

Nov. 22, 1960

H. L. CURTIS
KNITTING MACHINE

2,960,853

Filed Oct. 15, 1956

6 Sheets-Sheet 1

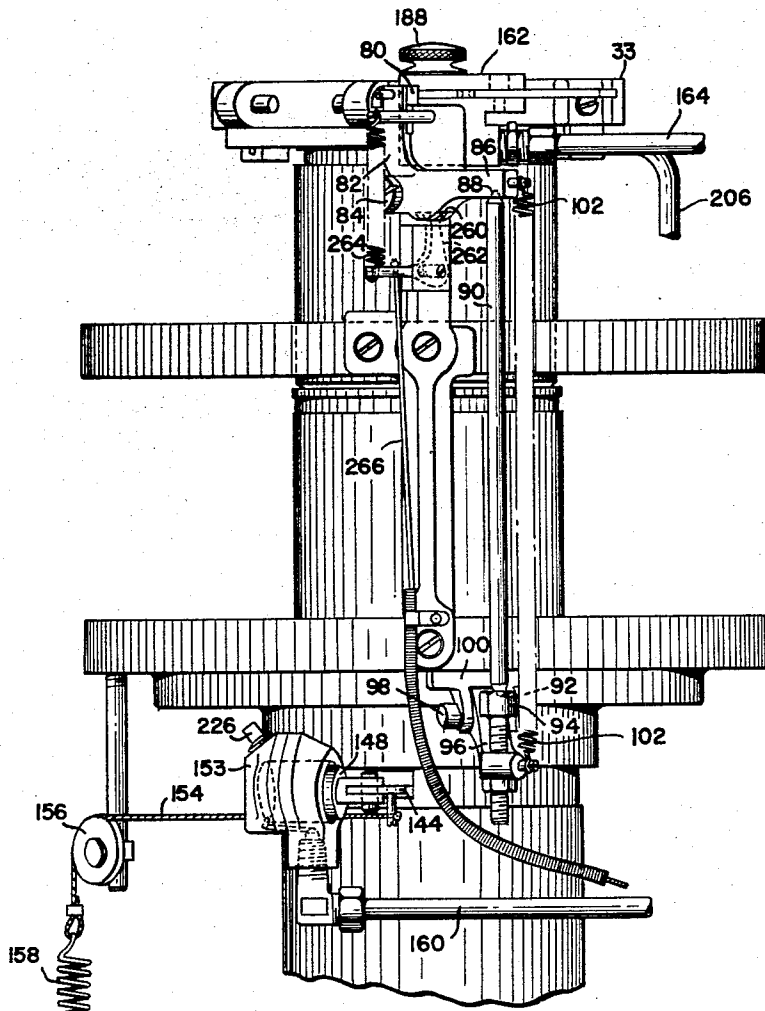


FIG. 1.

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6 Sheets-Sheet 2

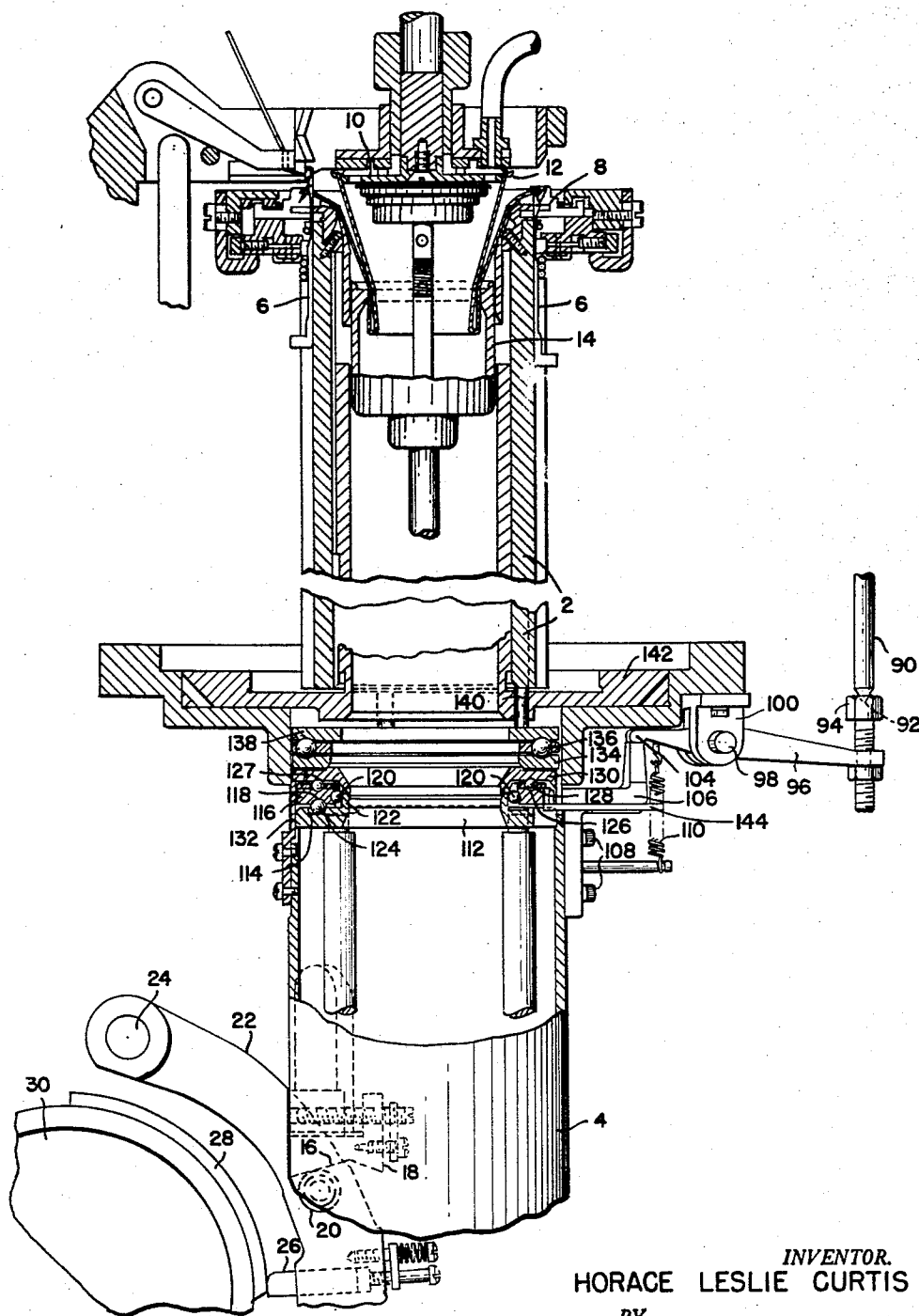


FIG. 2.

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6 Sheets-Sheet 3

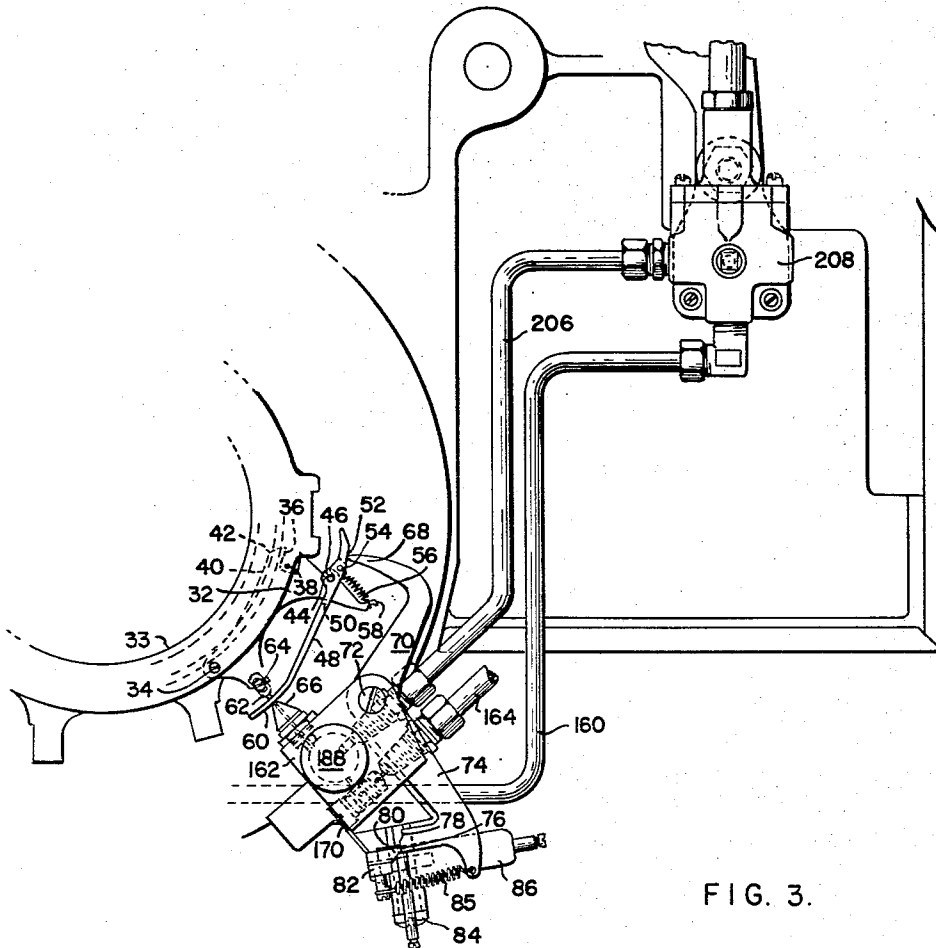


FIG. 3.

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6 Sheets-Sheet 4

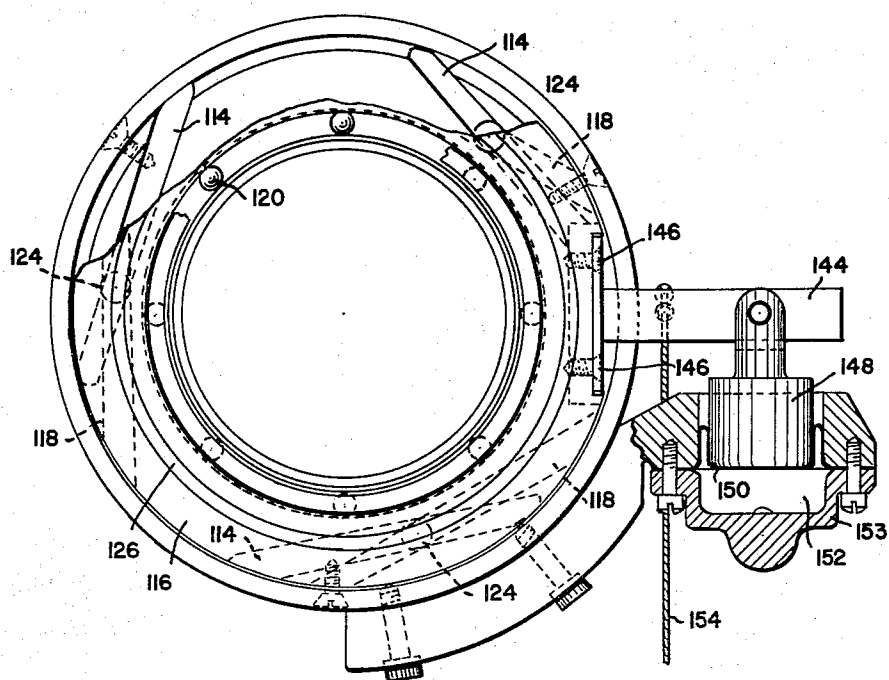


FIG. 4.

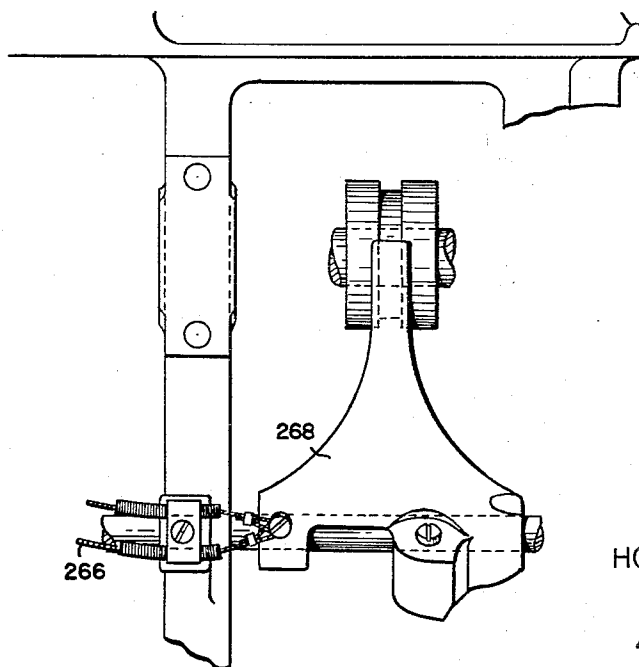


FIG. 5.

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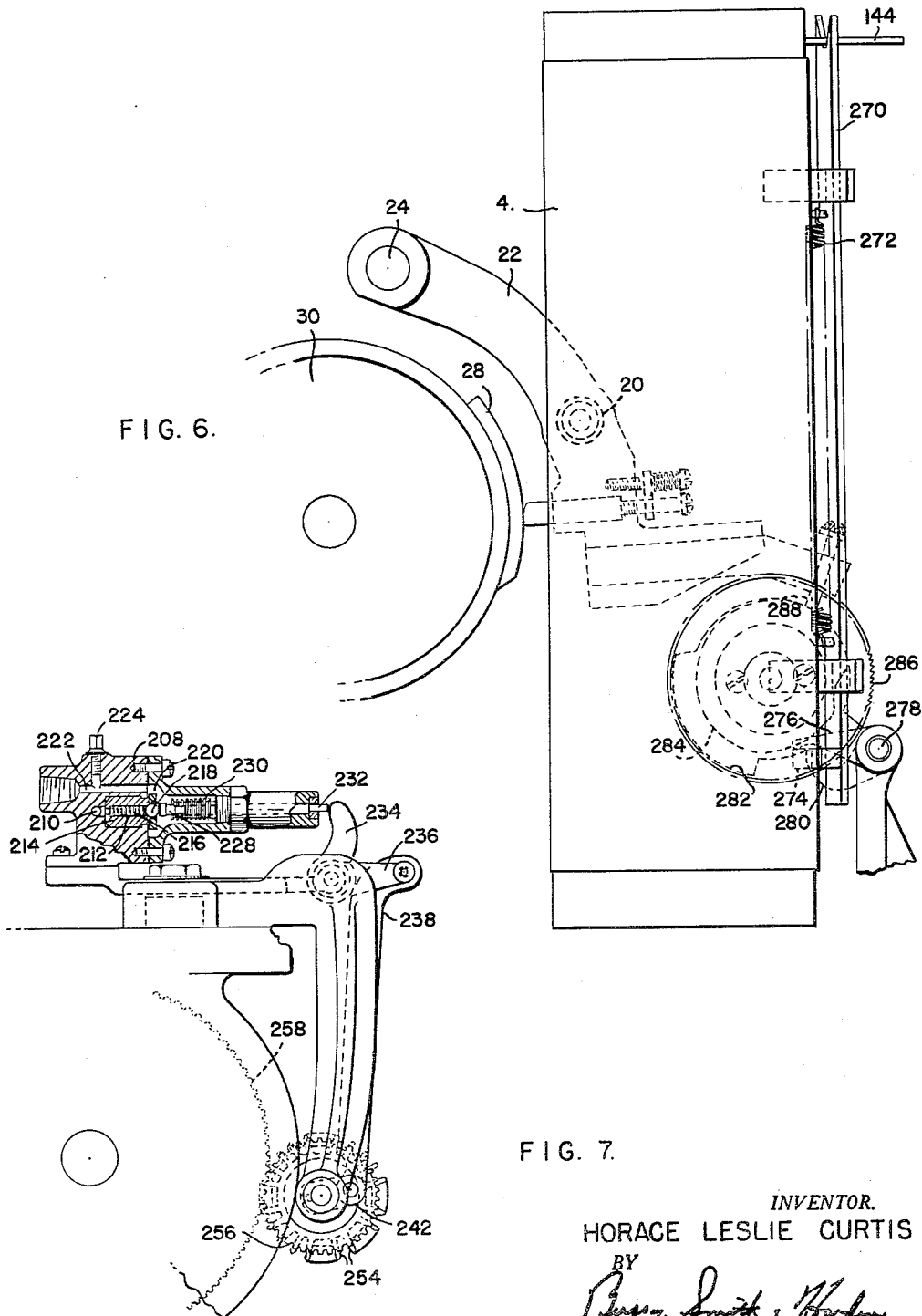
Nov. 22, 1960

H. L. CURTIS
KNITTING MACHINE

2,960,853

Filed Oct. 15, 1956

6 Sheets-Sheet 5



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H. L. CURTIS
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2,960,853

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6 Sheets-Sheet 6

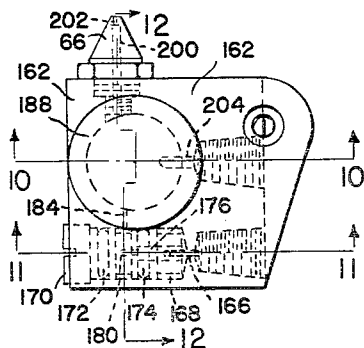


FIG. 9.

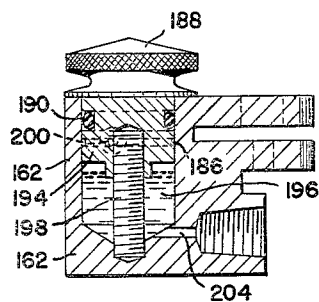


FIG. 10

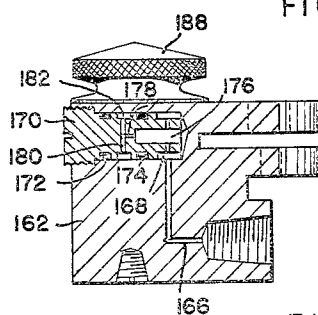


FIG. 11.

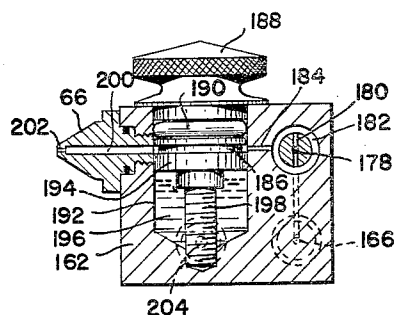


FIG. 12.

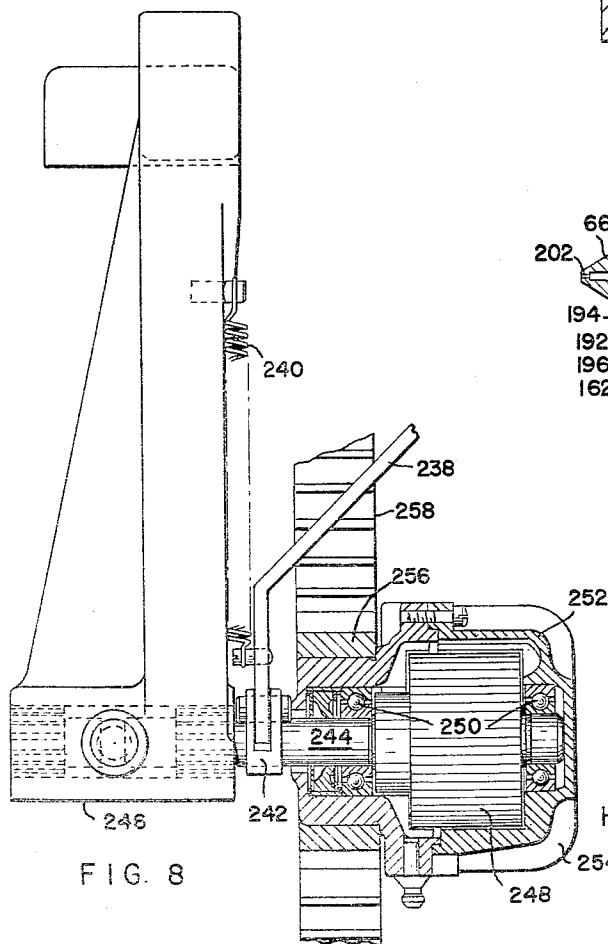


FIG. 8

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1

2,960,853

KNITTING MACHINE

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Filed Oct. 15, 1956, Ser. No. 615,818

7 Claims. (Cl. 66—55)

This invention relates to knitting machines and has particular reference to the automatic control of stitch size and is particularly directed to machines for the knitting of sheer ladies' hosiery.

Difficulties are experienced in the knitting of sheer ladies' hosiery, in particular, in that, due to variations in yarn and in the tension of yarn fed to the needles, stitches of varying length or size are produced. The variations in size of individual loops are minute, but due to the fact that a lady's stocking contains a very large number of courses, the minute variations of individual stitch lengths are cumulative to the end that successive stockings produced on the same machine and seemingly under identical conditions will vary greatly with the result that, after finishing, the stockings must be carefully sorted into pairs of approximately equal lengths. Furthermore, while the intention may be to produce stockings of particular lengths, there may be produced undesired numbers of stockings varying so far from the desired lengths that for a mill to fill an order an excessive number of stockings may have to be produced, the stockings of undesired lengths being then retained in hopes of filling an order requiring their lengths.

Furthermore, the variations in stitch lengths may occur in such fashion that groups of courses having stitches of abnormal lengths may be interposed between groups of courses having stitches of normal lengths, and the result in such cases will be the appearance of horizontal shadowy streaks which may make the stockings unacceptable.

Further, stitches may vary in size sufficiently to produce abnormal reductions or increases in stocking circumference causing the stocking to be locally too tight or too loose when worn.

The variations indicated above as of objectionable type are not to be understood as those which are intentionally provided for the shaping of stockings. It is common practice to change stitch size in a smoothly continuous fashion in shaping ladies' hosiery from the calf portions into the ankle portions. Such variations are definitely programmed by the controlling mechanism of the knitting machine. The objectionable variations here under discussion are those which normally occur beyond intentional control.

In the patent to Vernon Thomas Stack, No. 2,685,786, dated August 10, 1954, there is disclosed mechanism in a knitting machine for the automatic control of stitch lengths having as its object the prevention of shadow streaks or rings, the production of proper stocking diameters, and the attainment of stockings of desired overall lengths. In accordance with the mechanism of said Stack patent, there is provided detection of variations of lengths of stitches as the stitches are being formed, with provision for correction of stitch lengths so as to avoid the cumulative occurrence of stitches in large groups of successive courses which would lead to the objectionable results above discussed. In brief, in accordance with the said patent, the positions of sinkers are detected to give rise to signals indicative of variations of stitch lengths from

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normal, and the signals thus produced control through reversible electric motor means devices which change the relative positions of the stitch drawing needle cams and the ledges of sinkers over which the stitches are drawn. The mechanism so shown allows for the intentional variations of stitch length incidental to the usual fashioning or shaping procedure, but prevents deviations from the locally normal stitch lengths in such fashion that cumulative errors do not occur.

Improved mechanism for the control of stitch lengths is described in the application of Robert H. Lawson, Serial No. 598,829, filed July 19, 1956. In accordance with that application, the control is pneumatic rather than electrical. Pneumatic control provides smooth and reliable operations, avoiding the possibilities of failure of electrical elements and the complexities involved in electrical control. Furthermore, from a practical standpoint, a single type of pneumatic mechanism may be provided for all localities, domestic and foreign since, except for a driving motor for the air supply, it is independent of the local power supply which may vary from place to place in voltage and frequency and would necessitate the provision of wholly different electrical systems for various places. Due to the relatively slow and smooth action of a pneumatic control, sudden variations in stitch lengths or sizes are prevented, and this is highly desirable since any sudden change in stitch length will be noticeable as a streak or mark in the fabric. Desirably, the corrective action should be slow so that in successive courses, even though a corrective action is taking place, there will be no change in stitch length which will be apparent to the eye.

The broad object of the present invention is simplification and improvement of the stitch control mechanism described in said Lawson application. Whereas in said Lawson application the stitch control mechanism is employed to raise and lower the needle cylinder raising tube throughout the entire range of its rise and fall necessary to fashion a complete stocking, in accordance with the present invention the conventional mechanical linkage which has been standard in knitting machines is effective to do the major portion of the work of producing the necessary rise and fall for approximate fashioning, and the stitch control acts merely as a trimmer control changing the effective length of the cylinder raising tube to correct for slight deviations in the fabric produced by temperature or yarn tension conditions or by other abnormalities which could cause the length of the stitch to be other than desired. Since the control is called upon to effect only minor changes in the needle cylinder position, considerable simplification results, the controlling elements being required to move only relatively slightly.

Further objects of the invention relating to attainment of optimum results will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a front elevation of the upper portion of a knitting machine showing the sensing head and other elements provided in accordance with the invention;

Figure 2 is a front elevation, partly in section, showing, in particular, tube and needle cylinder raising devices;

Figure 3 is a plan view of the sinker cap of the machine showing a feeler cam together with certain devices associated therewith;

Figure 4 is a cut-away plan view, partly in section showing the cylinder raising mechanism and associated parts;

Figure 5 is a fragmentary elevation showing a connection of the clutch shipper fork to a throw out cable;

Figure 6 is a side elevation showing the cylinder raising tube and certain associated devices;

Figure 7 is an end view, partly in section, showing, in particular, an oil cut off valve and its operating linkage;

Figure 8 is an elevation, partly in section, showing the mechanism for operating the oil shut off valve;

Figure 9 is a plan view showing details of a pneumatic-hydraulic control head;

Figure 10 is a vertical section taken on the plane indicated at 10—10 in Figure 9;

Figure 11 is a vertical section taken on the plane indicated at 11—11 in Figure 9; and

Figure 12 is a vertical section taken on the broken surfaced indicated at 12—12 in Figure 9.

As noted above, the invention is particularly applicable to knitting machines for the production of ladies' sheer hosiery wherein the matter of stitch control is particularly important, though it will be evident that the invention is more broadly applicable to knitting machines generally. For purposes of illustration the invention will be described as applying to a machine of the type arranged to knit ladies' sheer hosiery, the machine which will specifically be referred to being of the type disclosed in Robert H. Lawson Patents 2,625,026, dated January 13, 1953, and 2,709,352, dated May 31, 1955. Such a machine, certain parts of which are particularly indicated in Figure 2, comprises a slotted needle cylinder 2 associated with which is the non-rotating but axially movable cylinder raising tube 4 which is vertically moved for the major control of stitch length, and between which and the needle cylinder there is interposed mechanism provided in accordance with the present invention for the minor correction and control of stitch length. Heretofore, such a tube has been raised intermittently to control changes in stitch length as between major parts of the complete stocking and, in particular, where yarn changes have been effected, and also for the gradual control of stitch length to produce proper fashioning of the stocking from the calf into the ankle. The adjustment of stitch length in this fashion is well known and occurs in accordance with the present invention and is the result of changing the vertical height relationship between the ledges of the sinkers 8, over which the stitches are drawn by the needles 6, with respect to the level of the cams (not shown) which are at a generally fixed height and control the needle movements. The machine is illustrated as comprising also the dial 10 which carries transfer elements 12 for the production of turned welts. Also indicated is a grab takeup 14 of the type described in detail in said Lawson patents, which takeup makes possible the maintenance of proper tension during the knitting of stockings which are individually and separately knit, each being started on bare needles. In the remaining portion of the description herein there will be referred to only those elements which are intimately concerned with the invention herein involved, it being understood that the knitting machine is otherwise of conventional type arranged to knit complete stockings including heels and toes.

The cylinder raising tube 4 is provided with a cam surface 16 formed on an adjustable block 18 which is engageable by a roller 20 carried by a lever 22 pivoted at 24 and provided with an adjustable follower 26 arranged to be acted upon by cams 28 on the main cam drum 30.

As in said Stack patent and in the Lawson application referred to above, stitch length is detected through the use of a lever 32 which bears against the outer edges of the sinkers 8. This lever 32 is pivoted to the sinker cap 33 at 34 and has its movements limited by the provision of a slot 36 embracing a pin 38. Engagement of the sinkers occurs between the points indicated at 40 and 42 of the lever 32. At its free end the lever is provided with a hook portion forming a slot 44 within which there is located a pin 46 carried by a baffle member 48 which is slotted between the lines indicated at 50 and 52 to embrace the lever 32. A pin 54 carried by the baffle member 48 adjacent to the pin 46 has secured to it one end of a spring 56 which at its other

end is anchored to an extension 58 of lever 32. The end of baffle member 38 remote from the pin 46 provides a baffle region 60 which is limited in its clockwise movement as viewed in Figure 3 by an adjustable stop 62 secured by a screw 64 to a lateral extension of the lever 32 relatively close to its pivot 34. The baffle 60 serves to control flow of air escaping from a nozzle generally indicated at 66 which will be described in greater detail hereafter.

Closely adjacent to the pin 54 and to the pin 46 the member 48 is engaged under normal operating conditions by the end 68 of a lever 70 which is mounted on a fixed pivot 72. It will be noted that the pin 54 to which the spring 56 is attached lies between the pin 46 and the point of engagement of the lever end 68 with baffle member 48. The arrangement thus described has the following characteristics:

Assuming that the end 68 of lever 70 does not engage the baffle member 48, it will be evident that this baffle member forms, effectively, an integral part of lever 32, moving therewith. This results from the fact that the spring 56 not only seats the pin 46 in the trough of slot 44 but also urges it in a clockwise direction so that its end 60 is in engagement with the stop 62. It will be noted that the relationship of the baffle end 60 of member 48 to the pivot 34 and to the nozzle 66 is such that, as the lever 32 rocks, the spacing of baffle 60 relatively to the nozzle is substantially unchanged, the baffle 60 moving in an arc approximately perpendicular to the axis of the nozzle. Assuming, now, that the lever 32 is fixed, counterclockwise movement of the lever end 68 into engagement with the member 48 would first result in counterclockwise movement of the member 48 about pin 46 which is held seated in the slot 44 by spring 56, which also holds the member 48 in contact with the lever end 68, the spring acting on the member 48 at a point between pin 46 and this lever end. Such movement, however, would be arrested when the baffle 60 engages the end of the nozzle 66. Further movement of the lever end 68 would then result in lifting of pin 46 from its seated position in the slot 44 so that the member 48 is then held by spring 56 against the nozzle and the lever end 68. When such a position is attained, it will be evident that, if lever 70 is then fixed, the baffle will continue to engage the nozzle until the lever 32 moves sufficiently counterclockwise to again seat the pin 46 in slot 44, further movement of the lever 32 then causing the pin 46 to move it so that the member 48 fulcrums about the lever end 68 to move clockwise away from the nozzle 66 toward and finally into engagement with the stop 62.

The foregoing does not actually occur in practice but indicates generally some of the properties of the linkage involved. The actual normal operation may be best described as follows:

Assuming the lever end 68 to have a fixed position, if the sinkers are inwardly beyond a normal position under the action of the usual spring band so as not to engage the lever 32, the spring 56 will hold pin 46 seated in the bottom of slot 44 and the member 48 will engage the stop 62. Under these conditions the lever 32 is free to float, without any action thereon, by the spring 56, between positions limited by engagement with the sinkers and by engagement of member 48 with lever end 68. Under these conditions the nozzle 66 is open and the action, as will appear hereafter, is that of shortening the stitches so that the sinkers will be held further outwardly by the stitches.

As the sinkers move further outwardly, they will ultimately reach the position insuring engagement of member 48 with lever end 68 while the pin 46 is engaged in the bottom of slot 44 and member 48 engages stop 62. Beyond this sinker position, the lever 32 must be urged outwardly against the action of spring 56 since the lever end 68 provides a fixed fulcrum. The pin 46 remains in

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the bottom of slot 44, but the baffle member 48 swings toward and finally against the nozzle 66. If the sinkers move outwardly beyond the position corresponding to engagement of member 48 with nozzle 66, the lever 32 must so move that the bottom of slot 44 disengages pin 46. It may be noted that until this last action happens the spring 56 exerts only a negligible force tending to urge the sinkers inwardly.

The lever arrangements involved produce, as will be evident, a very large magnification of movements from those of the lever 32 to those of the baffle 60 of member 48. Thus the arrangement is extremely sensitive to changes of stitch length which effect movements of the lever 32. The sinkers are urged inwardly, of course, by the usual spring band.

The lever 70 has an extension 74 which is provided with a pair of steps 76 and 78 joined by a slope and arranged to be engaged by the end portion 80 of a lever 82 which is mounted on the shank of a screw 84 so as to be axially slidable thereon. A spring 85 shown in Figure 3 but omitted from Figure 1 for clarity urges the lever end 80 against one or the other of the steps 76 and 78 by connection at its ends respectively to the levers 74 and 82. The lever 82 has a horizontal arm 86 provided with a socket 88 in which there is seated the upper rounded end of a rod 90 which also has a lower rounded end seated in a socket 92 in an adjustable screw 94 carried by an outer end of a lever 96 having a fixed pivot at 98 in a bracket 100 secured to a bed plate of the machine. A spring 102 interconnects the lever arm 86 with the lever 96 to take up lost motion. An end 104 of the lever 96 engages a bracket 106 which is secured by screws 108 to the cylinder raising tube 4. A spring 110 maintains tight engagement between the lever end 104 and the bracket 106.

As a result of the foregoing, the lever 70 when its step 76 engages lever end 80 has definite positions related to the height of the tube 4, the various springs which have just been described taking up all lost motion so that the relative positions are definitely maintained.

Reference may now be made particularly to Figures 2 and 4. Secured in the upper end of tube 4 is a ring 112 which is provided with three equiangularly spaced grooves 114 in its upper surface. Each of these grooves is inclined at a slight angle to the horizontal so that the most clockwise end of each is slightly lower than the counterclockwise end. Above the ring 112 there is a ring 116 which is also provided with three equiangularly spaced grooves 118, facing downwardly, which latter grooves are also slightly inclined with respect to the horizontal so that, again looking down on the assembly from above, the most clockwise end of each groove is slightly lower than its counterclockwise end. The ring 116 is mounted concentrically with the ring 112 by means of spaced balls 120 engaged in a race in the inner circumference of ring 116 and with a flange 122 extending upwardly from the inside of the ring 112, the balls being properly spaced by a spacer. Between the rings 112 and 116 and in the crossing grooves therein are three balls 124 which, by reason of the equiangular spacings of the grooves are also at all times equally spaced, the rotational movements of ring 116 with respect to ring 112 being so limited that upper and lower grooves of a pair can never become parallel but always intersect as indicated in Figure 4.

Above the ring 116 there is located a non-rotatable ring 130, the latter being supported by balls 128 located in a race 126 in the ring 116 and in a race 127 in the ring 130, the balls being spaced by a spacing member. The ring 130 is held against rotation relative to the tube 4 by a spline-providing key 132 secured to the tube 4, so that the ring 130 is free to move vertically relative to the tube. Supported by the ring 130 is the lower race 134 of a ball bearing which includes the spaced balls 136 and the upper race 138 on which rest the pins 140 slidable in the drive gear 142 and supporting the cylinder 2. This last ar-

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angement for driving a needle cylinder and yet permitting it to move vertically is essentially conventional.

Secured to the ring 116 is a lever 144 which projects outwardly through an opening in the wall of the tube 4. The ring 116 and lever 144 have only limited movement of about 5°.

When the ring 116 is rotated through lever 144 the balls 124 roll and slide in the inclined raceways to cause the ring 116 to move vertically, the amount and direction of the vertical movement depending on the amount and direction of the rotation imparted to ring 116. Because the ball races are never parallel to each other in a vertical plane the balls can never escape from the point of intersection and accordingly no ball retainer is necessary. While the action of the balls is not completely a true rolling one, it deviates from this ideal so little that the additional friction resulting from cramping and sliding is scarcely perceptible for the angles and limited arc of travel used. The result is a highly effective device for transforming horizontal to vertical motion and at the same time obtaining a very large mechanical advantage, all without the possibility of backlash and with the entire mechanism occupying the very small space available. The moving parts in this arrangement are isolated from any torque which might be transmitted to them from the lower race of the thrust bearing 134—138 through the use of the non-rotatable splined ring 130.

The lever arm 144 is controlled through a pneumatic-hydraulic system which will now be described. The arm 144 is pivoted to a piston 148 which is driven by, or itself moves, a diaphragm 150 which closes a chamber 152 in a member 153, which will be hereafter referred to as the power cylinder. Since only relatively small movements are involved, the power cylinder is quite small. The arm 144 is urged in a clockwise direction through a cable 154 by a spring 158, the cable passing over a pulley 156 so that the spring may be quite long, running to its anchorage in the lower portion of the frame of the machine. The reason for using a long spring is to maintain a substantially constant force on the arm 144 throughout its extent of movement. The cylinder 153 is maintained full of oil which is introduced or withdrawn through the connection 160.

Reference may now be made to Figures 9 to 12, inclusive, which show the hydraulic and pneumatic connections directly associated with the nozzle 66. A metal block 162 is drilled and tapped to provide various chambers and passages, some of the drilled passages being closed after drilling to provide effectively the active passages illustrated in these figures. Compressed air at regulated substantially constant pressure is introduced through pipe 164 (Figure 3) to the passage indicated at 166 from which it passes into the innermost portion 168 of a bore which receives a plug 170. This plug is provided with two annular grooves which receive O-rings 172 and 174 to define a central compartment separate from 168 and sealed off with respect to the atmosphere. The compartment provided at 168 communicates with an enlarged interior bore 176 in plug 170, and this in turn communicates through a restricted opening 178 with a transverse passage 180 communicating with an annular groove 182 located between the O-rings. The groove 182 communicates through a passage 184 with a groove 186 in another plug 188 which is sealed by an O-ring 190 in an enlarged bore 192, the lower portion 194 of the plug 188 below the groove 186 having a diameter slightly smaller than that of the bore 192 so that air from the groove 186 may pass quite freely to the space below the plug. Below the plug is a body of oil 196 forming part of a fixed quantity of oil which fills certain other parts of the system as will be described. The plug 188 is conveniently held in place by being threaded on the upper portion of a screw stud 198 which is threaded into an opening at the lower end of the bore 192. The nozzle 66 is threaded into the block 162 and is provided with a central bore 200

terminating at the end of the nozzle in a substantially reduced opening 202. The nozzle opening 202 is substantially larger than the reduced passage 178; for example, with the former approximately 0.02 inch in diameter, the latter may have a diameter of about 0.0135. The result is that the air pressure above the oil 196 in bore 192 is quite sensitive to the position of the baffle 60 in relation to the nozzle. When the opening 202 is closed by the baffle 60 the pressure above the oil may rise substantially to the air supply pressure. On the other hand, if the baffle 60 moves only a few thousandths of an inch away from the nozzle the air is free to escape through the opening 202 to such extent, due to the restricted opening 178, that the pressure above the oil may fall to little above atmospheric pressure. It has been found convenient to use air at a supply pressure of approximately ten pounds per square inch.

The bottom of bore 192 communicates through a passage 204 with a connecting pipe 206 (Figure 3) which runs to a shut-off valve 208 (Figure 7) wherein it communicates with a passage 210, in turn communicating with a passage 212 in a seat member 214 which houses a compression spring 216 tending to unseat from the end of the passage a ball 218 which provides a valve. Exterior to the ball is the chamber 220 which communicates through passage 222 with the pipe 160 running to the power cylinder. The ball 218 is at certain times, as will be explained later, pressed against its seat against the urging of spring 216 by the member 228 carried by one end of a bellows 230, the free end of which is connected to and arranged to be axially moved by a pin 232. It is desirable that the oil 196 should be free of air from the portion thereof in bore 192 through pipe 206, the shut-off valve, the pipe 160, and the power cylinder chamber 152. For the removal of the air vents are provided in the valve member 208 and in the power cylinder, these being closed off by plugs 224 and 226. There is thus a substantially incompressible body of oil between the upper surface of the oil in bore 192 and the diaphragm 150. This is desirable to effect a locking action as will be described.

Referring now particularly to Figures 7 and 8, actuating means for the stem 232 comprises a lever 234 arranged to press against this stem when a second arm 236 of this lever is raised by a link 238 under the action of a tension spring 240. The link 238 is pivoted at its lower end to an arm 242 carried by a rocking shaft 244 which is mounted in bearings in a bracket 246. The shaft 244 carries a cylindrical member 248 which may be referred to as a stator since it has only limited rocking movements. Mounted on ball bearings 250 on the shaft 244 there is a rotor in the form of a housing 252 which is exteriorly provided with cooling fins 254. Secured to this housing is a gear 256 which meshes with the rotating bull gear 258 of the machine. The stator 248 has limited clearance with the inner surface of the rotor 252 and is desirably coarsely knurled, the space between the stator and rotor being packed with grease so that as the rotor rotates during operation of the knitting machine the dynamic friction which is involved drags the stator 248 in such direction as to lower the link 238 thus effecting release of the pin 232 to permit the ball 218 to be unseated by the spring 216. Thus free communication is provided between the bore 192 and the power cylinder when the machine is operating at any normal speed. On the other hand, whenever the machine stops the spring 240 acts to force the ball 218 against its seat closing off communication and completely trapping whatever oil there may be between the ball and the power cylinder. Since this oil is incompressible, this essentially means that the arm 144 is locked in position, the spring 158 pulling it and the piston 148 against the unyielding diaphragm backed up by the trapped oil. This is desirable in the event that the machine is ever stopped by the knitter during the knitting

of those portions of a stocking in which the controlling action is desired. Otherwise, the power cylinder piston would very likely travel to one extreme or the other of its stroke and remain there until the machine was restarted. Upon restarting the machine the piston would then have to travel a considerable distance back to the position determined by the control action and the time interval for this restoration would possibly be as much as required for the knitting of several courses. The stocking would then show either a tight or loose ring marking the point where the machine stoppage occurred, resulting in spoiling the stocking.

During reciprocatory knitting of the heel and toe, the sinker cap 33 must be free to oscillate and with it the sinker following lever 32. At this time, therefore, the lever 73 must have its end 68 withdrawn from the baffle member 48. As has already been noted, the lever 86 is slidable on its mounting stud 84. The lever 86 is provided with a slot 260 in which there engages the upwardly extending arm of a lever 262 pivoted to the frame and urged clockwise as viewed in Figure 1 by the action of a spring 264 on its horizontally extending arm. This latter arm is connected through a Bowden wire 266 with the usual belt shipper 268, which, as shown in Figure 5 occupies a right hand position during rotary knitting but moves toward the left to the slow speed position when reciprocatory knitting is taking place. When the shipper 268 is in its right hand position, the Bowden wire 266 maintains the lever 86 in its forward position, as illustrated in Figure 3, wherein its portion 80 engages the high cam portion 76 of lever 74 to maintain the lever end 68 in its normal controlling relationship with respect to the baffle 48. On the other hand, when the shipper moves to the lower speed position, the spring 264 is free to move the lever 86 to the position where its portion 80 is brought opposite the portion 78 of lever 74. The result is withdrawal of the lever end 68 by the spring 85, so that clearance is effected.

The result of this is to permit the baffle to engage the stop 62 with the result that the air pressure on the oil is released, and with the result that the arm 144 would move clockwise. This would lower the knitting cylinder. To prevent this action there comes into operation the mechanism particularly illustrated in Figure 6.

A bar 270 guided on the raising tube 4 is provided at its upper end with a notch having upwardly diverging edges embracing the arm 144. This bar is urged upwardly by a spring 272. At its lower end it is provided with a block 274 engageable by an arm 276 secured to a rock shaft 278 mounted in the frame and provided with an arm 280 in the form of a cam follower lever arranged to be acted upon by cams 282 secured to the usual driving gear for the main cam drum which makes one revolution for each revolution of the cam drum. When a portion of the cam 282 forces the arm 280 downwardly, the bar 270 is lowered so that the arm 144 is released. However, during heel and toe knitting, or if desired during other phases of the knitting during which automatic control is not desired, the follower 280 rides on a lower portion of this cam, and the spring 272 is free to move the bar 270 upwardly to lock the arm 144 in a central position. Thus, during such knitting the cylinder height is determined solely by the cams on the main cam drum acting through the lever 22.

Coaxial with the mounting of the cam 282 but entirely independent thereof is the usual fashioning cam 284 which is stepped about during leg knitting in conventional fashion through the ratchet 286, the fashioning cam 284 acting upon the follower 288 which is carried by an extension of the lever 22.

The general operation may now be described.

During the makeup of a stocking the cylinder height is controlled by the main cam drum through lever 22 and the fine adjustments effected in accordance with the present invention may be undesirable, since at the beginning

the needles are without complete stitches. Therefore, at this time a portion of cam 282 may be provided to permit the spring 272 to move the bar 270 upwardly to lock the arm 144.

During welt and leg formation the automatic control is desirably operative and consequently the bar 270 is held lowered by the cam 282. In accordance with the present invention, the stitch length is primarily determined either by the action of cams on the main cam drum or by the action of the fashioning cam upon the lever 22. The control effected by movement of arm 144 is essentially corrective only. When oil is delivered to the power cylinder, the arm 144 moves counterclockwise to raise the cylinder, and conversely, when oil is released from the power cylinder by lowering of the pneumatic pressure in the bore 172 the arm 144 is moved clockwise by spring 158 to lower the needle cylinder.

As will be evident from what has already been described, any particular height of the cylinder raising tube 4 determines a corresponding position of the end 68 of lever 70. The position of this end in turn determines the radial position of the sinkers which will cause the baffle 60 to be located in such close range of proximity to the nozzle 66 as will effect control of air flow to vary the air pressure on the oil in bore 192. If, for a given position of the tube 4 the stitches are too tight so that the lever 32 is urged outwardly by the sinkers, the baffle 60 will close off the nozzle 66 with resulting increase of air pressure on the oil to cause the arm 144 to be moved counterclockwise to raise the needle cylinder with the resulting drawing of longer and, therefore, looser stitches. A converse action takes place if the stitches are so loose that the follower lever 32 is free to move inwardly with resulting release of the baffle from the nozzle, a drop of pressure on the oil, and release of the arm 144 for clockwise movement by the spring 158. In actual operation the baffle attains, or very slightly oscillates about, an equilibrium position with a resulting positioning of the arm 144 to produce stitches of the desired length. Either for abrupt changes of height of the cylinder raising tube 4 or for the progressive changes in height determined by the fashioning cam, the lever 70 is correspondingly moved so that correspondingly proper length stitches are produced under the automatic control. Due to the fact that pneumatic control is used to provide pressure and that oil must flow to achieve adjusting changes, there is sufficient damping action to prevent any undesirable hunting in the control. Nevertheless, the response of the control is sufficiently rapid to prevent any appreciable accumulation of stitches of improper length.

The matter of interruption of control during heel and toe knitting has already been described.

It will be evident that various changes in details may be provided in accordance with the invention without departing from the scope thereof as defined in the following claims.

What is claimed is:

1. Stitch control means for a knitting machine having a needle cylinder, needles mounted therein, elements cooperating with the needles for the formation of stitches and cams for effecting needle movements, comprising means sensing the size of stitches produced, a cylinder raising tube, means operating independently of said sensing means for imparting vertical movements to said tube, and means interposed between said cylinder and said tube and responsive to said sensing means for imparting additional vertical movements to said cylinder concurrently with operation of said independently operating means.

2. Stitch control means according to claim 1 in which said interposed means comprises superposed members having pairs of opposed sloping tracks arranged in crossing relationship, balls located at the crossing points of said tracks, and means for relatively shifting said members.

3. Stitch control means according to claim 1 in which said interposed means comprises superposed members having pairs of opposed sloping tracks arranged in crossing relationship, balls located at the crossing points of said tracks, and means for relatively rotating said members.

4. Stitch control means according to claim 1 including means for rendering said interposed means non-responsive to said sensing means.

5. Stitch control means according to claim 1 including means for locating said interposed means in a fixed position of adjustment.

6. Stitch control means for a knitting machine having needles and elements cooperating therewith for the formation of stitches comprising means sensing the size of stitches produced, hydraulic power means responsive to said sensing means for controlling the size of stitches being formed, and means for blocking flow of liquid operating said hydraulic power means to prevent response thereof to said sensing means.

7. Stitch control means for a knitting machine having needles and elements cooperating therewith for the formation of stitches comprising means sensing the size of stitches produced, and means responsive to said sensing means for controlling the size of stitches being formed, said sensing means comprising a movable member positionable in relation to stitch size, a baffle mounted on said movable member, a pneumatic nozzle controlled by said baffle and constituting the output of the sensing means, and means providing an adjustable fulcrum for said baffle.

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