the purpose of this description it is assumed that the reversal is from right to left with the parts as shown in Fig. 6. At this point the brush 318 crosses the separation line 314 from surface 306 onto surface 307. A heavy starting torque is imposed upon the clutch elements 110, 111 which is preferably thereafter sharply reduced as the carrier rod is brought up to speed to about 10% of the initial charge without producing slippage. The carrier slide bar continues its movement to the left from one to the other position until the associated stop 242 engages the associated slow-down bell crank lever 234 mounted upon and travelling with the associated bracket 230 on the half-speed drive shaft 154, thus slowing the main slide bar to half speed. Thereafter, the bell crank lever 234 engaging cam 250 still further slows the movement of the slide bar 108 and associated carrier bar until arrested by engagement with a stop on the stop block 208. At the same time the cam follower brush 318 crosses the diagonal dividing line 316 to deenergize the main slide bar driving clutch 110, 111.

In order to simplify the electrical controls for the machine an electrical control shaft is employed which is adapted to have imparted thereto a stepped rotation which is timed with the rotation of the main cam shaft 30 of the machine. Successive steps of rotation are dictated by means of buttons on the pattern chain of the machine as shown in Fig. 7. When it is desired to impart a stepped rotational movement to the control shaft indicated at 404 in Figs. 1 and 10, a button is placed on the chain 284 which will rock a lever 298 which in turn closes the contacts of a switch 302. The contacts for this switch, as shown in Fig. 9, are normally open in a circuit which includes a solenoid 400 indicated in Figs. 1, 9 and 10. Energizing of the solenoid operates to shift a roller 401 mounted on an actuating lever 403 into alignment with a cam 402 on the main cam shaft 30. The cam 402 is shaped to rock the lever 403 once for each revolution of the cam shaft 30. The lever 403 is formed with a laterally extending arm 405 which carries a pawl 406 for engagement with a ratchet 407 on the electrical control shaft

404. For shifting the follower roll 401 into and out of engagement with cam 402 there is provided a forked roll shifting lever 410 which is pivoted on the bell crank 403, and is connected at its upper end by a Bowden wire 411 with the armature of the solenoid 400. A stop 412 mounted on the frame of the machine limits movement of the lever 403 toward the cam shaft under the influence of its tensioning spring 413 when the roller 401 is not in register with the cam 402. The electrical shaft 404 is held yieldably in each successive stepped position by means of a detent mechanism which comprises a toothed wheel 408 secured to the shaft 404 (see Fig. 10), and a spring-pressed detent 409 having a V-shaped tooth engaging surface engaging yieldably in the notches formed by the adjacent teeth of the wheel 408.

The electrical control shaft 404 has mounted thereon switch actuating cams which are identical in construction, each consisting of a disk or frame such as that designated at 414 (Fig. 1) which is capable of receiving about the periphery thereof one or more cam segments 415 for engagement with a switch 416. It will be evident that the control shaft 404 may be made of a length sufficient to accommodate any desired number of switch operating cams. Further, it is contemplated that approximately 30 cam segments may be placed about the periphery of any one of the cams thus providing a total number of 30 steps which are made available by successive increments of rotation of the electrical control shaft 404. In view of the complexity of the mechanism employed no attempt has been made to indicate the specific position of the actuating cams on each of the several switch operating disks. The positions of the cams will, however, be evident to one skilled in the art from the drawings taken in connection with the following description of the operation.

The operation of the various circuits will now be explained as follows:

It is assumed that at the start of the operation all of the carrier rods are in the storage position. As a first step in starting the machine, the pattern chain 284 operates a pattern lever such as that indicated at 298 (Fig. 7) to close a switch 302 (see Figs. 7 and 9). The closing of the switch 302 causes solenoid 400 to be energized shifting the follower 401 onto its cam 402 and through bell crank pawl lever 403 effecting a stepped rotation of the control shaft to position (1). Switch 416 closes (see Figs. 9 and 10). At this time all the normally closed switches, as shown in the circuit for the main clutch 110 will be closed so that the main clutch 110, 111 is energized to drive the main carrier slide bar 108. Switch 419' (Fig. 10) closes completing a circuit to solenoid 280 (Fig. 6) causing arms 266 and control rod 264 of the shock absorber mechanism to be depressed so that the stops 242, 248 are held out of their operative position. It will be understood that the shifting of these stops to the inoperative position is necessary at this time to permit the main slide bar 108 to be moved to its extreme end position. The machine is then allowed to make one or two revolutions to insure that the carrier slide bar 108 is positioned properly. However, in order to control the movement of the slide bar 108 more accurately, two limit switches 421' and 422' are placed in series in the main clutch circuit to open the circuit and stop further movement of the clutch and slide bar. These switches are placed at each end of the main slide bar, one of which is shown in Fig. 6, near the top and to the left of the frame, while the other is out of the range of the drawing. These two switches are only actuated when the slide bar 108 reaches its extreme end position, which will only occur when bringing in or taking out a carrier rod from the storage position. They also have the capacity of centering the slide bar properly, in the event that it should become positioned too far on one side, which can happen, if, for some reason the current should fail leaving the main slide bar half-way across its normal movement, while, at the same time, the coulier motion may be at the end of its stroke. It is understood that the main slide bar also has dead stops for the extreme end positions, which would take any undue pressure from the limit switches 421' and 422'.

As a next step in the operation of the electrical control, a bump on the pattern chain will actuate switch 302 to cause the control shaft 404 to be moved to position (2). Switch 417 closes causing high speed carrier clutch 136—138, more generally referred to as clutch 98', to be energized, thus connecting carrier 98 to be driven from the main carrier bar 108. Normally closed switch 418 opens thus deenergizing the associated high speed carrier clutch brake 150. The selected carrier 98 will now move away from its stop position following the movement of the main carrier slide bar 108. It will be understood that the operation thus far described takes place with the machine operating at a relatively slow speed. It will be understood that carriers 99 and 100 may be operated in a similar manner and the associated braking elements will be disconnected by actuating the respective switches 418' and 418'' illustrated in Figs. 9 and 10.

After the carrier has moved sufficiently away from its end position a bump on the pattern chain operates through its associated pattern lever 298 to close switch 302 causing electrical control shaft 404 to be shifted to position (3). Switch 419' opens since for this position no cam segment is put on the disk for switch 419' so that the stop hold-out solenoid 280 is deenergized permitting the slow down shock absorbing mechanism stops 242, 248 to be shifted to their operative position. The operation of the machine may now be continued at the full speed.

The operation of the electrical connections associated with the carrier slow down and stop mechanism which operates to slow down and traverse the main slide bar and associated selected carrier rod at the end of the traverse in each direction will be reviewed briefly as follows:

Assuming that the main slide bar 108 is moving from right to left from the position shown in Fig. 6, the rotary switch 419 mounted on the main cam shaft 30 will function first, the contacts thereof being shifted from a normally closed to an open position. This means that at the beginning of the stroke while the contacts are closed the clutch is actuated by the full voltage of 90 volts from the power supply. Switch 416 remains closed. Now, as the machine moves the slide bar and carrier rod about 1 inch away from its starting position, the rotation of the switch 419 will cause the contacts thereof to open, so that the voltage passing only through the variable resistor 420' is reduced to a low figure arbitrarily set at 15 volts. It will be understood that this voltage is subject to change, but must be low enough to permit slippage of the clutch when stop 242 will overtake and engage against the bell crank lever 234, thus causing the main carrier slide bar 108 to be slowed down to move at the half speed with the half-speed driver 154. This mechanical slow down takes place about 1½ to 2 inches from the dead stop on a block 208. The vertical arm of the slow down bell crank now engages the main slide bar 108 and associated carrier rod. As the carrier rod seats against its dead stop on block 208 the follower contact member of a rotary brush type switch 304 will break the circuit to the main clutch 110. The contact member is the brush 318. Rotary switch 304 has an inclined line of separation as shown in Fig. 2 which will vary the length of time the switch is closed in accordance with the variations in the width of the stocking being knitted.

It is understood that the coulier motion including the slur bar and driver continue to the limit of their movement to the left thus producing an overtravel of the main

driver 106 with respect to the main slide bar 108 which for the widest part of the stocking will be in the order of 1–1½ inches. It will be understood that the stocking is narrow when the travel is shorter and the overtravel becomes longer in direct proportion. When the end of the coulier stroke is reached and the needles have completed their knitting motion, the followers associated with the rotary clutch 110, 111 will move respectively onto the energized and high voltage contact surface of the respective rotary switches 304 and 419, thus energizing the main slide bar clutch 110, 111 at the full voltage.

During the return stroke the operations above described are repeated in the same order from left to right.

The procedure employed for introducing additional carrier rods into the field of knitting, as for example in the heel, may be briefly described as follows:

The operation of the machine is first slowed in the usual manner, preferably by automatic means. After the slowdown has taken place switch 302 is actuated by a button on the chain which acts through the solenoid 400 to advance the control shaft 404 to the next position (4). A segment on the disk controlling switch 419' will throw this switch at this time energizing solenoid 280 which causes the stops 242, 248 of the shock absorbing mechanism to be rendered inoperative as above described to permit the main carrier slide bar 108 to be moved to its extreme end position. At this point in the operation it will be understood that the length of the stroke of the main slide bar 108 will have been reduced from the original 15 inches which would be the full width of the stocking to about 8 inches which would be the width of the ankle. In order to permit the continued movement of the slide bar 108 to its extreme position the active carrier rod in use must be left in the field of knitting momentarily. At about the same time that the stops 242, 248 are rendered inoperative and on the same movement of the electrical control shaft 404, the switch 417 will open. This is due to the fact that on this movement, no cam segment will be under the switch 417, permitting it open and break the circuit to the carrier rod clutch 98'. Also, on this same movement, the switch 418 will be moved, because, here again, no cam segment will be under the respective disk in its 4th position. Switch 418 thus is permitted to return to its normally closed position causing brake 150 to be re-energized. This action will act to hold the carrier rod momentarily in its end position. With this clutch 98' released and with the shock absorbing mechanism out of operation, the main carrier slide bar 108 is now permitted to move under the influence of the coulier mechanism to its extreme end position in order to engage with and move the heel carrier rod 99 from the storage position. In order to effect this movement it is necessary that the rotary switch 304 be rendered inoperative so that the electro-magnetic clutch 110, 111 connecting the main slide bar 108 to move with the coulier driver 106 will remain energized. To this end a cam segment will throw switch 423', shunting out switch 304. The operation of these switches will become evident from studying electrical diagram, Figs. 9 and 10.

When the coulier drive including the slide bar 108 has reached its extreme end position, a button on the chain acts through an associated lever 298, and will close switch 302 to advance the control shaft 404 to position (5). It will be noted, however, that any time that the slide bar 108 reaches its extreme end position, one of the two limit switches 421', 422' will break the circuit to the main clutch. Now, in order to return the slide bar on the following stroke, it is essential that some means be taken to re-energize the main clutch, even though one of the two limit switches 421', 422' is holding the circuit open. A rotary brush type switch 424' is employed to this end. This switch is identical to switch 419, and is timed on the cam shaft 30 to close just before the beginning of a new stroke so that in the event one of the two limit switches 421', 422' have been broken at the end of the previous stroke, this switch 424' will reclose the circuit. This switch is never out of the circuit, but will have no effect unless switch 416 is closed, and then only if one of the switches 421', 422' are open. Also, this switch 424' is timed to open again, just after the slide bar 108 moves away a short distance on the new stroke, allowing the switches 421', or 422' to remake, whichever one had been open.

Continuing with the new position (5) of the control shaft 404, one of the heel carrier clutches is now energized in order to bring the carrier into the field of knitting. Usually, the right hand heel carrier is brought in first, although this is optional. Therefore, the slide bar 108 is at its extreme right end position when the control shaft 404 is advanced to position (5). Then a limit switch 417' will close. This is another switch identical to switches 416, 417, 418 and 419'. It also has a disk and cam segment on the control shaft 404 such as those for 96', 97', 99', 100', 101', 102'. Let us assume that it controls clutch 99'. Upon closing of the switch 417', then clutch 99' will become energized, and, as the machine starts moving, the heel carrier will also start moving into the field of knitting. In order to permit the carrier 99 to be rendered operative, movement of the control shaft 404 to position (5) acts also to open switch 418' to disengage the associated brake.

Since the heel carrier rod is a short course carrier, a somewhat different switching arrangement must be inaugurated for these initial courses, than for a main carrier rod, which travels the entire distance of the width of the stocking. The same carrier rod circuit can be used as for a main carrier, but, in addition, more switching is required to control the short course carrier rods, since the cut-off switching of the main slide bar 108 is not useful for these short course carrier rods. As explained earlier, the short course carrier rods must be brought in out of storage at a one to one ratio with the movement of the coulier, but once they are in the field of knitting the speed of the short course carrier rods can be reduced in relation to the speed of the coulierng stroke. Therefore, it is essential that they be brought in by means of the main slide bar 108, and then later transferred to the slow speed slide bar 162. In the case of the initial course for bringing in the short course carriers, the rotary switch 304 for the main slide bar is rendered inoperative, and other means are employed for stopping the short course carriers. This is accomplished in the following manner:

On the movement of the control shaft 404 to position (5), the limit switch 423' is closed, by placing a segment on the disk for this switch at position (5). Also, another switch 426' is opened (see Figs. 9 and 10). This switch is identical to switches 416, 417, 418, and 419', and has its own disk and cam segments. Since this switch is a closed type, the operation of it will open the circuit and, a study of the diagram will reveal that this action will remove the full 90 volts from the clutch 99' for the heel carrier rod. The remaining voltage, which comes through the variable resistor 427', will be approximately 15 volts. This is sufficient voltage to move the carrier rod 99 in at low speed, and, at the same time, permit the clutch 99' to slip after the short course carrier rod 99 reaches its destination. The main slide bar must, however, be carried to the other extreme end of its movement, in order to pick up the other short course carrier rod, stored on the opposite side of the knitting head. Since the switch 304 has been shunted the main slide bar 108 will continue until it reaches its dead stop and the limit switch 422', or 421', whichever side of the movement is effective.

It will be understood that the circuit above described for the short course carrier rod 99 is duplicated for other carrier rods, the circuits for carrier rods 98 and 100 being shown by way of example. The control circuit for high speed carrier clutch 98' includes variable resistor 427 which is arbitrarily set for convenience at 15 volts and

a normally closed shunt switch **426** similar to the switch **426'** above described. The circuit for the carrier **100'** similarly includes a variable resistor **427''** arbitrarily set for convenience at 15 volts, and a normally closed shunt switch **426''**.

The next step is to pick up the other short course carrier rod which for convenience is designated as rod **100**. First, the pattern chain operates switch **302** to further index the electrical control shaft **404** to position (6). All of the limit switches for the main slide bar **108** and for the high speed carrier clutch **99'** for the first activated heel carrier rod **99** will remain static, but another circuit similar to that previously described for clutch **99'** by controlling clutch **100'** will be activated through another limit switch **417''** similar to limit switch **417**. The process of bringing in the second heel carrier **100** will be the same as for the first heel carrier **99**. In this operation switch **423'** remains closed so that rotary switch **304** which would shut off the power to the main clutch **110** as the main slide bar **108** approaches the limit of its normal operating range, is shunted. A normally closed switch **426''** is opened thus reducing the power to clutch **100'**, now shunted through the variable resistor **427''**, to 15 volts. It will be understood that the first heel carrier **99** will not have been disconnected during this operation, but will be permitted to move about as the slide bar is actuated.

After the second heel carrier is engaged at the end of that stroke, the electrical control shaft **404** is again advanced to position (7) as pattern chain again operates switch **302** to effect indexing of the shaft **404**. At this point a number of electrically controlled functions take place simultaneously. First, through the proper cam segments being placed on the respective disks, switch **417** is closed to reactivate the circuit for the main or leg carrier rod **98**, and at the same time, switch **418** is moved to open the circuit to the associated brake **150**.

Secondly, switch **417'** is opened which renders the high speed carrier clutch **99'** for the carrier **99** inoperative. Switch **417''** opens which renders high speed carrier clutch **100'** for the second heel carrier rod **100** also inoperative. Thirdly, a switch **428** is closed to engage the low speed carrier clutch **189** to drive the first heel carrier **99** at the slow rate, and switch **428'** closes to engage the slow speed carrier clutch **188** for driving the second heel carrier **100** at the slow rate. At the same time switch **434** opens to disengage brake **204** associated with the slow speed carrier clutch **188** and switch **434'** opens to disengage brake **436** associated with the slow speed carrier clutch **189**. The switches **434** and **434'** take the form of micro-switches controlled by means of cams mounted on the electrical control shaft **404**. Also switch **429** is closed to engage the slow speed main clutch **164—166**. Switch **419'** is now released thus releasing solenoid **280** and causing the shock absorbing mechanism to be reactivated. The machine can now be returned to high speed operation.

It will be understood that circuits similar to those above described are provided for the remaining carriers for both low speed and high speed operation. Since description or further illustration of these circuits would be near duplication, further description of same has been omitted.

It will be noted that the circuit employed for controlling the main slow speed clutch **164—166** for driving the slow speed slide bar **162** differs in certain respects from the circuit employed for controlling the main clutch **110** for driving the main slide bar **108**. Since the slow speed slide bar **162** will always travel through the same course and is not affected by the width of the stocking, it is not necessary to include a variable type brush switch which would correspond with the brush switch **304** employed with the main clutch. It has been found necessary only to include two limit switches **430** and **431** in series in the circuit for the slow speed main clutch **164** as illustrated in Fig. 9. One of these switches only has been shown also in Fig. 6 of the drawings. These switches are so placed as to be rendered operative respectively at the two ends of the stroke of the slow speed slide bar **162**. One additional switch **432** of the rotary brush type mounted on the main cam shaft **30** is provided for shunting out each of the two switches **430**, **431**. This rotary switch **432** is timed to close energizing the clutch just before the beginning of a new stroke, and to open immediately after the respective limit switch **430** or **431**, as the case may be, closes shortly after the new stroke commences.

The circuits employed for controlling each of the slow speed carrier clutches **185—189**, of which the two circuits for the clutches **189** and **188** have been illustrated, include in addition to the switch **428**, above described, a variable rotary brush type switch **433** in the low speed carrier clutch **189** circuit, and a switch **433'** in the low speed carrier clutch **188** circuit, which are identical with the switch **304** and are employed for varying the moment at which the low speed carrier clutch is disconnected. These switches operate to disconnect power from the respective heel carrier rods individually at varying points in the carrier travel according to the width of the heel. A limit switch **434** operated from the control shaft **404** is employed to disengage the brake **204** associated with the low speed carrier clutch when the respective carrier is in operation. A similar limit switch **434'** similarly operated from the control shaft **404**, is employed to disengage the brake **436** associated with the low speed carrier clutch **189** when carrier **99** is in operation.

The invention having been described what is claimed is:

1. In a straight knitting machine, the combination with a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver connected to be positively reciprocated by said coulier mechanism, a carrier slide bar, a rotary electro-magnetic clutching device connected between said driver and said slide bar, at least one yarn carrier supporting rod, and a rotary electro-magnetic clutch connected between the carrier slide bar and the carrier rod whereby the carrier rod is driven from the carrier slide bar.

2. In a flat full-fashioned type knitting machine having a cam shaft, and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, the combination of a carrier drive mechanism which comprises a coulier mechanism driven from the shaft, a driver connected to be reciprocated by said coulier mechanism, a carrier slide bar, a rotary electro-magnetic clutching device connected between said driver and carrier slide bar, at least one carrier supporting rod, a rotary electro-magnetic clutch connected between the carrier slide bar and carrier rod, adjustable stops on the machine for arresting the traverse of the carrier rod and carrier slide bar therewith, a rotary switching device driven synchronously with the coulier mechanism having means to adjust the switch timing, electrical connections comprising energizing and at least partially de-energizing circuits for said rotary electro-magnetic clutching device controlled by said rotary switch, and means responsive to the position of said stops for correspondingly varying the adjustment of said switching device.

3. In a flat full-fashioned type knitting machine having a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver connected to be reciprocated by said coulier mechanism, a carrier slide bar, a rotary electro-magnetic clutching device connected between said driver and carrier slide bar, a plurality of yarn carrier supporting rods, means selectively connecting the carrier rods to be driven by the carrier slide bar, adjustable stops on the machine for arresting the traverse of the carrier rod and the carrier slide bar therewith, electrical connections comprising energizing and at least partially deenergizing circuits for said electro-magnetic clutching device, and a switching device

for said circuits timed with the movement of the carrier slide bar.

4. In a flat full-fashioned type knitting machine, having a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver connected to be reciprocated by said coulier mechanism, a carrier slide bar, a rotary electro-magnetic clutching device connected between said driver and carrier slide bar, a plurality of yarn carrier supporting rods, means including a rotary electro-magnetic clutch for connecting a selected carrier rod with the carrier slide bar, adjustable stops on the machine for arresting the traverse of a selected carrier rod and the main carrier slide bar therewith, electrical connections comprising energizing and at least partially deenergizing circuits for said electro-magnetic clutching device, a rotary switch for said circuits timed with the movement of the carrier slide bar and in accordance with the adjustment of said stops, and electrical means for controlling said electro-magnetic clutch for selectively connecting and disconnecting a selected carrier rod to move with said carrier slide bar.

5. In a flat full-fashioned type knitting machine, having a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver connected to be reciprocated by said coulier mechanism, a carrier slide bar, a rotary electro-magnetic clutching device connected between said driver and carrier slide bar, a plurality of yarn carrier supporting rods, means including a rotary electro-magnetic clutch for connecting a selected carrier rod with the carrier slide bar, electro-magnetic carrier rod braking devices for holding each of said yarn carrier supporting rods in stopped position, adjustable stops on the machine for arresting the traverse of a selected carrier rod and the main carrier slide bar therewith, pattern means for the machine actuated from the cam shaft, electrical means including a switch timed with the rotation of the cam shaft for energizing and deenergizing said rotary electro-magnetic clutching device in accordance with the adjustment of said stops, and electrical control devices actuated by said pattern means for selectively energizing and deenergizing said electro-magnetic carrier rod clutch and said electromagnetic carrier rod braking devices.

6. In a straight knitting machine, the combination with a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a carrier slide bar, an electro-magnetic clutching device comprising a driving clutch element driven from the coulier mechanism and a driven clutch element connected to drive said slide bar, electrical means comprising energizing and at least partially deenergizing circuits for said electro-magnetic clutching device, a rotary switching device continuously driven in timed relation to said cam shaft comprising separated cylindrically shaped contact surfaces, connected with the respective circuits, a contact member engaging said surfaces, and means for relatively adjusting the position of said contact surfaces and contact member to vary the angular position with respect to the switch axis at which said member passes from one to the other surface.

7. In a straight knitting machine the combination with a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit and carriers for feeding yarn to the needles, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a carrier slide bar, an electro-magnetic clutching device comprising a driving clutch element driven from the coulier mechanism and a driven clutch element connected to drive said slide bar, adjustable stops on the machine for arresting the traverse of the carrier slide bar, a plurality of rotary switching devices continuously driven in timed relation to said cam shaft each comprising separated cylindrically shaped contact surfaces, electrical means comprising energizing and deenergizing circuits for said electro-magnetic clutching device connected with the respective contact surfaces of one switching device, and energizing and partially deenergizing circuits for said electro-magnetic clutching device connected with the respective contact surfaces of the other of said switching devices, a contact member associated with each switching device for engaging the contact surfaces thereof, and means for adjusting the positions of said stops and simultaneously for adjusting the position of at least one contact member to correspondingly vary the angular position with respect to the switch axis at which said member passes from one to the other surface.

8. In a straight knitting machine, the combination with a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a carrier slide bar, a rotary electro-magnetic clutching device comprising a driving clutch element driven from the coulier mechanism, and a driven clutch element connected to drive said slide bar, electrical means comprising energizing and at least partially deenergizing circuits for said rotary electro-magnetic clutching device, and a rotary switching device continuously driven in timed relation with said cam shaft and connected with said electrical means for energizing and deenergizing said clutch in timed relation with the movement of said slide bar.

9. In a straight knitting machine, the combination with a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a carrier slide bar, a rotary electro-magnetic clutching device comprising a driving clutch element driven from the coulier mechanism, and a driven clutch element connected to drive said slide bar, electrical connections comprising energizing and at least partially deenergizing circuits for said rotary electro-magnetic clutching device, adjustable stops on the machine for controlling the traverse of the carrier slide bar, a switching device acting in timed relation to the movement of the slide bar for conditioning said electrical circuits to energize and deenergize said clutch, means for adjusting the stops to control the traverse of the carrier slide bar, and means acting in accordance with said adjustment of the stops to correspondingly adjust the timing of said switching device.

10. In a straight knitting machine, the combination with a cam shaft, knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the needles, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a carrier slide bar, a rotary electro-magnetic clutching device comprising a driving clutch element driven from the coulier mechanism, and a driven clutch element connected with said slide bar, electrical connections comprising energizing and at least partially deenergizing circuits for said rotary electro-magnetic clutching device, adjustable stops on the machine for controlling the traverse of the carrier slide bar, a rotary switch having a contact face with an edge thereof offset diagonally along the axis of the switch, a cooperating contact member adjustable longitudinally of said axis, means for adjusting the positions of said stops, and means for positioning said contact member longitudinally of the switch axis in a proportion to the adjustment of said stops.

11. In a straight knitting machine, the combination with a cam shaft, and knitting mechanism comprising a knitting section including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the

sinkers movable from storage positions at the ends of the knitting section, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a slow speed driver reciprocated by said coulier mechanism at a rate substantially slower than the driver, at least one yarn carrier supporting rod adapted for operation as a short course carrier rod, a carrier slide bar arranged to be driven by said driver, a slow speed carrier slide bar connected to be driven by said slow speed driver, means connecting a carrier rod to be driven selectively from said carrier slide bar and from said slow speed carrier slide bar as a short course carrier rod, pattern means, and automatic means controlled by said pattern means for connecting the carrier rod to be driven selectively from said carrier slide bar to and from the storage position and from said slow speed carrier slide bar to feed yarn.

12. In a straight knitting machine, the combination with a cam shaft, and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a yarn carrier slide bar connected to be reciprocated by said coulier mechanism, a slow speed carrier slide bar connected to be reciprocated by said coulier mechanism at a rate substantially slower than the carrier slide bar including a magnetic clutch, at least one carrier support rod, disconnectible means for imparting movements to the carrier rod from the carrier slide bar, disconnectible means including a magnetic clutch connecting the carrier rod to be reciprocated from said slow speed carrier slide bar, and pattern means controlling said disconnectible means including said magnetic clutches to cause the carrier rod to be driven selectively from said carrier slide bar and from said slow speed carrier slide bar.

13. In a straight knitting machine, the combination with a cam shaft, and knitting mechanism comprising a knitting section including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers movable from storage positions at the ends of the knitting section, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a yarn carrier slide bar connected to be reciprocated by said coulier mechanism, a slow speed carrier slide bar connected to be reciprocated by said coulier mechanism at a rate substantially slower than the yarn carrier slide bar, at least one carrier support rod, a rotary electro-magnetic clutch connected between the carrier slide bar and the carrier rod for moving said carrier rod to and fom the storage position, a separate rotary electro-magnetic clutch connected between the slow speed carrier slide bar and the carrier rod for moving said carrier rod to feed yarn, pattern means for the machine, and electrical means actuated by said pattern means for controlling said electro-magnetic clutches to cause the carrier rod to be driven selectively from said carrier slide bar to and from the storage position and from said slow speed carrier slide bar to feed yarn.

14. In a straight knitting machine, the combination with a cam shaft, and knitting mechanism comprising a knitting section including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers movable from storage positions at the ends of the knitting section, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a yarn carrier slide bar connected to be reciprocated by said coulier mechanism, a slow speed carrier slide bar connected to be reciprocated by said coulier mechanism at a rate substantially slower than the yarn carrier slide bar, at least one short course carrier support rod, a rotary electro-magnetic clutch connected between the carrier slide bar and the carrier rod, a separate rotary electro-magnetic clutch connected between the slow speed carrier slide bar and the carrier rod, electrical connections for rendering each of said clutches individually operative and inoperative, and pattern means for the machine controlling said electrical connections for energizing the first-mentioned rotary electro-magnetic clutch to shift said short course carrier rod between the storage and operating position and for energizing said latter rotary electro-magnetic clutch to drive said short course carrier rod from the slow speed carrier slide bar.

15. In a straight knitting machine, the combination with a cam shaft, and knitting mechanism comprising a knitting section including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers movable from storage positions at the ends of the knitting section, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a yarn carrier slide bar connected to be reciprocated by said coulier mechanism, a slow speed carrier slide bar connected to be reciprocated by said coulier mechanism at a rate substantially slower than the yarn carrier slide bar, a plurality of carrier support rods, disconnectible means connecting selected carrier rods to be reciprocated from the carrier bar, disconnectible means connecting other selected carrier rods to be reciprocated as short course carriers from said slow speed carrier bar, pattern means for the machine, and pattern actuated control means for said disconnectible means for connecting and disconnecting said selected carrier rods to be driven from said carrier bar and short course carrier rods to be moved to and from storage position, and for connecting and disconnecting said short course carriers to be driven while feeding yarn to the sinkers from said slow speed carrier bar.

16. In a straight knitting machine, the combination with a cam shaft, and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a carrier slide bar, and a rotary electro-magnetic clutching device connecting the carrier slide bar to be driven from the driver, a slow speed driver reciprocated by said coulier mechanism at a rate substantially slower than the carrier slide bar, a slow speed carrier slide bar, a rotary electro-magnetic clutching device connecting the slow speed slide bar to be driven by the slow speed driver, yarn carrier rods including short course carrier rods, rotary electro-magnetic clutches connected between each of said carrier rods and the carrier slide bar, additional rotary electro-magnetic clutches connected between the slow speed slide bar and selected short course carrier rods, electrical connections for rendering each of said clutches individually operative and inoperative, pattern means controlling said electrical connections for connecting said carrier actuated slide bar with selected carrier rods including a selected short course carrier rod to move said short course carrier rod between operative and inoperative positions, and pattern means controlling said electrical connections to operatively connect any activated short course carrier rod with said slow speed carrier slide bar.

17. In a straight knitting machine, the combination with a cam shaft and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarns to the sinkers of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a carrier actuating slide bar, a rotary electro-magnetic clutch connecting said carrier slide bar to be driven from the driver, a slow speed driver reciprocated by said coulier mechanism at a rate substantially slower than the driver, a plurality of yarn carrier supporting rods, a slow speed carrier slide bar connected to be

driven by said slow speed driver, rotary electro-magnetic clutches connected between said slide bar and each of said carrier rods, additional rotary electro-magnetic clutches connected between the slow speed slide bar and selected carrier rods, electrical connections for rendering each of said clutches individually operative and inoperative, and pattern means controlling said electrical connections for rendering selected ones of said clutches operative and inoperative.

18. In a straight knitting machine, the combination with a cam shaft and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a carrier actuating slide bar, a slip clutch driving means connecting the slide bar to be driven from the driver, a slow speed driver reciprocated by said coulier mechanism at a rate substantially slower than said slide bar, adjustable stop devices on the machine operable to limit the movement of the slide bar, a slow down device comprising slow down members shiftably supported on the slow speed driver, abutments on the slide bar arranged for engagement with the respective slow down members thereby to slow the slide bar to the rate of the slow speed driver, and a contact surface on each stop device rendered operative by engagement of the respective slow down member therewith for shifting the respective slow down member to further slow the slide bar.

19. In a straight knitting machine the combination with a cam shaft, and knitting mechanism including sinkers, spring beard needles movable as a unit and carriers for feeding yarn to the sinkers, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a main carrier slide bar, a slip clutch driving means connecting the slide bar to be driven from the driver, a slow speed driver reciprocated by said coulier mechanism at a rate substantially slower than said slide bar, adjustable stop devices on the machine operable to limit the movement of the slide bar, a slow-down device comprising pivoted slow down members on the slow speed driver, an abutment on the slide bar for engagement with a slow down member, and cam means associated with a stop device arranged to engage with and to rock the slow down member to further slow the slide bar.

20. In a straight knitting machine the combination with a cam shaft, and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a carrier slide bar, a rotary electro-magnetic clutch connecting said carrier slide bar to be driven from the driver, a slow speed driver reciprocated by said coulier mechanism at a substantially slower rate, adjustable stop devices on the machine operable to limit the movement of the slide bar, a slow down device comprising pivoted slow down members on the slow speed driver, abutments on the slide bar for engagement with said slow down members, and cam means associated with the stop devices arranged to engage and rock the slow down members to further slow the slide bar, electrical means having alternate positions to energize and to at least partially deenergize said rotary electro-magnetic clutch, and a switching device controlled with relation to the movement of the slide bar for conditioning said electrical means to energize the clutch at each reversal of the bar and to deenergize said clutch prior to the engagement of the slow down device with an abutment.

21. In a straight knitting machine the combination with a cam shaft, and knitting mechanism including sinkers, spring beard needles movable as a unit, and carriers for feeding yarn to the sinkers, of a carrier drive mechanism which comprises a coulier mechanism driven from the cam shaft, a driver reciprocated by said coulier mechanism, a carrier actuating slide bar, an electro-magnetic slip clutch driving means connecting the slide bar to be driven from the driver, a slow speed driver reciprocated by said coulier mechanism at a rate substantially slower than said slide bar, adjustable stop means on the machine operable to limit the movement of the slide bar, a mechanical slow-down device comprising slow down members shiftably supported on the slow speed driver, abutments on the slide bar arranged for engagement with the respective slow down members thereby to slow the slide bar to the rate of the slow speed driver, and a contact surface on each stop device rendered operative by engagement of the respective slow down member therewith for shifting the respective slow down member to further slow the slide bar, electrical means including energizing and at least partially deenergizing circuits for said slip clutch driving means, and a rotary switching device continuously driven in timed relation with the cam shaft and connected with said electrical means to energize said slip clutch driving means with each reversal of the driver and thereafter to deenergize said slip clutch driving means in advance of the engagement of the slow down member with the surface of the respective stop means.

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