May 21, 1946. R. C. AMIDON 2,400,525

KNITTING MACHINE

Filed Jan. 3, 1944 5 Sheets-Sheet 1

Fig. 1.

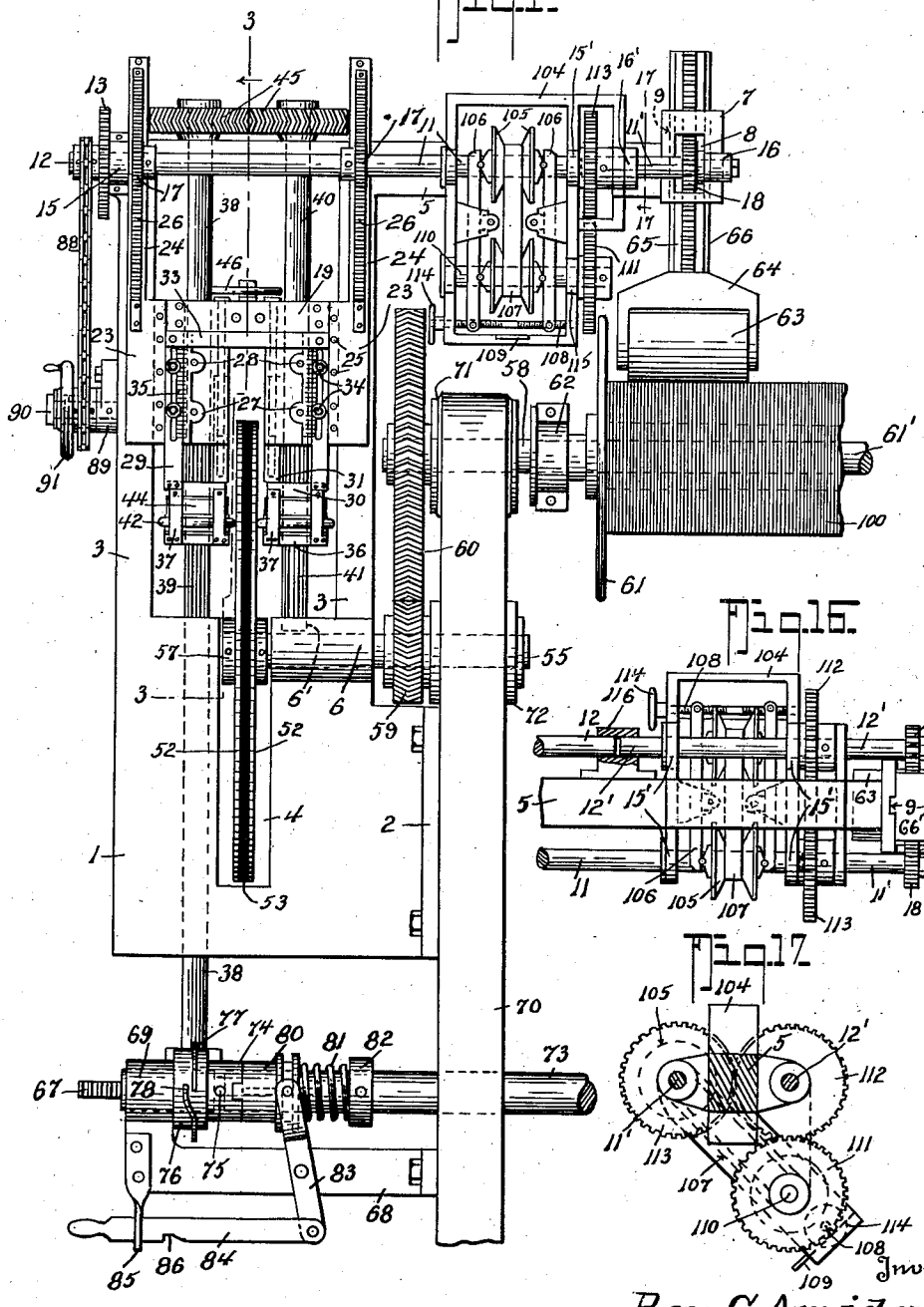

Fig. 16.

Fig. 17.

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KNITTING MACHINE

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Fig. 2.

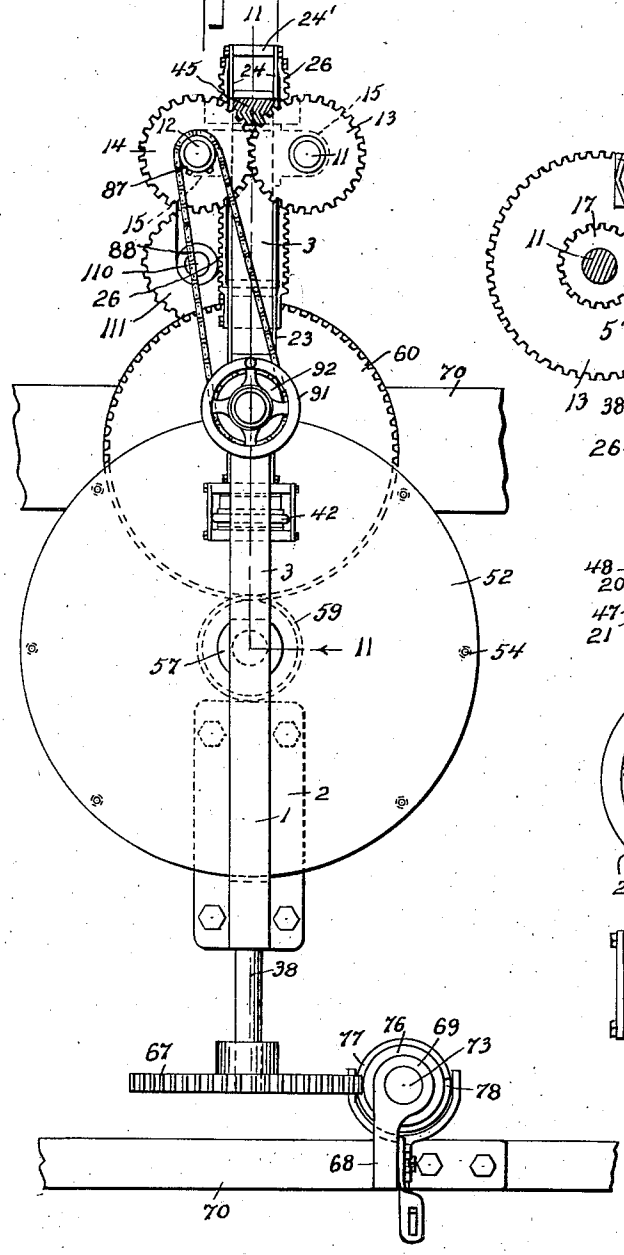
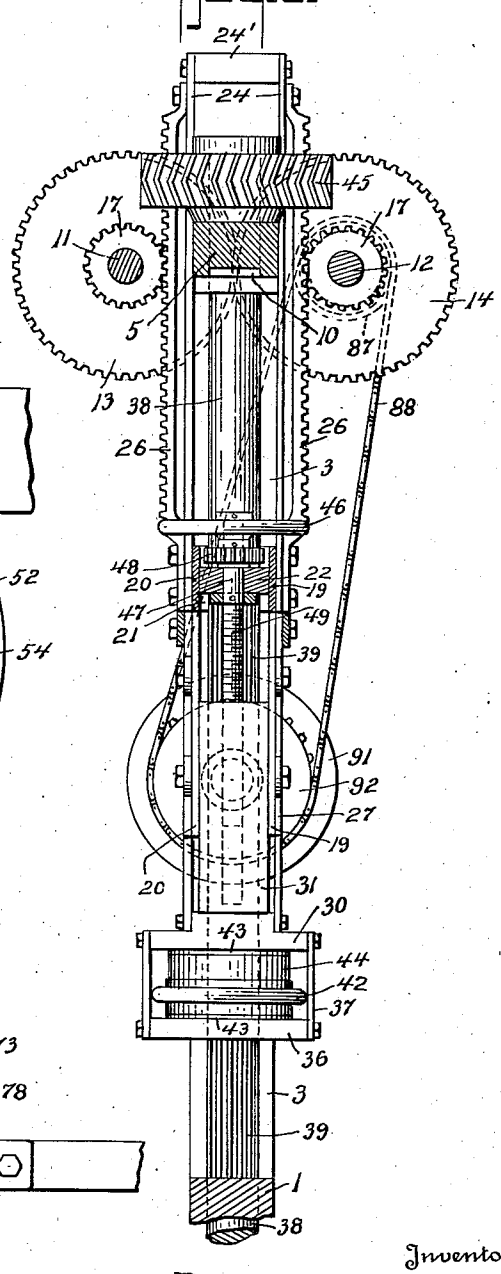


Fig. 3.



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KNITTING MACHINE

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Fig. 4

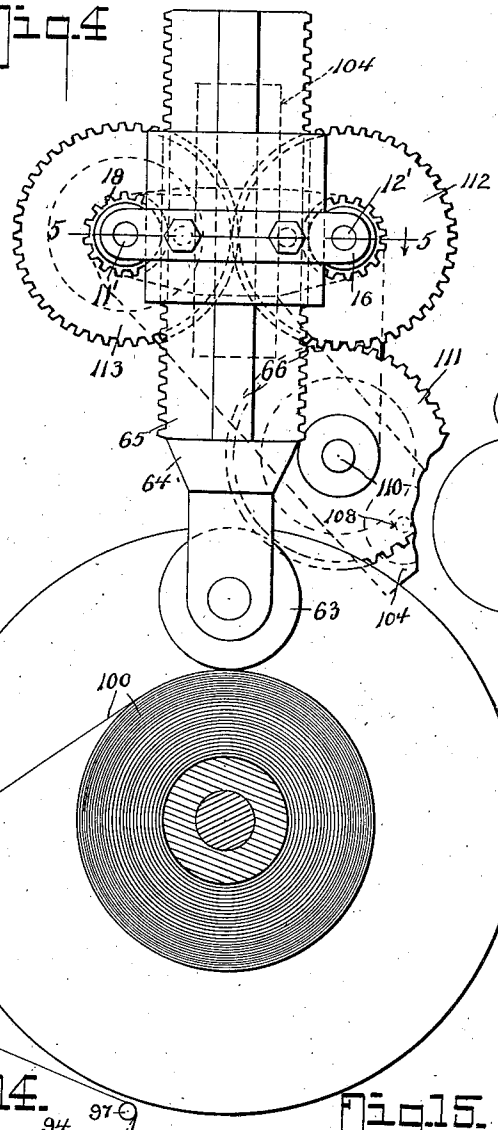


Fig. 5.

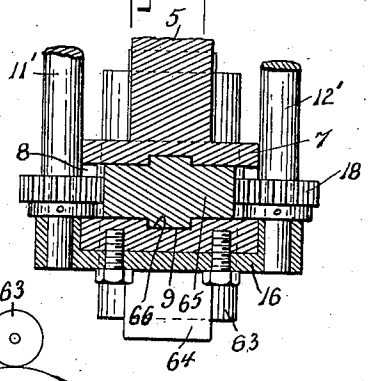


Fig. 12.

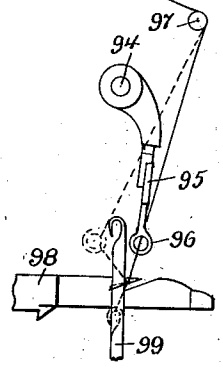


Fig. 14.

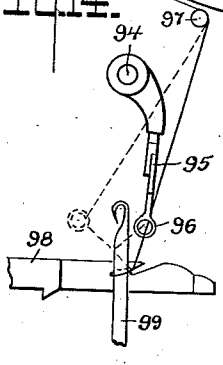


Fig. 15.

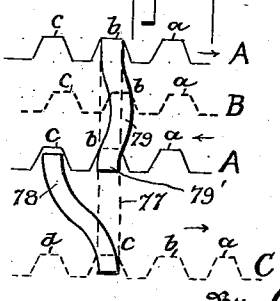
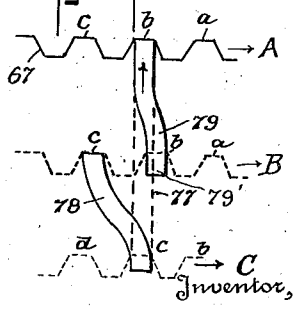


Fig. 13.



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KNITTING MACHINE

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Fig. 6.

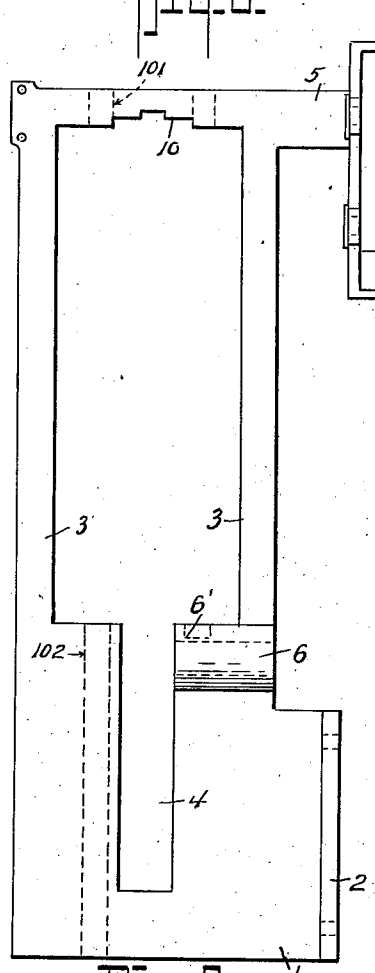


Fig. 7.

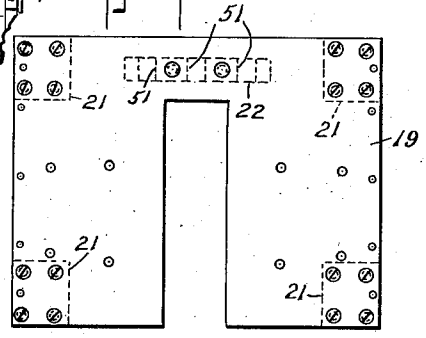


Fig. 8.

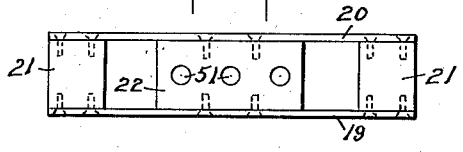


Fig. 10.

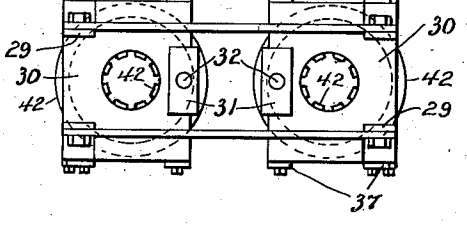
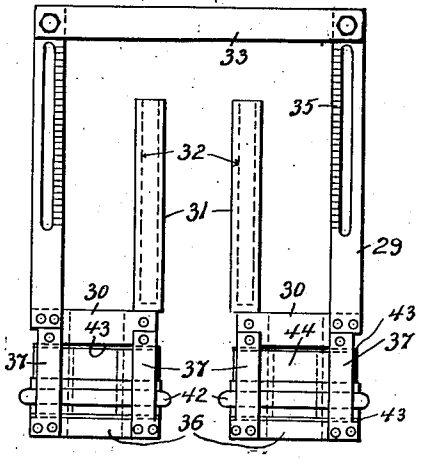


Fig. 9.



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KNITTING MACHINE

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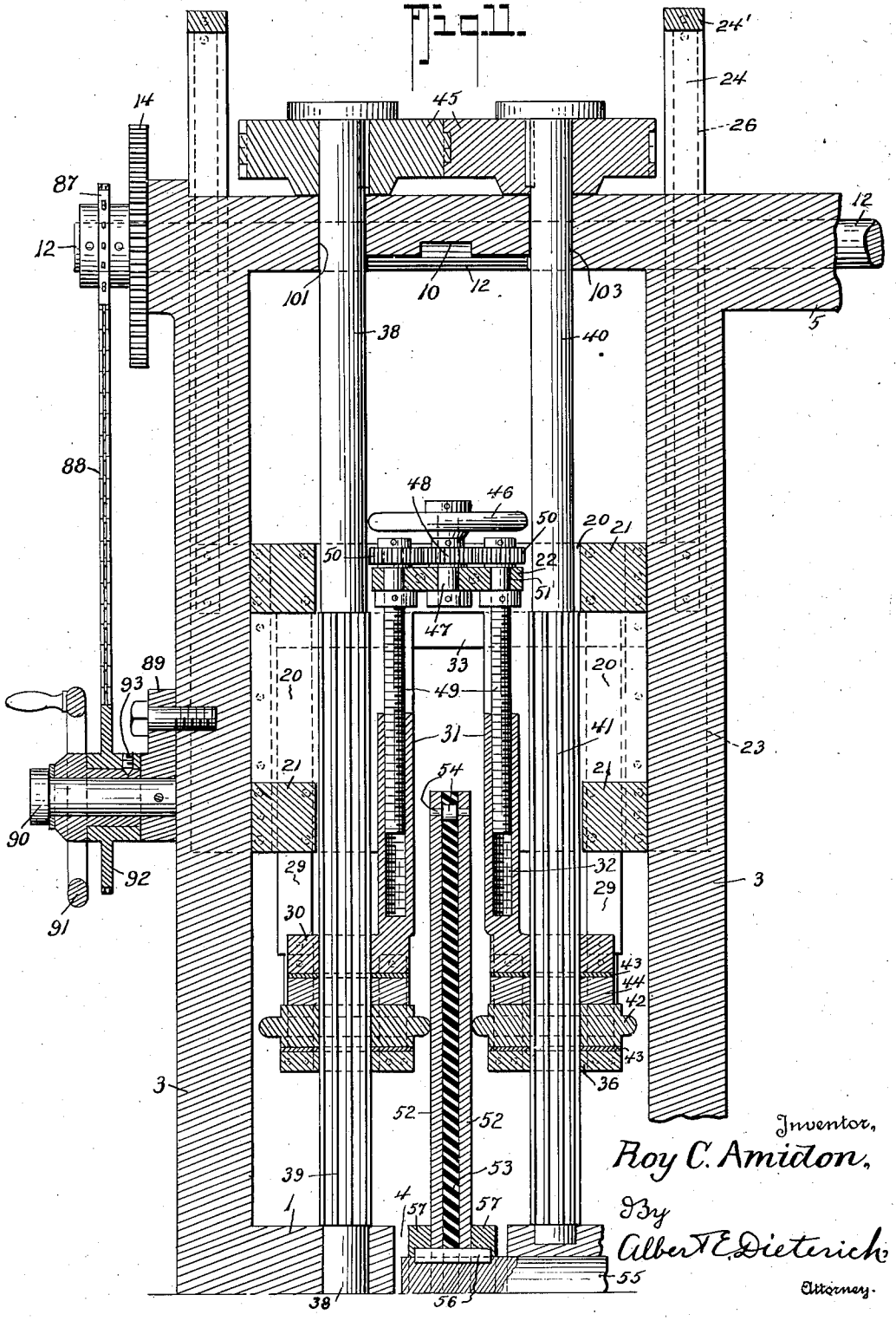
Fig. 11.



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Patented May 21, 1946 2,400,525

UNITED STATES PATENT OFFICE

2,400,525

KNITTING MACHINE

Roy C. Amidon, Reading, Pa., assignor to Vanity Fair Mills, Inc., Reading, Pa., a corporation of Pennsylvania.

Application January 3, 1944, Serial No. 516,777

15 Claims. (Cl. 66—86)

My invention relates to knitting machines, and particularly to machines of the tricot type.

More specifically, the present invention relates to mechanism for feeding or delivering the thread or yarn, used in the knitting process, from the warp beams to the needles. In the production of fabrics made upon the tricot or so-called fast-warp machines, or in any process using the warp principle, the density of the fabric or tightness of the stitches is largely determined by the feeding (portion of yarn allotted to each knitting cycle).

In warp knitting machines the thread or yarn is initially wound on one or more warp beams and is passed from the beams, through thread or yarn guides that are carried by the guide bars of the machine, to the needles.

In order to control the turning movement of the beams it has been found necessary to provide a brake or clutch system regulated by the movement of a tension rod over which the threads or yarns pass and which is actuated by the draw of the warp thread or yarn as the guides place the same around the needles and in the knock-over of the stitch in the knitting process.

It has already been proposed to drive the warp beams with a continuous drive; nevertheless the use of a tension device is necessary in this case also to take up the slack as released by the rotating warp beam during the time, in the knitting cycle, when no thread or yarn is being used by the guides and/or by the needles in the knock-over process. The use of spring-loaded tension rods is not always uniform over the entire width of the machine at various speeds of the machine.

Any stopping or starting of the machines heretofore in use, with which I am familiar produces an irregularity in the knitting operation, resulting in the formation of an undesirable line or streak, called a "stop-mark" in the fabric.

My invention, therefore, has for its general object to overcome the objectionable features of the machines above referred to.

More specifically, my invention has for an object to provide an intermittent drive for each warp beam to turn the beam in timed relation to the thread or yarn consumption during the knitting cycle and cause it to discharge or release the thread or yarn in the correct proportion and at the correct or proper times, and to do this regardless of the changing circumference or diameter of the beam as the knitting function proceeds.

Other objects of the invention are: to eliminate the necessity for using brakes; to eliminate the necessity for using spring-loaded or yieldable tension rods; and to provide means for causing the beam itself to take up slack and maintain uniform tension on the thread or yarn during the full knitting operation.

Other objects of the invention will in part be obvious and in part be pointed out hereinafter.

To the attainment of the aforesaid objects and ends the invention still further resides in the novel details of construction, combination and arrangement of parts, all of which will be first fully described in the following detailed description, and then be particularly pointed out in the appended claims, reference being had to the accompanying drawings, in which:

Fig. 1 is a front elevational view illustrating my invention.

Fig. 2 is an end elevation of the same looking in the direction from left to right in Fig. 1.

Fig. 3 is an enlarged detail vertical section taken on the line 3—3 of Fig. 1.

Fig. 4 is an enlarged detail end elevation looking from right to left in Fig. 1.

Fig. 5 is a horizontal section on the line 5—5 of Fig. 4.

Fig. 6 is a front elevation of the main frame, drawn to the scale of Fig. 1.

Fig. 7 is a front elevation of the sliding carriage, drawn on the scale of Fig. 1.

Fig. 8 is a top plan view of the same.

Fig. 9 is a front elevation of the driving friction wheel carrier with the friction wheels in position.

Fig. 10 is a top plan view of the same.

Fig. 11 is an enlarged vertical section on the line 11—11 of Fig. 2.

Fig. 12, Fig. 13, Fig. 14 and Fig. 15 are diagrammatic views hereinafter specifically referred to.

Fig. 16 is a detail top plan view of a portion of my apparatus showing the variable speed mechanism.

Fig. 17 is a cross section on the line 17—17 of Fig. 1.

In the drawings, in which like numerals and letters of reference indicate like parts in all the figures, 1 represents the main frame of the machine. This frame includes the uprights 3, the top cross arm 5, the sub-frame 104, forming a part of the cross arm, and the slide-bearing member 7. The member 7 has an opening 8, into which the gears 18 project, and has vertical grooves 9 for the feathers 66 of a rack-bar 65 later again referred to. The frame also includes a mounting flange 2 through the medium of which, and cap screws or bolts, the frame is mounted on an end frame 70 of a knitting ma-

chine. The frame 1 has a slot 4 and shaft bearings 6, 6', and a recess 10 to receive the hand wheel 46, later again referred to.

Mounted in bearing apertures 101 and 102 in the main frame is a first vertical driving shaft 38. A second vertical driving shaft 40 is journaled in bearings 103 and 6' in that frame. The shafts 38 and 40 are operatively connected together to turn at the same speed by means of herringbone gears 45, best shown in Fig. 11. The shafts 38 and 40 have fluted portions 39 and 41, respectively, on which the driving friction wheels are slidably held, as will later be more fully explained.

Mounted in suitable bearings 15 are parallel shafts 11 and 12 respectively, which shafts are geared together by suitable gears 13 and 14. The shaft 11 terminates at the right hand bearing 15' of the change-speed device, while a short shaft 11' extends coaxially from the end of the shaft 11 to a bearing 16. The shaft 12 terminates at the frame bearing 116, while a short shaft 12' extends from the frame bearing 116 through both of the back bearings 15'. The shafts 11' and 12' are connected by gears 113 and 112. A variable speed shaft 110 is mounted in the frame 104 and carries a gear 111 which meshes with the gear 112 (see Figs. 1, 16 and 17).

The shafts 11 and 12 carry pinions 17 which mesh with the racks 26 that are carried by the uprights 24 of the carriage-engaging plates 23. These plates 23 are secured to the carriage by cap screws 25.

The uprights 24 of the plates 23 on one side of the frame are connected to those on the opposite side by blocks 24'.

The shafts 11' and 12' carry pinions 18 which project into the openings 8 in the bearing or guide 7 and engage the racks 66 of the bar 65.

The sliding carriage comprises the front plate 19 and back plate 20 between which spacing blocks 21 are secured. A bearing block 22 is also secured between the plates 19 and 20 (see Figs. 7, 8 and 11). On the face of the plate 19 (and also on the plate 20 if desired) are graduated scale plates 27, secured at 28 to cooperate with the adjacent graduations 35 on the slotted arms 29 of the friction wheel carrier.

The friction wheel carrier is composed of the pairs of arms 29 connected by horizontal bars 33 and secured at their lower ends to the base blocks 30. The blocks 30 carry upstanding blocks 31 which are bored and tapped, as at 32, to receive the adjusting screws 49, the screws 49 being mounted in bearing apertures 51 in the block 22 and having gears 50 which mesh with a third gear 48 on a stub shaft 47 also journaled in the block 22, as best shown in Fig. 11. Cap screws 34 pass through the slots of the arms 29 into the carriage.

Suspended rigidly from each upper base member 30, by bars 37, is a lower base member 36. The driving friction wheels 42, wear discs 43 and spacers 44 are located between the upper and lower base members 30 and 36 respectively.

Mounted on a shaft 55, that is journaled in bearings 6 and 72, is a driven friction wheel. The driven friction wheel may comprise two metal discs 52 located between a resilient disc 53 (rubber for example) which tends to maintain good contact at all times between the friction wheels. Cross-connecting pins 54 may be provided to tie the discs 52 and 53 together. Collars 57 on the shaft 55 and a key 56 serve to secure the driven friction wheel to the shaft 57 (see Figs. 1 and 11).

The beam shaft 61' and spool 61 are coupled, as at 62, to a shaft 58 which is mounted in a bearing 71 and is driven through herringbone gears 59 and 60 from the shaft 55.

The rack bar 65 carries a beam-contacting roller 63, mounted in a fork 64. It will be observed that the rack bar 65 moves up and down vertically along a radius of the beam and the axes of the several shafts 38, 40, 55, 58, and those of the beam and roller and also the rack bar all lie in the same vertical plane, the ideal positions for accurate adjustments and functioning of the apparatus.

Referring now more particularly to Figs. 1 and 2, it will be seen that the shaft 38 is provided with a toothed wheel 67 which meshes with an interrupted flange 77 on a hub 76 having a clutch member 74 rotatably mounted on the cam shaft 73 (or any other constantly movable suitable shaft of the knitting machine). The member 74 may be mounted to turn on the shaft 73, but not be slidable thereon, by means of a pin and groove connection 75. A bracket 68 is mounted on the end frame 70 and is provided with a bearing 69 for the end of the cam shaft 73. A shiftable clutch member 80 is keyed to slide on the shaft 73 and is normally held in engagement with the clutch member 74 by a spring 81 held by a collar 82 adjustable on the shaft. The member 80 may be shifted out of engagement by means of a forked lever 83 and pull bar 84, the latter having a notch 86 to engage the slotted bracket 85 through which the rod 84 passes and latch the clutch in the non-operative position.

The interrupted flange 77, meshing with the teeth of the toothed wheel 67, has a curved or worm portion 78 of a suitable pitch—say enough to move the toothed wheel one tooth for each revolution of the shaft 73. The flange 77 may also have another curved portion 79 which may terminate in a straight end 79' which lies in a plane offset from that of the uncurved part of the flange 77, or it may curve back and terminate in the same plane as the uncurved part of the flange, as shown, respectively in Figs. 13 and 15 and hereinafter more fully explained.

As best shown in Figs. 2 and 11, a sprocket 87 is mounted on the shaft 12. A bracket 89 is secured to the frame 1 and carries a stub shaft 90 on which is mounted a hand wheel 91 and sprocket 92. A chain 88 takes over the sprockets 87 and 92 for a purpose later to be made clear. The sprocket 92 is secured to turn with the hand wheel 91 by a set screw 93.

In Figs. 12 and 14, 94 indicates the rock-shaft which carries the thread guide 96 and racking bar 95 of the knitting machine, while 97 indicates a stationary thread guide bar, 98 a knock-over sinker and 99 a needle of the machine, while 100 indicates the thread or yarn. Figs. 12 to 15 are diagrammatic views soon again to be referred to.

Referring now to Figs. 1, 16 and 17, it will be seen that a suitable change-speed gearing is interposed between the shafts 11, 11' and 12, 12', a Reeves type being shown for purposes of illustration, but any other suitable type may be employed if desired. The shaft 11 extends through the bearings 15' only, while shaft 11' is mounted in the bearings 16, 16'. As before stated, the shaft 12 extends through bearing 15 and into bearing 116 (see Fig. 16). The shaft 12' is mounted in both back bearings 15', Fig. 16, and in a bearing

16. A variable speed shaft 110 is mounted in bearings 115, in the frame 104, and is connected with shaft 12' by means of suitable gears 111 and 112, the shafts 12' and 11' being connected by the gears 112 and 113, as best shown in Fig. 17. Shiftable coned-discs 105 are carried by and turn with the shafts 11 and 110, while a belt 107 takes about these pairs of discs. Rockably mounted levers 106 are provided for shifting the discs farther apart and closer together to obtain the changes of speed desired, the movement of the levers being accomplished by means of an adjusting worm 108 and hand wheel 114. The adjustments are indicated on a dial 109 in the usual way.

Operation

Assume the parts to be positioned as shown in Fig. 1. Each rotation of the shaft 73 will turn the toothed wheel 67 the distance of one tooth, which, with the setting of the friction and change-speed gears as shown, will advance the beam the distance required to feed off enough thread or yarn as is required for one course of the knitting. Movement of the shaft 38 is transmitted to shaft 55 through the friction drive 42, 52—53 and from shaft 55 to the beam shaft through the herringbone gears 59, 60. The change in the positions of the friction wheels 42 with respect to the friction wheel 52—53 varies in proportion to the decrease in the diameter of the beam as the thread is taken off. If it is desired to lengthen or shorten the feed of the thread to the needles for different knitting the clutch 80 is thrown out, the cap screws 34 are loosened and the setting of the friction wheels 42 on the friction wheel 52—53 is changed accordingly, after which the cap screws are again tightened. This setting is made with reference to the scale 35 which has been calibrated for the purpose. This change in the setting of the friction drive without change in the control to the beam would not alone result in an accurate feed-off of the thread during the knitting process; it therefore becomes necessary, after changing the friction drive, to make a corresponding change in the connections between the carriage and the beam-engaging roller 63. This is done by adjusting the change-speed mechanism mounted in the frame 104 by proper manipulation of the hand wheel 114, guided by the scale 109, as will be clear to those skilled in the art.

In the knitting process thread is laid about the needles by the thread guide or guides and on the down strokes the needles draw the thread through previously formed and knocked-over loops, there being periods of dwell during which no thread is being drawn from the beam. Depending on the way the thread guides are mounted, i. e., the way they move from front to back of the needles in laying the thread, the guides pull more or less of the thread in addition to the pull of the needles. This makes it necessary, in knitting machines generally, to provide yieldable thread tensioning guides. My invention has been designed to do away with the resilient guides and provide a positive thread feed at all times. For example: if the thread guides 96 are so mounted as to swing back and forth and rack the thread about the needle without a backlash of the thread, then I provide a flange 77 with a deflection 79 sufficient to move the beam just far enough to allow the thread guides 96 to function while keeping the thread taut or under a constant tension, the end of the deflected portion 79 terminating to one side of the general plane of the dwell portion of the flange (see Fig. 13); if, however, the movement of the thread guide 96 results in a pull and a slack on the thread, then the deflected portion 79 terminates in the same plane as the dwell portion of the flange or as near thereto as necessary to reverse the beam movement to take up the slack.

If it be desired to knit with a looser thread than can be done with the adjustment shown in Fig. 1, the friction wheels 42 are adjusted lower on the wheel 52—53 and the proper compensation in the change-speed gearing is made by turning the hand wheel 114 so that as the roller 63 moves down with the lessening diameter of the beam a proper differential is maintained between the downward movement of the roller 63 and the downward movement of the friction wheels 42 so as to feed always the same length of thread or yarn from the beam at each step of rotational movement of the beam.

The use of herringbone gears 45, 59 and 60, and the use of anti-friction bearings (not shown) wherever possible will prevent backlash or looseness in the transmission between the shaft 38 and the beam, as well as prolong the life of the same.

When it is desired to insert a new beam in place of an empty one, the clutch 80 is thrown out and the wheel 91 is turned to lift the beam-engaging roller out of the way. After the beam has been replaced with the full beam, the wheel 91 is reversed until roller 63 again rests on the thread 100.

It should be understood that when more than one beam is used in a knitting machine, my apparatus will be duplicated accordingly, i. e., one device will be provided for each warp beam.

Attention is called to the fact that the expansible friction wheel 52—53 gives a flexible contact with the driving wheels 42 and prevents slippage. Further, the outer surfaces of the discs 52 may be roughened or milled to aid in preventing slippage.

With my invention in use, a formula may be set up which will produce the same degree of tightness or density of stitches at all times in any given width of fabric, for the reason that the output of warp thread or yarn is positive and is delivered to the guides and needles of the knitting machine in the same amounts as are used by the guides and needles while performing their knitting cycles; the output of warp thread is not dependent upon any cam or spring action between the warp beam and the needles during the knitting process.

In the manufacture of knitted fabrics, when more than one warp beam is used, the rate of the discharge of the threads or yarns from the several beams, in relation one to another, is very important, as fabrics of different degrees of density or elasticity are in demand for different purposes.

By the use of my invention, changes may be made by simple adjustments of the several warp beam operating units whereby positive alterations may be made to change the degree of density or elasticity of the knitted fabric, as may be desired.

As heretofore intimated, I am aware that attempts have been made to provide means for positively driving the beam. In the attempt with which I am familiar the beam is driven with a continuous motion from a constantly rotating shaft, a change-speed gearing being provided for adjusting the speed at which the thread is ad-

vanced. Such means obviously requires the use of a yieldable thread guide between the beam and the needles in order to take up the slack while casting the thread about the needles or the slack will prevent knitting the courses evenly. In the apparatus just referred to, an attempt has also been made to actuate the change-speed gearing automatically by connecting a lever device with the adjusting element of the change-speed gearing and letting the free end of the lever rest on the periphery of the roll of thread on the beam. This method, however, will not result in an accurate or uniform feed of the thread from the beam throughout the knitting operations as the line of contact between the end of the lever and the thread on the beam varies due to the arc of movement of that end on the pivotal center of the arm or lever. In other words, the movement of the line of contact between the pivoted arm and the thread on the beam is in the arc of a circle and not along a radius of the beam. These objectionable features of the prior art devices are overcome in my apparatus.

From the foregoing description, taken in connection with the accompanying drawings, it is thought the complete construction, operation and advantages of my apparatus will be clear to those skilled in the art to which it appertains.

What I claim is:

1. In a knitting machine having thread guides and knitting needles: the combination with a thread-carrying beam, of means for turning the beam in two separate steps with a dwell in between, one step being a forward and backward turning to maintain tension on the threads as they are wrapped around the needles and the other step being a forward turning to feed threads for the stitch drawing movement of the needles.

2. In a knitting machine having knitting needles, thread guides for laying thread about the needles and a constantly rotating shaft: a thread-carrying beam; and means operatively connected with said shaft for intermittently turning said beam in two separate steps with a dwell in between to deliver a predetermined constant length of thread to the thread guides for casting purposes, and thereafter delivering additional thread to the guides and needles according to the requirements of the needles.

3. In a knitting machine having knitting needles, thread guides for laying thread about the needles and a constantly rotating shaft: a thread-carrying beam; and means operatively connected with said shaft for turning said beam in two separate steps with a dwell in between to deliver a predetermined constant length of thread to the thread guides for casting purposes, and thereafter delivering additional thread to the guides and needles according to the requirements of the needles.

4. In a knitting machine having thread guides, knitting needles, a cam shaft for operating the needles and guides, and a warp beam: power transmitting mechanism between the cam shaft and the beam for turning the beam accordingly as the knitting process continues, said mechanism including a member on the cam shaft having a flange, a drive shaft having a toothed wheel meshing with said flange, power transmission gearing between said drive shaft and said beam, said flange having a straightway portion and having a curved portion for turning the wheel one tooth for each revolution of the cam shaft.

5. In a knitting machine having thread guides, knitting needles, a cam shaft for operating the needles and guides, and a warp beam: power transmitting mechanism between the cam shaft and the beam for turning the beam accordingly as the knitting process continues, said mechanism including a member on the cam shaft having a flange, a drive shaft having a toothed wheel meshing with said flange, power transmission gearing between said drive shaft and said beam, said flange having a straightway portion and having a curved portion for turning the wheel one tooth for each revolution of the cam shaft, and having a second curved portion for turning the wheel a lesser distance than the first mentioned curved portion for purposes described.

6. In a knitting machine having a cam shaft, knitting needles and thread guides operated from the cam shaft, and having a warp beam: a stationary frame mounted on the knitting machine; a driving shaft carried by said frame; a driven shaft carried by said frame; a gear connection between said driven shaft and the warp beam; a friction wheel on the driving shaft and a friction wheel on the driven shaft engaged by the first mentioned friction wheel; a carriage for said first mentioned friction wheel; and means governed by the reduction in the diameter of the roll of thread on the beam for effecting the lowering of said carriage in proportion thereto, thereby governing the distance the beam is turned during each revolution of the crank shaft.

7. In a knitting machine wherein are provided knitting needles, thread guides, a cam shaft for operating the needles and thread guides, and wherein is provided a warp beam: a stationary frame mounted on the machine; a driven pair of vertical inter-geared shafts mounted in bearings on said carriage and operatively connected with said cam shaft; friction drive wheels vertically slidably mounted on said shafts; a driven shaft journaled in bearings on said frame; a friction driven wheel on said last-named driven shaft with both sides of which said first mentioned friction wheels engage; gear connections between said last-named driven shaft and said warp beam; a carriage for said friction drive wheels slidably mounted in said frame and continuously tending to move in one direction to shift said friction drive wheels on said friction driven wheel; and means governed by the beam for controlling the movement of said carriage for purposes described.

8. In a knitting machine wherein are provided knitting needles, thread guides, a cam shaft for operating the needles and thread guides, and wherein is provided a warp beam: a stationary frame mounted on the machine; a driven pair of vertical inter-geared shafts mounted in bearings on said carriage and operatively connected with said cam shaft; friction drive wheels vertically slidably mounted on said shafts; a driven shaft journaled in bearings on said frame; a friction driven wheel on said last-named driven shaft with both sides of which said first mentioned friction friction wheels engage; gear connections between said last-named driven shaft and said warp beam; a carriage for said friction drive wheels slidably mounted in said frame and continuously tending to move in one direction to shift said friction drive wheels on said friction driven wheel; at least one rack carried by said carriage; at least one shaft rotatably mounted on said frame and having a pinion to engage said rack; a rack bar carrying a member engaging the beam thread and continuously tending to move toward the axis of the beam; and an oper-

ative connection between said one shaft and said rack bar.

9. In a knitting machine wherein are provided knitting needles, thread guides, a cam shaft for operating the needles and thread guides, and wherein is provided a warp beam: a stationary frame mounted on the machine; a driven pair of vertical inter-geared shafts mounted in bearings on said carriage and operatively connected with said cam shaft; friction drive wheels vertically slidably mounted on said shafts; a driven shaft journaled in bearings on said frame; a friction driven wheel on said last-named driven shaft with both sides of which said first mentioned friction wheels engage; gear connections between said last-named driven shaft and said warp beam; a carriage for said friction drive wheels slidably mounted in said frame and continuously tending to move in one direction to shift said friction drive wheels on said friction driven wheel; at least one rack carried by said carriage; at least one shaft rotatably mounted on said frame and having a pinion to engage said rack; a rack bar carrying a member engaging the beam thread and continuously tending to move toward the axis of the beam; and an operative connection between said one shaft and said rack bar, said connection including another shaft having a pinion engaging the rack bar, and a speed changing gear connection between said one shaft and said another shaft.

10. In a knitting machine wherein are provided knitting needles, thread guides, a cam shaft for operating the needles and thread guides, and wherein is provided a warp beam: a stationary frame mounted on the machine; a driven pair of vertical inter-geared shafts mounted in bearings on said carriage and operatively connected with said cam shaft; friction drive wheels vertically slidably mounted on said shafts; a driven shaft journaled in bearings on said frame; a friction driven wheel on said last-named driven shaft with both sides of which said first mentioned friction wheels engage; gear connections between said last-named driven shaft and said warp beam; a carriage for said friction drive wheels slidably mounted in said frame and continuously tending to move in one direction to shift said friction drive wheels on said friction driven wheel; at least one rack carried by said carriage; at least one shaft rotatably mounted on said frame and having a pinion to engage said rack; a rack bar carrying a member engaging the beam thread and continuously tending to move toward the axis of the beam along a radius of the beam; and an operative connection between said one shaft and said rack bar.

11. In a knitting machine wherein are provided knitting needles, thread guides, a cam shaft for operating the needles and thread guides, and wherein is provided a warp beam: a stationary frame mounted on the machine; a driven pair of vertical inter-geared shafts mounted in bearings on said carriage and operatively connected with said cam shaft; friction drive wheels vertically slidably mounted on said shafts; a driven shaft journaled in bearings on said frame; a friction driven wheel on said last-named driven shaft with both sides of which said first mentioned friction wheels engage; gear connections between said last-named driven shaft and said warp beam; a carriage for said friction drive wheels slidably mounted in said frame and continuously tending to move in one direction to shift said friction drive wheels on said friction driven wheel; at least one rack carried by said carriage; at least one shaft rotatably mounted on said frame and having a pinion to engage said rack; a rack bar carrying a member engaging the beam thread and continuously tending to move toward the axis of the beam; an operative connection between said one shaft and said rack bar, said connection including another shaft having a pinion engaging the rack bar, and a speed changing gear connection between said one shaft and said another shaft; and means for changing the gear ratio between said friction gears and that of said speed changing gear connection for purposes described.

12. In apparatus of the class described: the combination with the beam of a knitting machine and a continuously rotating shaft of the same; of a stationary frame having slideways; a carriage slidably mounted on said carriage; at least one friction wheel carried by said carrier; a driving shaft operatively connected with said continuously rotating shaft by means of which said driving shaft is turned a predetermined distance for each revolution of said continuously rotatable shaft, said friction wheel being slidably mounted on said driving shaft; at least one rack carried by said carriage; at least one shaft having a pinion meshing with said rack and being mounted in bearings on said frame; said frame having a slide-bearing member projected over said beam; a beam-thread contacting member slidably mounted in said slide-bearing member; another shaft operatively connected with said beam-thread contacting member and with said one shaft; a driven shaft; a friction wheel on said driven shaft to be engaged by said first mentioned friction wheels; gear connections between said driven shaft and said beam; by virtue of all of which as the thread is unwound from the beam the beam will be turned progressively farther in proportion to the reduction of the diameter of the roll of thread on the beam.

13. The machine of claim 5 wherein said flange has a third curved portion for turning the wheel backward a predetermined distance.

14. In a knitting machine let-off, wherein is provided a warp beam rotatable to let off warp means for positively rotating the warp beam intermittently in one direction to let off warp, means controlled by the diameter of the warp on the warp beam for varying the extent of each rotative let-off movement of the warp beam, and means for rotating the warp beam in the other direction to maintain the warp under even and uniform tension, the improvement which includes, as a part of said warp-beam-rotating means, a driving shaft having a flange and a driven shaft having a toothed wheel meshing with said flange, said flange having a straightway portion and having a curved portion for turning the toothed wheel one tooth for each revolution of said driving shaft, said flange having a second curved portion for turning said toothed wheel a lesser distance than the first mentioned curved portion, and having a third curved portion for returning the toothed wheel a lesser distance than the distance between two teeth of the toothed wheel for purposes described.

15. In a knitting machine let-off, wherein is provided a warp beam rotatable to let off warp, means for positively rotating the warp beam intermittently in one direction to let off warp, means controlled by the diameter of the warp on the warp beam for varying the extent of each rotative let-off movement of the warp beam, and

means for rotating the warp beam in the other direction to maintain the warp under even and uniform tension, the improvement which includes, as a part of said warp-beam-rotating means, a driving shaft having a flange and a driven shaft having a toothed wheel meshing with said flange, said flange having a straightway portion and having a curved portion for turning the toothed wheel one tooth for each revolution of said driving shaft, said flange having a second curved portion for turning said toothed wheel a lesser distance than the first mentioned curved portion, and having a third, reversely curved, portion for returning the toothed wheel to the point from which it was advanced by said second curved portion for purposes described.

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