United States Patent

Paepke

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[54] HORIZONTAL SELECTOR JACKS AND THEIR ACTUATION

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[52] **U.S. Cl.** .....**66/50 R**

[51] **Int. Cl.** **D04b 15/78**

[58] **Field of Search**.....66/25, 50 R, 50 A, 50 B, 154 A

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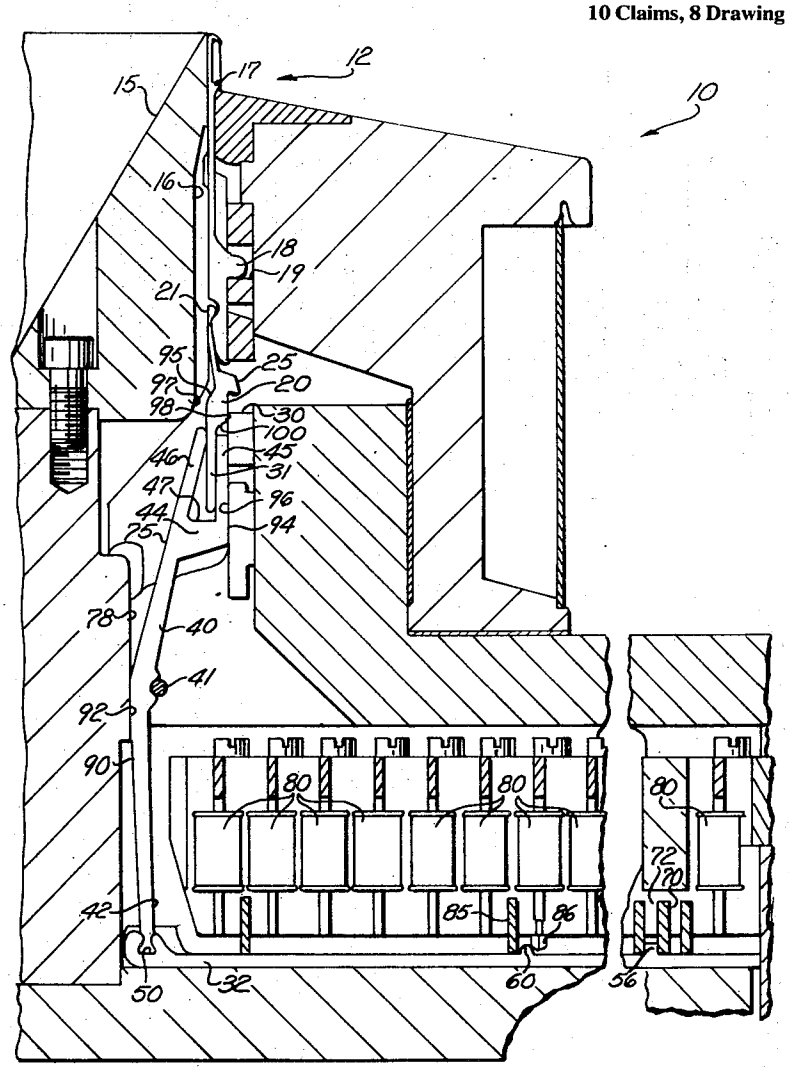
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Primary Examiner—Wm. Carter Reynolds
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[57] **ABSTRACT**

A circular knitting machine comprises a rotatable knitting needle cylinder which carries a plurality of knitting needles through knitting stations. A needle-moving jack is pivotally connected with each of the knitting needles and is movable in a needle-raising stroke and a needle-lowering stroke to effect needle raising and lowering, respectively, Each of the needle-moving jacks has a butt thereon which is received in a cam track which operates to effect the raising and lowering of the needle-moving jacks. A mechanism is provided for controlling the operation of each knitting needle as it progresses through the stations. The mechanism specifically effects pivoting of the needle-moving jack so that the butt thereon is removed from the cam track to thereby prevent raising and lowering of the needle. The means which effects the pivoting movement of each needle-moving jack comprises a selector jack which is linearly movable in a direction substantially transverse to the axis of rotation of the needle cylinder and interconnecting means which operatively connect the selector jack and the needle moving jack so that movement of the selector jack effects the pivoting movement of the needle-moving jack. Electromagnetic means are provided to control the movement of each selector jack so that a selector jack is moved to effect the pivoting movement of the needle-moving jack so as to prevent raising and lowering of the needle or not moved to allow the needle-moving jack with which it is associated to remain with its butt in the cam track and effect movement of the needle.

10 Claims, 8 Drawing Figures



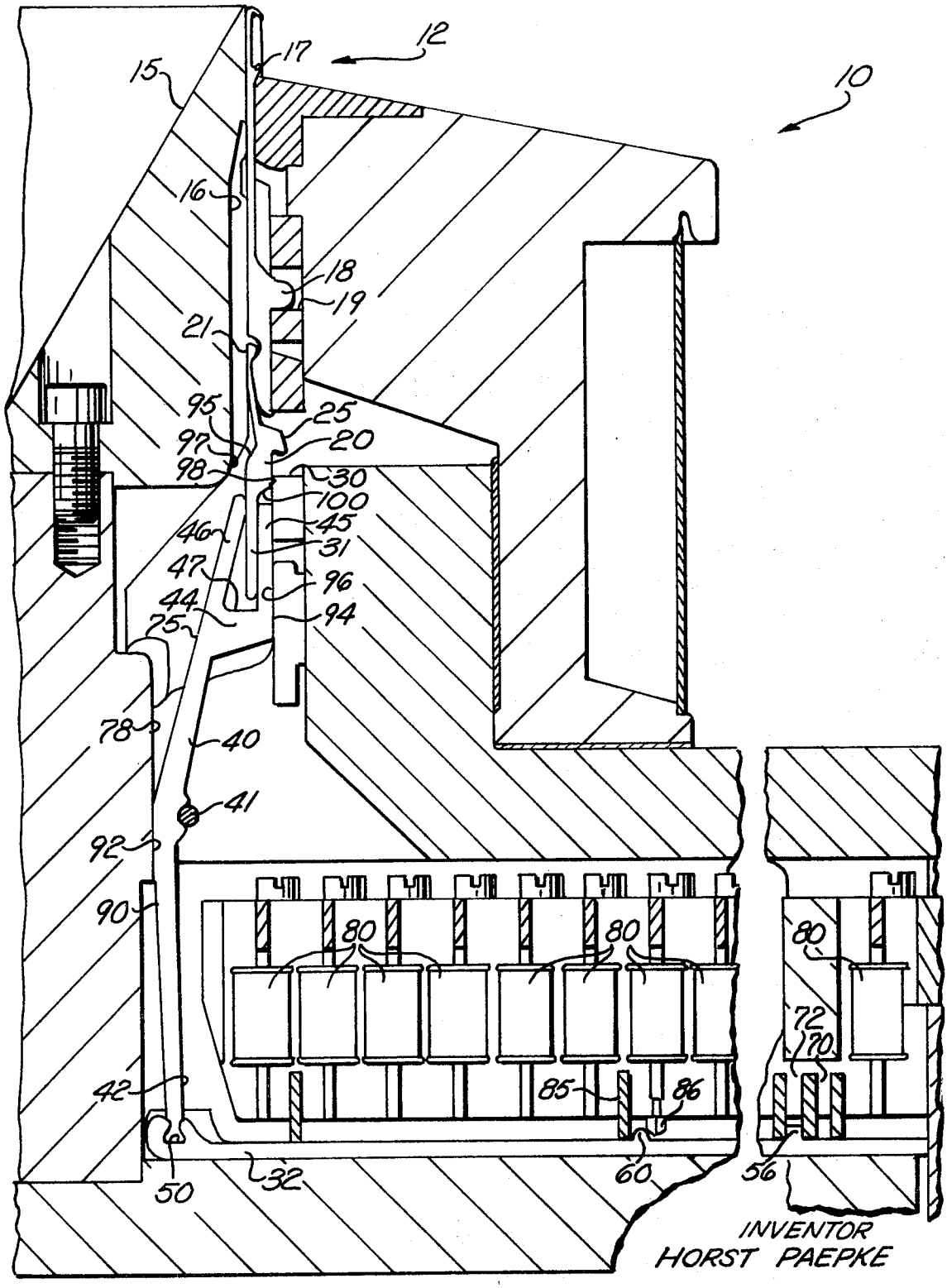


FIG.1

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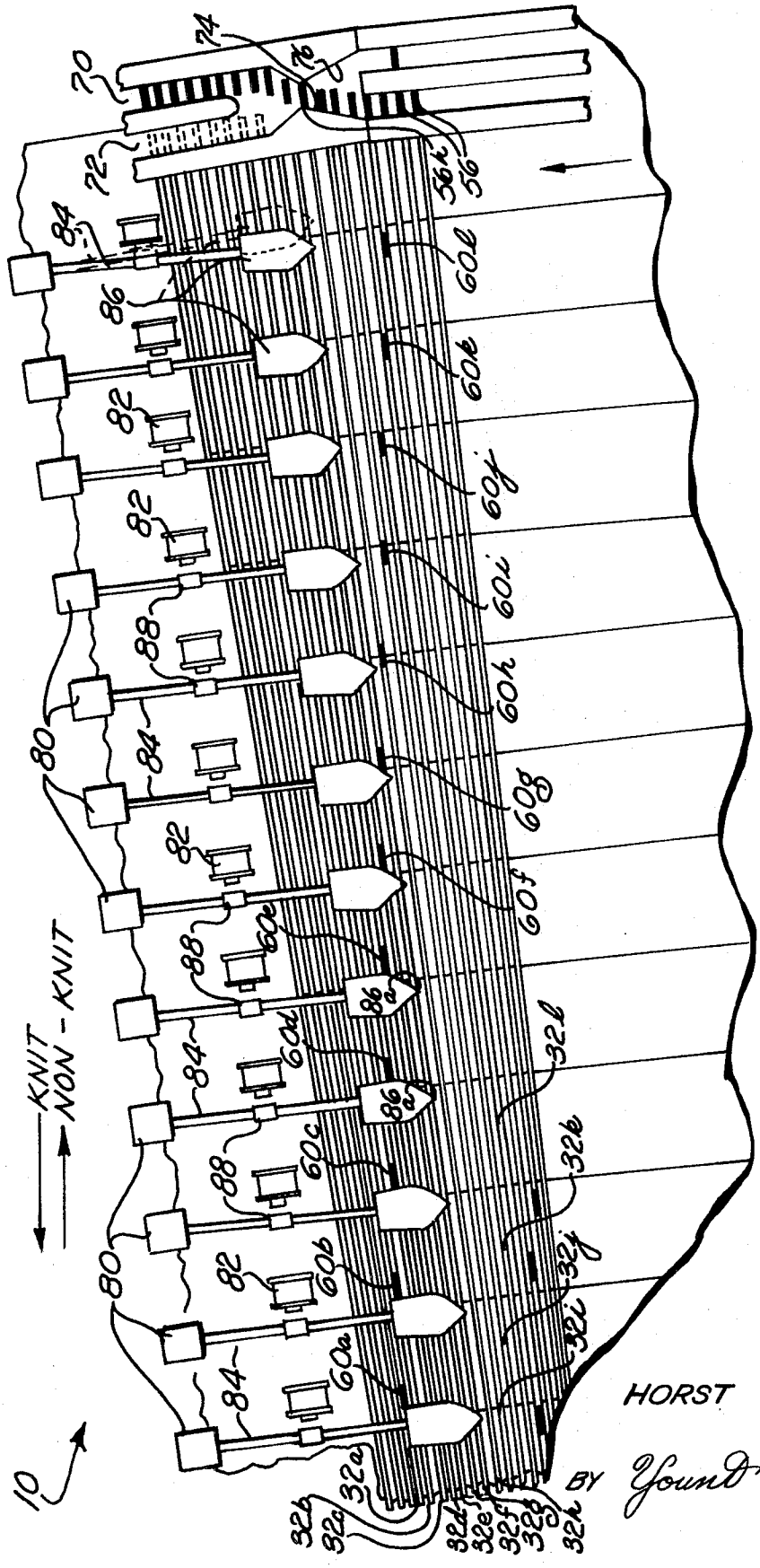


FIG. 2

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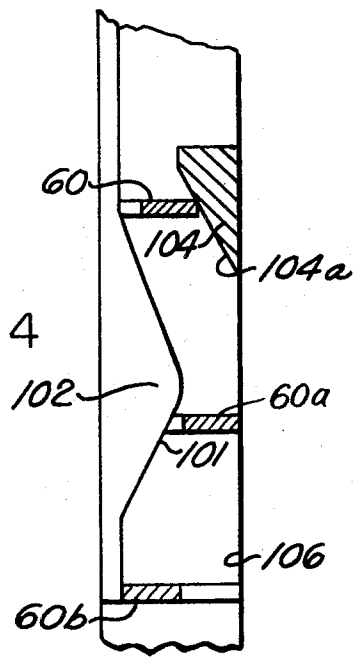


FIG. 4

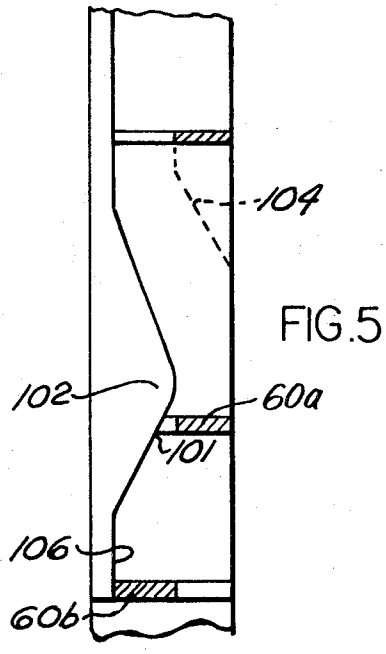


FIG. 5

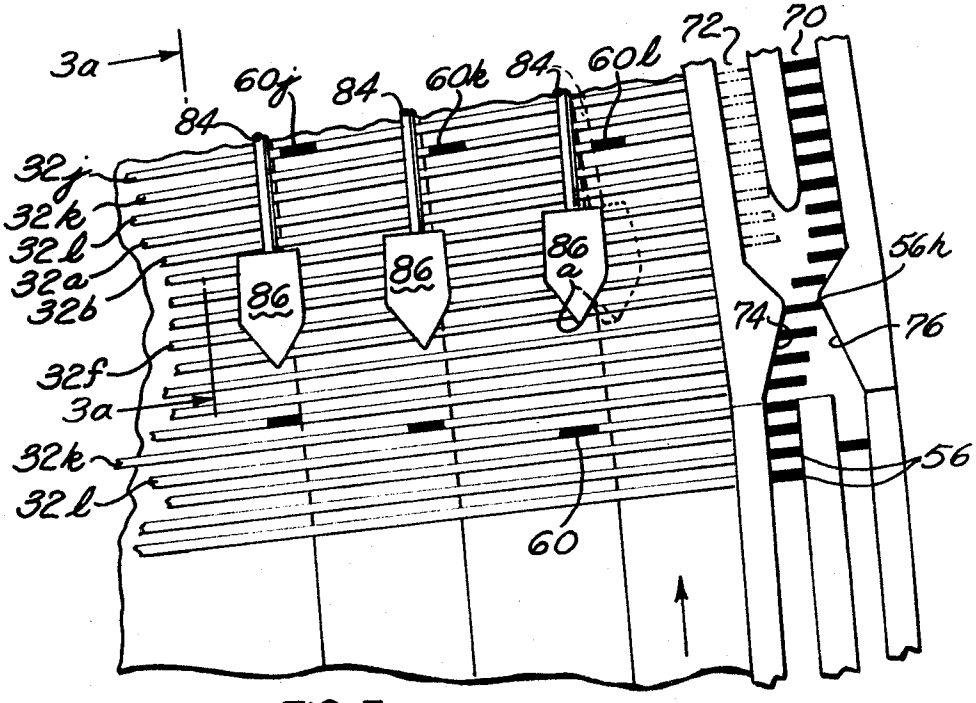
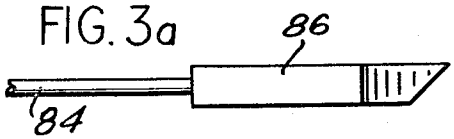


FIG. 3

FIG. 3a



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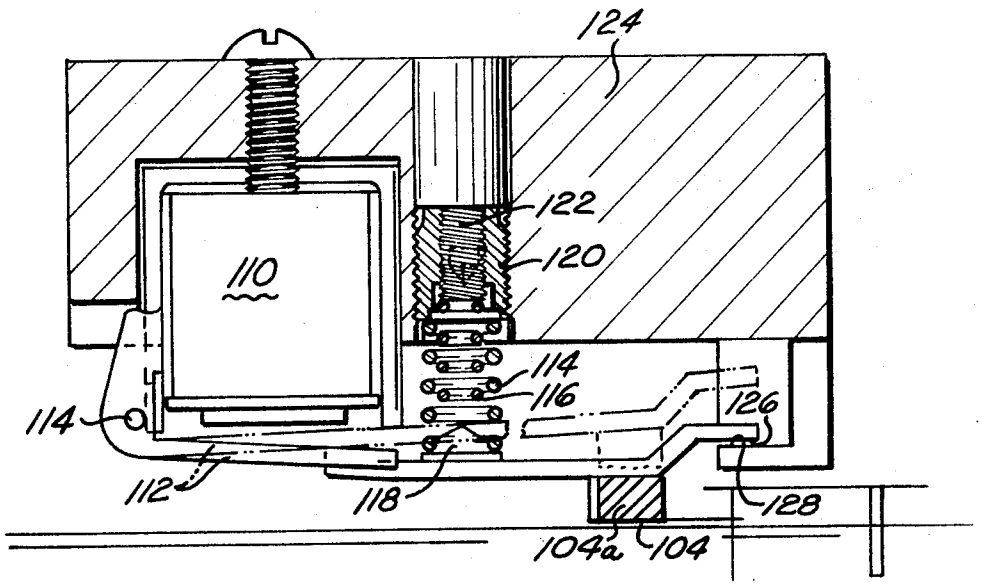


FIG. 6

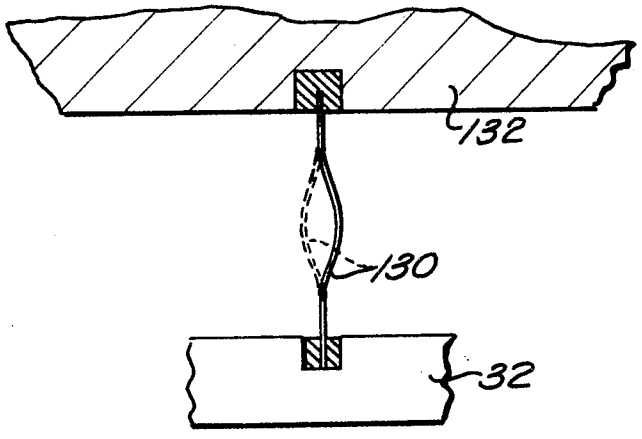


FIG. 7

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HORIZONTAL SELECTOR JACKS AND THEIR ACTUATION

The present invention relates to a circular knitting machine having a plurality of knitting stations through which knitting needles are sequentially advanced and which includes a mechanism for selectively controlling the operation of the needles at the knitting stations.

Known circular knitting machines include a mechanism for selectively controlling the operation of the knitting needles. Numerous patents disclose and describe circular knitting machines which include a mechanism for selectively controlling the needle operation at each of the knitting stations. By these mechanisms the knitting needle may be controlled to either knit, welt, or tuck, as is well known.

Known designs of knitting machines of this type have been directed to the problems of providing accurate, rapid selection of the respective needles and high-speed operation of the machine with a minimum possibility of breakdown due to breaking of the needles or butts on the needles. One of these designs is disclosed in the Paepke application Ser. No. 824,227, now abandoned, entitled KNITTING MACHINE, filed May 13, 1969, and assigned to the same assignee as the present invention. The Paepke application discloses a mechanism for pivoting a needle-moving jack to thereby control operation of the knitting needle. The mechanism comprises a selector jack which is movable in a direction generally parallel to the axis of rotation of the rotating needle cylinder to thereby effect pivoting of the needle-moving jack.

A general object of the present invention is to provide a new and improved circular knitting machine which includes a mechanism for selectively controlling the operation of the needles and which provides for extremely accurate selection of the needles, minimizes the possibility of the machine jamming due to breakage of the needles or the needle-actuating jacks, enables the knitting machine to operate at extremely high speeds and which has a needle cylinder which may be of simple and compact construction.

The above general object is achieved by a unique machine design embodying the present invention. In particular, the unique design includes a needle-moving jack pivotally connected with each knitting needle. Each needle-moving jack is movable in a needle-raising stroke and a needle-lowering stroke to effect needle raising and lowering. Each needle-moving jack has at least one butt thereon which is receivable in a cam track. The cam track has a needle-raising portion which operates on the butts to raise the associated needle-moving jack as the jacks move therethrough to thereby raise the needle associated therewith, and a needle-lowering portion which operates on the butts to lower the associated needle-moving jack to thereby lower the needle associated therewith. Each needle-moving jack has a pivotal actuator jack associated with it. A horizontally disposed selector jack is associated with each actuator jack and is movable linearly in a direction substantially transverse to the axis of rotation of the needle cylinder to thereby effect pivoting of the jack actuator. Pivoting of the jack actuator effects pivoting of the needle-moving jack to move the butt of the needle-moving jack into or out of the cam track. A plurality of electromagnetic actuators operate on the selector jacks to effect movement thereof which results in the pivoting of the needle-moving jack.

Another object of the present invention is the provision of a new and improved knitting machine having a needle-moving jack pivotally connected with each knitting needle and pivotal relative thereto to control movement of the needle, a horizontally disposed selector jack associated with each needle-moving jack and movable linearly in a direction transverse to the axis of rotation of the needle cylinder, interconnecting means for operatively connecting the selector jack and the needle-moving jack so that movement of the selector jack effects pivoting of the needle-moving jack, and electromagnetic means for controlling the movement of the selector jack.

A further object of the present invention is the provision of a new and improved knitting machine having a needle-moving jack pivotally connected with each knitting needle and pivotal relative thereto to control movement of the needle, a series of horizontally disposed selector jacks associated with each needle-moving jack and movable linearly in a direction transverse to the axis of rotation of the needle cylinder, interconnecting means for operatively connecting the selector jack and the needle moving jack so that movement of one of the selector jacks effects pivoting of the needle moving jack, a plurality of electromagnetic actuators at each knitting station to control the pivoting movement of the needle-moving jacks and wherein each of the series of selector jacks have butts thereon at different locations and the electromagnetic actuators are located so as to actuate movement of only one of the selector jacks in the series.

Another object of the present invention is the provision of a new and improved knitting machine, as noted in the next preceding object, wherein the interconnecting means are jack actuators which are interposed between the needle moving jacks and the selector jacks so that movement of the selector jacks in a direction transverse to the axis of rotation of the needle cylinder effects pivoting of the jack actuators which thereby effects pivoting of the needle-moving jacks.

Still further objects, advantages and novel features of the present invention will be apparent to those skilled in the art to which it relates from the following detailed description of preferred embodiments thereof made with reference to the accompanying drawings, and in which:

FIG. 1 is a schematic representation of a circular knitting machine illustrating the needle-moving jack in a position in which it will effect raising of the needle:

FIG. 2 is a schematic representation of the means for indexing the selector jacks;

FIG. 3 is an enlarged schematic view more fully illustrating the cam means associated with the selector jacks shown in FIG. 1 and which prevents vibration of the selector jacks;

FIG. 3*a* is a schematic view taken approximately along the line 3*a*—3*a* of FIG. 3;

FIG. 4 is a schematic representation of a modified embodiment of the present invention and showing the mechanism in a position which the selector jacks are in a nonknitting position;

FIG. 5 is a schematic view of the embodiment of the present invention illustrated in FIG. 4 and showing the mechanism in a position in which the selector jacks effect knitting;

FIG. 6 is a schematic view of the electromagnetic mechanism for moving the cam member into and out of the path of the butts of the selector jacks; and

FIG. 7 is a schematic representation of the spring means which may be utilized to prevent vibration of the selector jacks and which is operable to hold the selector jacks in a selected position.

The present invention provides a new and improved circular knitting machine which includes means for selectively controlling the operation of the knitting needles at each of the knitting stations as the knitting needles advance through the stations. The present invention is directed primarily to the provision of a high-speed knitting machine in which there is a minimum chance of breaking the butts of needles and the control or selection of the knitting needles can be made accurately and rapidly.

Referring to FIG. 1, a portion of a circular knitting machine, generally designated **10**, is illustrated. The portion illustrated is a cross-sectional view which is somewhat schematic and shows a knitting station generally designated **12**. The knitting station **12** is one of a plurality of knitting stations which are located in sequence around a portion of the circular knitting needle-carrying cylinder **15**. The needle-carrying cylinder **15** is suitably driven or rotated about the axis thereof in a conventional manner and includes a plurality of vertically extending slots **16** in which knitting needles **17** are carried. The knitting needles **17** each have a butt **18** thereon which moves through a cam track or path **19**.

Each needle **17** has a needle-moving jack **20** associated therewith. The needle-moving jack **20** is pivotally connected

at its outer end 21 to its associated knitting needle 17. Each needle-moving jack 20 has a butt 25 thereon which is located intermediate the ends of the jack and which moves in a cam track 30.

Each of the needle-moving jacks 20 is associated with an interconnecting means for effecting pivotable movement of the needle-moving jacks 20. The interconnecting means includes a jack actuator 40 which is operable to effect pivoting movement of the needle-moving jack 20 so as to remove the butt 25 thereof from the cam track 30 upon pivoting of the jack actuator 40. The jack actuators 40 are associated with a plurality of horizontally disposed selector jacks 32, one of which is illustrated in FIG. 1. The selector jacks 32 are suitably connected to the jack actuator 40 so that linear movement of the selector jack in a direction substantially transverse to the axis of rotation of the needle-carrying cylinder 15 effects pivoting of the jack actuator 40 and the needle-moving jack 20. If the butt 25 of the needle-moving jack 20 is removed from the cam track 30 as the jack 20 moves into a knitting station, the knitting needle 17 associated with the jack 20 will move through that particular station without being raised by the jack 20. In the event, however, that the selector jack 32 is not operated to effect pivotal movement of the knitting needle-moving jack 20, the butt 25 thereof will remain in the cam track 30 to thereby effect movement of the knitting needle 17 in a vertical direction to effect a knitting operation.

The cam track 30 includes a plurality of cams therein which act upon the butt 25 of the needle-moving jack 20 to thereby effect raising and lowering movement of the needle. The plurality of cams which act upon the butt 25 are not illustrated but effect movement of the needle-moving jack 20 and the needle 17 in a well-known manner to thereby either effect tucking or knitting of the material in the knitting station.

The needle cam track 19 is widened in certain areas which are not illustrated so that the butt 18 of the needle 17 will not interfere with movement of the needle by the knitting needle-moving jack 20. Moreover, in the event that the needle-moving jack 20 or the selector jack 32 associated with the needle breaks or otherwise malfunctions, the cam track 19 will operate in a conventional manner to lower the knitting needle 17 associated therewith if the needle is in a raised position. Thus, it should be apparent that the knitting needle 17 may be controlled at each station so as to welt (not knit) or move either to tuck or knit the material. This is achieved by either allowing the butt 25 to remain in the cam track 30 or by merely moving or pivoting the needle-moving jack 20 out of the cam track 30 at the knitting station so that the corresponding needle will not be raised thereby. This pivoting movement is effected by movement of the selector jacks 32 in a direction transverse to the axis of rotation of the knitting needle cylinder 15.

The selector jacks 32 which are associated with each of the jack actuators 40 are horizontally disposed, elongate members having one end which defines a slot 50 in which the lower end 42 of the jack actuators 40 are slidably received therein. The selector jacks 32 are supported by a support means (best shown in FIG. 1). The support means is in the form of a horizontally extending plate fixedly connected with the needle cylinder and rotates therewith about a common axis. As can be seen in FIG. 1, the support means has a horizontal surface on which the selector jacks 32 are supported and the selector jacks 32 move relative thereto. The jack actuators 40 are pivotable about a pivot pin 41 by movement of the selector jack 32 in a horizontal direction. The jack actuators 40 each include an upper end 44 which defines a slot 47 in which the lower end 31 of the needle-moving jacks 20 are slidably received. The slot 47 is defined by a pair of projecting portions 45 and 46. The projecting portion 45 is located radially outwardly of the lower end 31 of the needle-raising jack 20 and the projection 46 is located radially inwardly of the lower end 31 of the needle-raising jack 20. Thus, it should be apparent that the lower end 31 of the needle-moving jack 20 is slidably received in the slot 47 formed by the projections 45 and 46 so that pivotal movement of the jack actuator 40 will effect pivotal movement of the needle-moving jack 20 about the upper portion 21 thereof.

The selector jacks 32 are arranged in successive series at each of the knitting stations with preferably 12 consecutive selector jacks 32*a*–32*l* in each series. Each selector jack in the series of twelve has an operating butt 60 located thereon. The butts 60*a*–60*l* on the respective selector jacks 32*a*–32*l* are in a horizontal staggered relationship with respect to each other. This staggered relationship of the butts 60 on the respective selector jacks 32 is best illustrated in FIG. 2 which schematically illustrates the selector jacks 32*a* to 32*l*.

Each of the selector jacks 32 includes a butt 56 thereon. The butt 56 is operable to be received in either of a pair of cam tracks 70 and 72, schematically illustrated in FIGS. 2 and 3. When the butt 56 is guided into the cam track 70, as is shown in full lines in FIGS. 2 and 3, the selector jack 32 moves radially of the cylinder, i.e., in a direction substantially transverse to the axis of rotation of the cylinder 15, to effect pivotal movement of the associated jack actuator 40 and the needle-moving jack 20 so that the needle 17 does not knit. When the butt 56 moves into the cam track 72, as is illustrated in phantom lines in FIGS. 2 and 3, the selector jack 32 will be moved radially so as to effect pivotal movement of the associated jack actuator 40 and the needle-moving jack 20 to effect knitting movement of the needle 17, as will be described in greater detail hereinbelow.

A suitable electromagnetic mechanism is utilized in association with the selector jacks 32 to control the position of the selector jacks 32 such that either the butt 56 thereon engages the cam track 72 so that the needle moves to a knit position, or the butt 56 moves into the cam track 70 so that the needle 17 does not knit. The electromagnetic mechanism generally comprises a series of electromagnetic selectors 80 at each station. The electromagnetic selectors 80 are arranged in a horizontal relationship at each station and there are twelve in number, which equals the number of selector jacks 32 in a series.

The electromagnetic selectors 80 are illustrated in FIG. 2 schematically for one station and each is associated with a coil 82. Each of the electromagnetic selectors 80 has a cantilever spring 84 associated therewith and upon which is mounted a cam member 86. The spring 84 normally biases the cam member 86 to the left, as is shown in full lines in FIGS. 2 and 3. Attached to the spring 84 is a coil-responsive member 88 which is operatively associated with the coils 82 so that energization of the coils 82 effects movement of the coil-responsive member 88, the spring 84, and the cam member 86 to the right as illustrated in phantom lines in FIG. 3. Thus, it should be apparent that upon energization of the electromagnetic selectors 80, the coils 82 will be energized to pivot the cam members 86 to the right in a horizontal direction against the bias of the spring 84.

The coils 82 and the associated cam members 86 are located so that when a coil is energized, the cam member 86 associated therewith moves into the path of movement of a butt 60 on a selector jack 32 and effects radial movement of the selector jack 32 as the selector jack moves therepast. When the coils 82 are energized, the butt 60 will effect movement of the selector jack 32 to the left, as viewed in FIG. 2, and the butt 56 of the selector jack 32 will move into the cam track 72 to thereby effect a knitting operation. Each cam member 86 acts on a different selector jack 32, as should be apparent from FIG. 2.

The horizontally staggered arrangement of the butts 60 on the selector jacks 32 and the corresponding horizontal arrangement of the cams 86 and the electromagnetic selectors 80 provides sufficient time for energization of a given coil 82 and de-energization thereof. More specifically, since each coil controls, in the present embodiment, every 12 selector jack 32, there is a time interval approximately equal to the time interval for 12 selector jacks to pass a given point within which a coil can be energized and de-energized. This time interval can be varied by varying the number of selector jacks in a series.

It should be realized that the cam members **86** effect operation of the selector jacks to control the operation of the needles as the needles move through the stations. To this end, the electromagnetic mechanisms are located at the beginning of each station so that the butt **56** moves into the cam track **70** or **72** to effect movement of the butt **25** of the needle-moving jack **20** into or out of the cam track **30** to thereby effect movement of the needle **17** when it moves through the knitting station.

As the needle **17** and the selector jacks **32** enter a particular station, the selector jacks **32** may be in any one of two radial positions depending upon whether the needles associated with the selector jack **32** have performed a knitting or welting operation in the previous station. As a selector jack **32** moves into a station, the selector jack encounters either the cam surface **74**, or the cam surface **76** which engages the butt **56** of the particular selector jack **32** to move the selector jack to a neutral position, as illustrated by the butt **56***h* in FIGS. **2** and **3**. If the selector jack in the previous knitting station had been in the position so as to effect knitting by a needle associated therewith, the butt **56** would engage with the cam surface **74**. If the selector jack in the previous knitting station had been in a position so as to effect welting by a needle associated therewith, the jack would engage with the cam surface **76**. However, it should be apparent that the selector jack **32** will arrive at the neutral position when it moves into a knitting station. Therefore, the cam members **74** and **76** cooperate to ensure that each selector jack **32** will take a predetermined neutral position as it enters the knitting station. When the selector jack **32** is disposed in the neutral position, the selector jack can easily be actuated either to effect knitting or non-knitting of the associated needle in the knitting station into which it is moving. As the selector jack **32** is being moved by the cam surfaces **74**, **76** so that it achieves the neutral position for selection, the butt **56** is securely trapped between the cam surfaces **76** and **74**. In this manner, the selector jack **32** is retained in a fixed position under complete control which removes the possibility of wobble or looseness.

If the needle associated with the selector jack **32**, which has been moved to its neutral position, is to welt, the electromagnetic coil **82** of the electromagnetic selector **80** which is associated with the jack **32** is not energized. When the coil **82** is not energized, the cam or shoe **86** associated therewith will retain its full-line position, as illustrated in FIGS. **2** and **3**, due to the biasing effect exerted by the spring **84** on the cam **86**. As a result, the cam **86** engages the butt **60** of the selector jack **32** to move the selector jack linearly to the right in a direction which is transverse to the axis of rotation of the cylinder **15** so that the butt **56** of the selector jack **32** moves into the cam track **70**. This effects movement of the selector jack **32** to the right, as shown in FIG. **1**, to thereby pivot the jack actuator member **40** in a counterclockwise direction about the pivot pin **41**. The pivotal movement of the jack actuator **40** acts on the lower portion **31** of the needle-moving jack **20** to effect a clockwise pivoting of the needle-moving jack **20** about the portion **21** thereof. The clockwise pivotal motion of the needle-moving jack **20** removes the butt **25** from the cam track **20** so that movement of the needle **17** to a knitting position will not be effected.

It should be apparent that when the selector jack **32** moves linearly to the right, as shown in FIG. **1**, the surface **75** of the jack actuator **40** will engage with the surface **78** of the needle cylinder **15**. Moreover, the surface **95** of the needle-moving jack **20** will engage with the surface **97** of the cylinder **15**. In this manner, the jack actuator **40** and the needle-moving jack **20** will be retained under complete control in a fixed position free from the possibility of any wobble or looseness. Moreover, it should be apparent that the butt **56** of the selector jack **32** will be securely engaged in the cam track **70** so that wobble of the selector jack **32** will be prevented. To further prevent the possibility of any wobble or looseness in the selector jack **32**, suitable spacer elements **85** may be positioned above the selector jack **32** so that vertical movement of the selector jack is prevented.

In the event that it is desired that the needle associated with selector jack **32**, which is entering the knitting station, is to knit or tuck, the electromagnetic actuator **80** and the coil **82** which is associated therewith will be energized. This will effect movement of the cam members **86** to the right to its position illustrated in phantom lines in FIGS. **2** and **3**. The cam member **86** will then engage the butt **60** of the selector jack to move the jack to the left, as viewed in FIGS. **2** and **3**, and cause the butt **56** to run into the cam track **72**. As a result, the selector jack **32** will move linearly to the position illustrated in FIG. **1**. The horizontal linear movement of the selector jack **32** effects a clockwise rotation of the jack actuator **40** around the pivot pin **41** which, in turn, effects a counterclockwise pivoting of the needle-moving jack **20** about its upper portion **21**. This movement enables the butt **25** of the needle-moving jack **20** to run in the cam surface **30**. The movement of the butt **25** of the needle-moving jack **20** in the cam surface will effect either knitting or tucking of the needle **17** in a well-known manner.

It should be apparent that when the selector jack **32** is in the position illustrated in FIG. **1**, vibration and linear movement of the selector jack will be prevented by the butt member **56** which is engaged in the cam track **72**. Moreover, the surface **90** of the jack actuator member **40** will engage with the surface portion **92** of the cylinder **15** and the surface portion **94** of the upper portion **44** of the jack actuator **40** will engage with the surface portion **96** of the cam box. The engagement of the surface portions **90**, **94** of the jack actuator **40** with the surface portions **92**, **96**, respectively, of the cam box **15** will prevent pivotal movement of the jack actuator **40** and pivotal movement of the needle-moving jack **20** as the needle-moving jack **20** is suitably secured in the upper portion **44** of the jack actuator **40**. The needle-moving jack **20** also has a surface portion **98** which engages with a surface portion **100** of the cam box to further prevent wobble of the needle-moving jack **20**. Thus, the selector jack **32**, the actuator jack **40**, the needle-moving jack **20**, and the needle **17** will be securely held in their proper positions to thereby reduce wobble and vibration of the parts.

It should be apparent that the correct final positioning of the selector jack **32** is accurately controlled by the butt **56** engaging in either the cam track **70** or **72** depending upon whether the needle **17** is to knit or welt. Even in the event that the selector jack **32** is only partially moved, the butt **56** will engage with one of the cam tracks **70** or **72** to bring the selector jack **32** into its final position. If the butt of a particular selector jack is moved only partially, the butt would still engage the rounded tip of the central member, as shown in FIG. **3**, which defines the cam tracks **70** and **72**, and this rounded tip on the central member would cause somewhat of a camming action to take place to cause the butt to move to an extreme position and enter the cam tracks **70** and **72**. Obviously, the partial movement must be such as to enable the central cam member to so act rather than the butt engaging the end thereof.

While a pair of cam tracks **70** and **72** have been used in the present embodiment of the invention to hold the selector jack **32** in its selected position, it should be realized that suitable spring means such as the spring **130** (FIG. **7**) could also be utilized for the same purpose. The spring **130** is operable to act on the selector jack **32** after the jack **32** has been moved to its selected position to keep the selector jack in that selected position as it passes through the knitting station. The spring **130** is located between the selector jack **32** and a member **132** which moves about the cylinder **15** with the jack **32** so that there is no relative rotation between the selector jacks **32** and the member **132**. The spring **130** comprises an overcenter spring with one end secured to the member **132** and the other end secured to the selector jack **32**, as illustrated in FIG. **7**. When the selector jack **32** is moved to effect a knitting operation, the jack **32** will move to the left and the spring **130** will be bent, as shown in phantom lines in FIG. **7**. When the spring is in its phantom-line position, it will exert a force on the selec-

tor jack 32 to bias the selector jack to the left and hold the selector jack in its knitting position. When the selector jack is moved to effect a non-knitting operation, the jack 32 will move to the right and the spring will assume its full-line position, as illustrated in FIG. 7. When the spring 130 is in its full-line position, it will exert a force on the selector jack 32 to urge the selector jack to the right to thereby hold the selector jack in its non-knitting position. It should be apparent that the spring 130 will be operable to hold the selector jack 32 in the position to which it has been moved by the cam member 86.

In view of the fact that the butt 25 of the needle-moving jack 20 is pivoted out of the cam track 30 when the needle associated with the jack 20 is to welt, the possibility of the butts 25 breaking and causing a jam-up of the knitting machine 10 is minimized. As a result, the knitting machine may be operated at an extremely high rate of speed. Moreover, since only one selector jack of each of the series of 12 selector jacks is moved by one of the electromagnetic selectors 80, the operation of the machine 10 at a high rate of speed is also facilitated.

It should be apparent from the above that a selector jack 32 normally moves to the right of the cam surfaces 86 so that the associated electromagnetic selector 80 need only be energized when the associated needle associated with the selector jack is to knit at a given station. Thus, if a needle is to welt at a station, the selector jack 32 associated therewith will pass to the right of the cam member 86 and the electromagnetic selector 80 and the associated coil 82 will not need to be energized. This is true even if the selector jack was in a knitting position in the preceding station because the cam members 74 and 76 cooperate to position the selector jack 32 in a neutral position prior to movement of the selector jacks 32 into the next preceding knitting station. As a result, a minimum amount of energization of the electromagnetic selector 80 and the coil 82 associated therewith is necessary to position the selector jack 32. This also adds to the speed at which the knitting machine may operate and further minimizes the possibility of machine failure.

It should be clear from the above description that at a given station a knitting needle may be operated to either knit or tuck. It should also be apparent that at a given station a given needle is not capable of performing both knitting and tucking. This is due to the fact that movement of the needle is effected in a manner depending upon the setup of the cams at a given station and which act upon the needle actuating jack butt 25 and the needle butt 18. Accordingly, the cam setup at one station may cause knitting to be effected, but the cam setting at another station may cause tucking to occur.

The embodiment of the present invention which is illustrated in FIGS. 4 and 6 is similar to the embodiment shown and described in detail hereinabove except for the electromagnetic means and the cam arrangement for effecting movement of the selector jacks 32. Accordingly, FIGS. 4 and 6 illustrate only the mechanism which effects the linear movement of the selector jacks 32 in a direction which is transverse to the axis of rotation of the knitting needle cylinder 15.

As illustrated in FIGS. 4 and 5, cam means are disposed within a cam slot 106 through which the butts 60 of the selector jacks 32 move. The selector jacks 32 and the butt 60 thereon move through the cam track 106 much in the same manner as the butts 60 move past the cam members 86 as described hereinabove. As the butts 60 enter the cam track 106, the butts 60 are in one of two positions, as illustrated by the butts 60*a* and 60*b* in FIG. 4. When the butts are in the position of butt 60*a*, the knitting needle in the preceding station has been in a non-knit position, and when the butts are in the position of the butt 60*b*, the knitting needle has been in a knit position in the preceding station.

As the butts move into the cam track 106, the butts 60 are moved to a non-knit position by the cam member 102. The cam member 102 includes a cam surface 101 which engages with the butts 60 which are in a knitting position to thereby move the selector jack 32 to a non-knit position. A cam member 104 is disposed adjacent to the cam track 106 and is operable to move into and out of the cam track 106. The cam member 104 is schematically illustrated in FIG. 5 in phantom lines in its non-operating position in which the cam member 104 is disposed adjacent to the cam track 106 and in FIG. 4 in its operating position in which the cam member is moved into the cam track 106 so as to engage with the butts 60 of the selector jacks 32 as the butts 60 move through the cam track 106.

The electromagnetic means which energize the cam members 104 includes a solenoid 110 for moving the cam member 104 into and out of the path of the butts 60. When the cam member 104 is moved into the cam track 106 as shown in FIG. 4, the butts 60 will engage with the cam surface 104*a* of the cam member 104 to move the selector jack to the left, as shown in FIG. 4, to thereby move the selector jack 32 to its knitting position to effect knitting of the needle 17.

The solenoid 110 has an arm 112 which is pivotably associated therewith. The cam member 104 is secured to the arm so that movement of the arm about the pivot pin 114 will effect movement of the cam member 104 into and out of the cam track 106. When the solenoid 110 is energized, the cam member 112 is moved upwardly to its position illustrated in dotted lines in FIG. 6 so that the cam 104 is removed from the cam track 106.

A suitable spring means is provided to bias the arm member 112 away from the solenoid 110 and bias the cam member 104 into the cam track 106. The spring means include a pair of coil spring members 114 and 116 which are axially aligned and which engage with the bracket 118 disposed on the arm 112. The bracket 118 cooperates with the springs 114 and 116 to align the springs relative to the arm 112. The opposite ends of the springs 114 and 116 engage with threaded members 120 and 122 respectively. The threaded members 120 and 122 are movable relative to each other and to the support member 124 which supports the members 120 and 122 and the solenoid 110. Thus, it should be apparent that rotation of the members 120 and 122 will effect movement of the upper ends of the springs 114 and 116 to thereby adjust the force with which the spring members bias the arm 112 away from the solenoid 110.

When it is desired to effect a knitting operation, the solenoid 110 will not be energized and the cam member 104 will be biased into the cam track 106 by the springs 114 and 116. A stop surface 128 is provided to engage with a stop surface 126 disposed on the arm 112 to limit the downward movement of the cam 104 under the influence of the springs 114 and 116 and thereby provide for positive positioning of the cam 104 in the cam track 106. The cam member 104 will then act on the butts 60 of the selector jacks 32 to move the selector jacks to thereby effect a knitting operation, as described hereinabove. When it is desired that the knitting needle of a specific knitting station is to be in a non-knit condition, the solenoid 110 will be energized to overcome the force of the springs 114 and 116 and move the cam member 104 out of the cam track 106. This will effect a non-knitting condition of the needle 17. It should be clear that when the solenoid 110 is de-energized, the springs 114 and 116 will return the cam member 104 to its full-line position to locate the cam 104 in the cam track 106.

It should be apparent that in the embodiment shown in FIGS. 4 and 5, the cam surface 101 of the cam member 102 acts on the selector butts 60 to move the selector jacks 32 linearly in a direction transverse to the axis or rotation of the needle cylinder 15 to move the selector jacks 32 into a non-knit position. If it is desired that the needle be moved to a knitting position, the electromagnetic means associated with the cam member 104 is not energized and the cam member 104 will remain in the path of movement of the butts 60. The butts 60 then engage with the cam surface 104a and effect linear movement of the selector jacks 32 to a knitting position.

From the foregoing, it should be apparent that a new and improved circular knitting machine has been provided for controlling the movement of the knitting needles on the rotatable knitting needle cylinder. A plurality of needle-moving jacks have been provided to control the movement of the

needle in a needle-raising or a needle-lowering stroke. The mechanism for controlling the operation of each needle-moving jack includes a series of horizontally disposed selector jacks which are movable linearly in a direction transverse to the axis of rotation of the needle cylinder to thereby position the needle-moving jacks and control movement of the knitting needle. An interconnecting means in the form of pivotal jack actuator is provided to effect pivotal movement of the needle-moving jacks in response to movement of the selector jacks in a direction transverse to the axis of rotation of the needle cylinder.

Having described my invention, I claim:

1. A circular knitting machine comprising a knitting needle cylinder rotatable through a plurality of knitting stations, a plurality of knitting needles carried by said cylinder, a needle-moving jack pivotally connected with each respective needle and movable in a needle-raising stroke and a needle-lowering stroke to effect a needle raising and lowering, each needle-moving jack having at least one butt thereon, cam means at each knitting station defining a cam track for receiving the butts of each of said needle-moving jacks, said cam track having a needle-raising portion which operates on said butts to raise the associated needle-moving jack as the needle-moving jack moves therethrough to thereby raise the needle associated therewith and a needle-lowering portion which operates on said butts to lower the associated needle-moving jack as the needle-moving jack moves therethrough to thereby lower the needle associated therewith, a support means fixedly connected with said needle cylinder for rotation therewith about a common axis, a horizontally disposed selector jack carried by said support means and operatively associated with each needle-moving jack and movable linearly in a horizontal direction transverse to the axis of rotation of said needle cylinder, and a pivotally supported actuator jack interconnected between said needle-moving jack and said selector jack so that linear horizontal movement of said selector jack effects pivoting of said jack actuator which in turn effects pivoting of said needle-moving jack to thereby move the butt of said needle-moving jack out of said cam track.

2. A circular knitting machine as defined in claim 1 wherein said electromagnetic means comprises a plurality of electromagnetic actuators at each knitting station, each of said electromagnetic actuators being operatively associated with only certain of said selector jacks.

3. A circular knitting machine as defined in claim 2 wherein said selector jacks are arranged in a series equal in number to the number of electromagnetic actuators, each of said selector jacks in said series having a butt thereon so as to pass adjacent only one of said electromagnetic actuators and said electromagnetic actuators at a knitting station having a member engageable with said butt to effect the control of the selector jack in that station.

4. A circular knitting machine comprising a knitting needle cylinder rotatable through a plurality of knitting stations, a plurality of knitting needles carried by said cylinder, a needle-moving jack pivotally connected with each respective needle and movable in a needle-raising stroke and a needle-lowering stroke to effect needle raising and lower, each needle-moving jack having at least one butt thereon, means defining a cam track for receiving the butts of each of said needle-moving jacks, said cam track having a needle-raising portion which operates on said butts to raise the associated needle-raising jack as the needle-moving jack moves therethrough to thereby raise the needle associated therewith and a needle-lowering portion which operates on said butts to lower the associated needle-moving jack as the needle-moving jack moves therethrough to thereby lower the needle-associated therewith, a support means fixedly connected with said needle cylinder for rotation therewith about a common axis, a selector jack carried by said support means and operatively associated with each needle-moving jack and movable linearly in a direction substantially transverse to the axis of rotation of said cylinder, interconnecting means for interconnecting said selector jack with said needle-moving jack so that movement of said selector jack effects pivoting of the butt of its associated needle-moving jack relative to said cam track, and electromagnetic means at each knitting station selectively actuatable to control said movement of the selector jacks at each knitting station to thereby control movement of the butts of said needle-moving jacks relative to said cam track at each knitting station, said electromagnetic means comprising a plurality of electromagnetic actuators at each knitting station, each of said electromagnetic actuators being operatively associated with only certain of said selector jacks.

5. A circular knitting machine as defined in claim 4 wherein said selector jacks are arranged in a series equal in number to the number of electromagnetic actuators, each of said selector jacks in said series having a butt thereon so as to pass adjacent only one of said electromagnetic actuators and said electromagnetic actuators at a knitting station having a member engageable with said butt to effect the control of the selector jack in that station.

6. A circular knitting machine as defined in claim 5 wherein said selector jack is reciprocable to effect pivoting of said needle-moving jack, and said interconnecting means includes a jack actuator interposed between said selector jack and said needle-moving jack and operable to effect pivotal movement of said needle-moving jack upon said reciprocation of said selector jack.

7. A circular knitting machine as defined in claim 6 further including a means defining a selector jack cam track to effect said reciprocating movement of said selector jack.

8. A circular knitting machine as defined in claim 6 further including a cam means for ensuring that each of said selector jacks are located in a predetermined selected position so as to be acted upon by its associated electromagnetic actuator.

9. A circular knitting machine as defined in claim 5 wherein each of said electromagnetic actuators comprise an electrical coil and a cam member pivotal into the path of movement of a butt on a respective selector jack upon energization of the coil and which cam member effects movement of the selector jack upon its passing thereby.

10. A circular knitting machine as defined in claim 7 wherein said each of said electromagnetic actuators comprise a cam member movable upon energization of an electrical coil and said cam member at least in part defining said selector jack cam track and effecting said reciprocating movement of said selector jack upon movement thereof.

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