May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 1

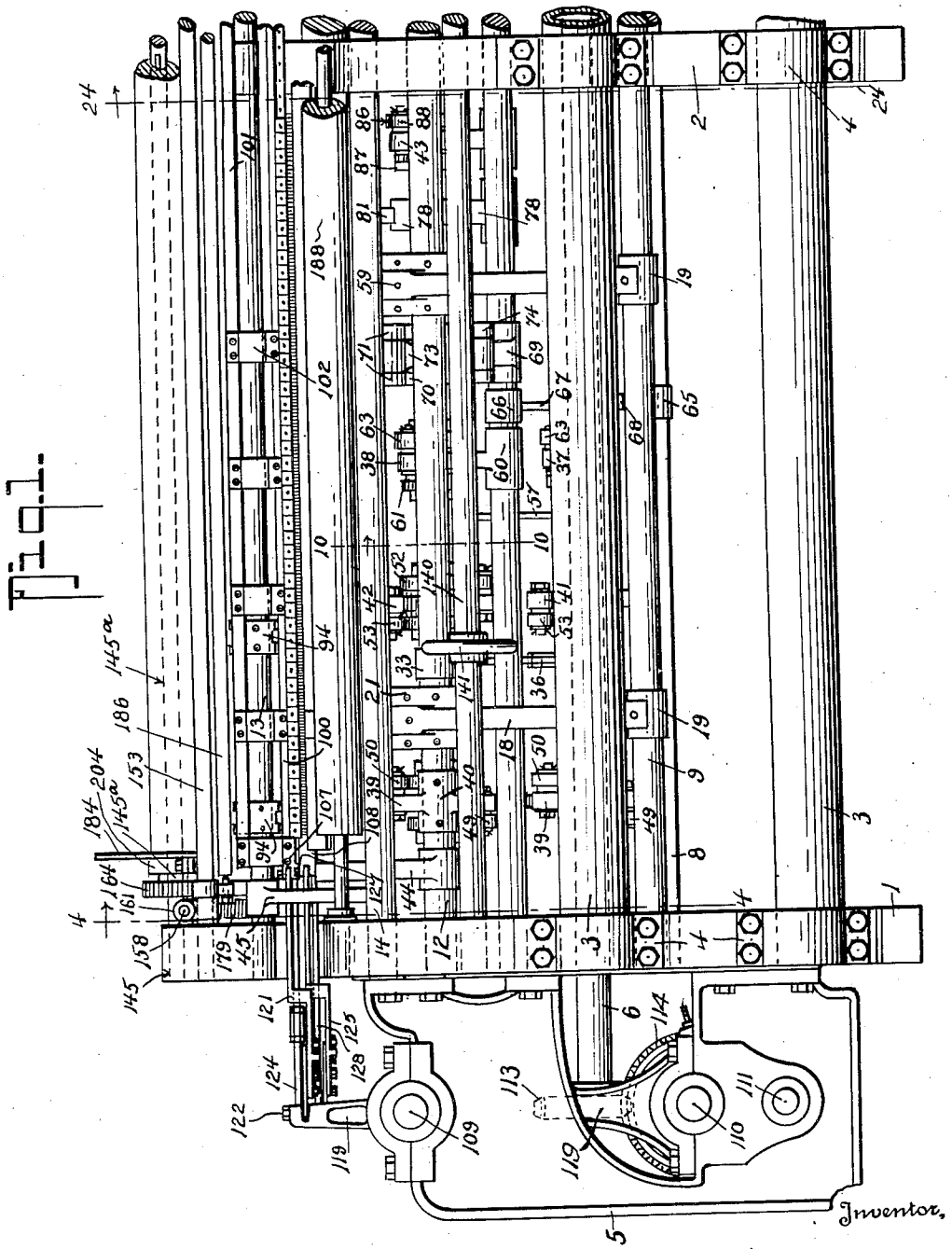


Fig. 1.

Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 2

Fig. 2.

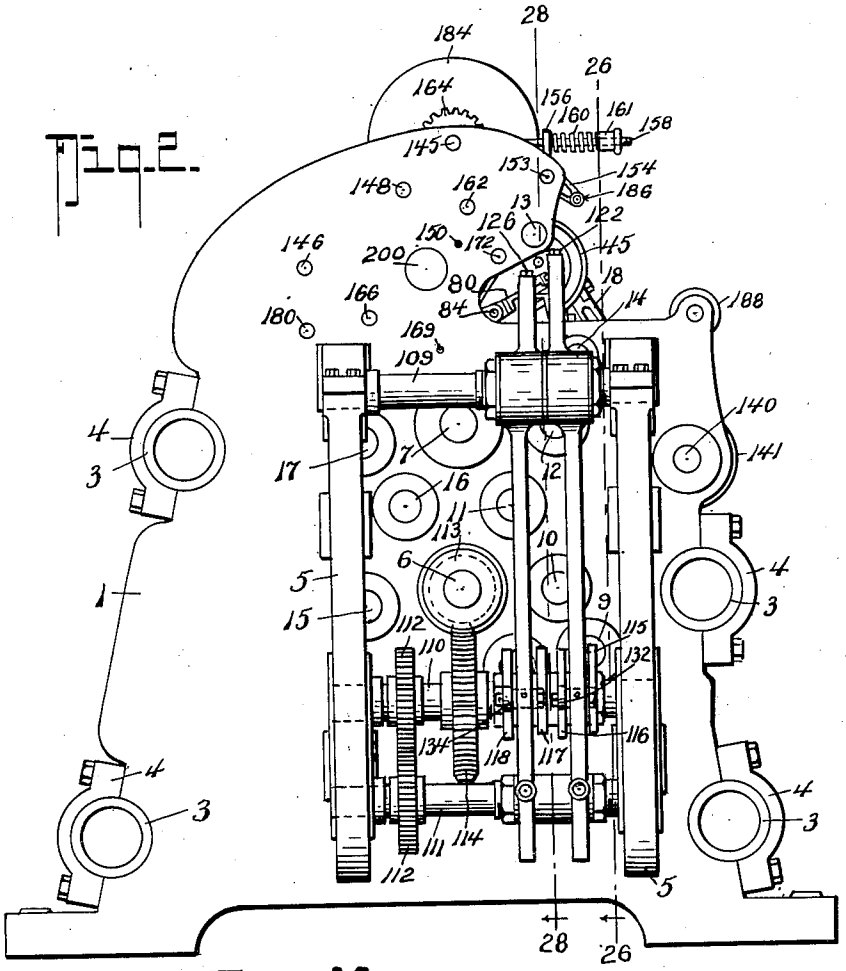


Fig. 43.

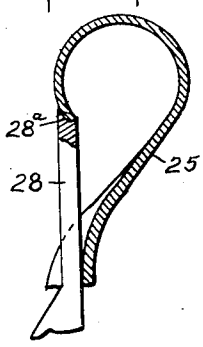
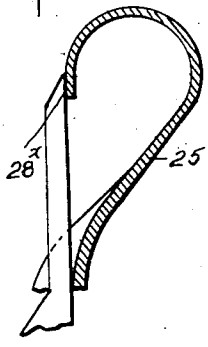


Fig. 44.



Inventor
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By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 3

Fig. 3.

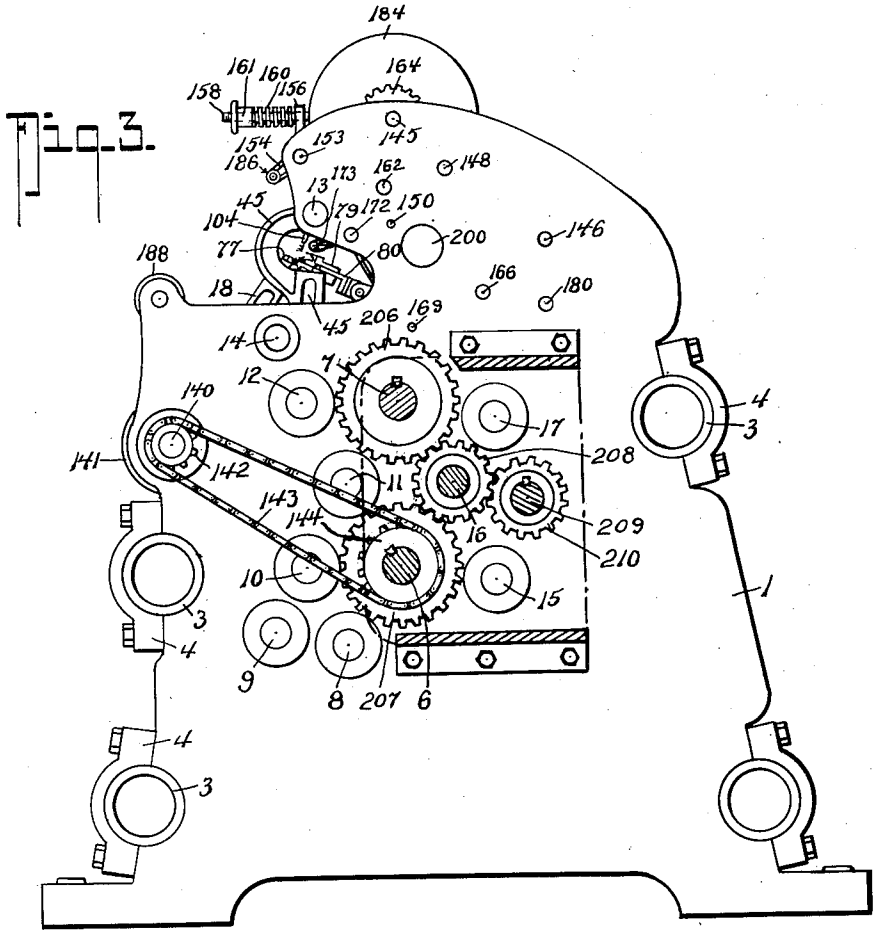
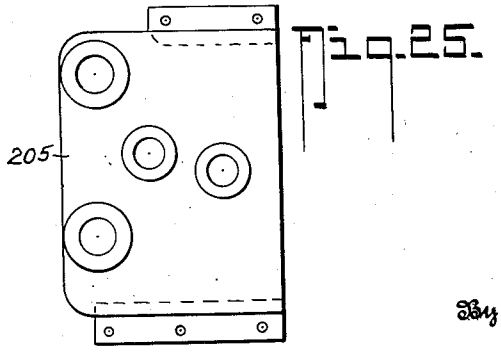


Fig. 25.



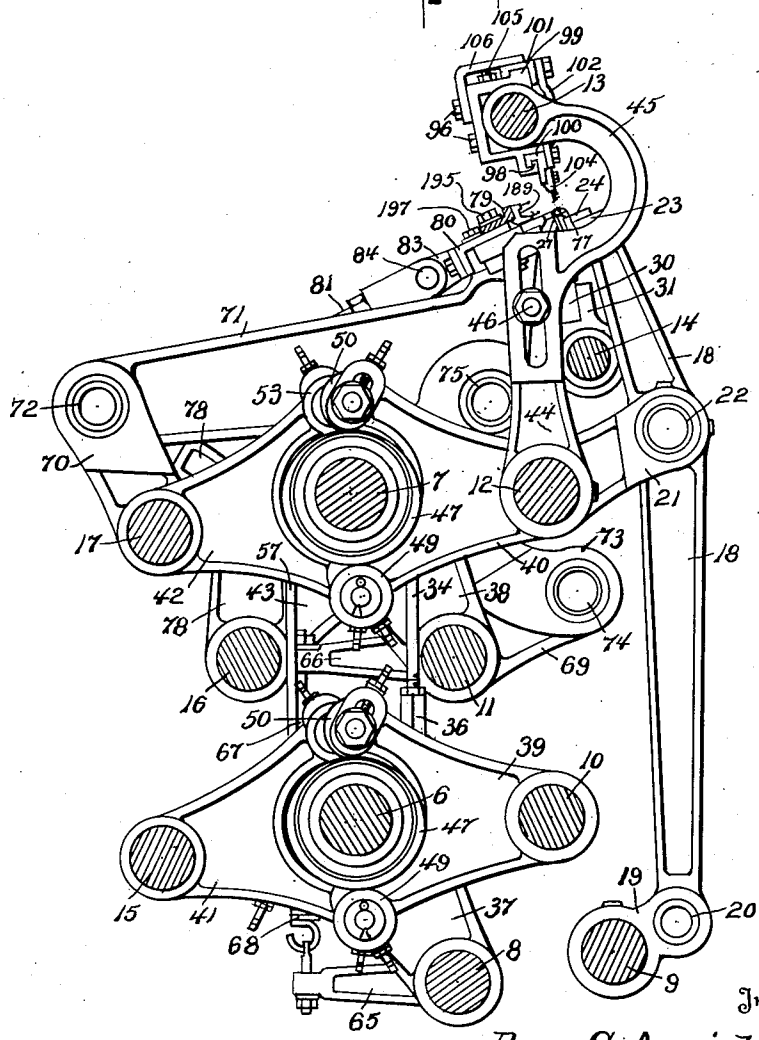
Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

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Fig. 4.



Inventor

Roy C. Amidon,

By Albert E. Dieterich,

Attorney

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 5

Fig. 5.

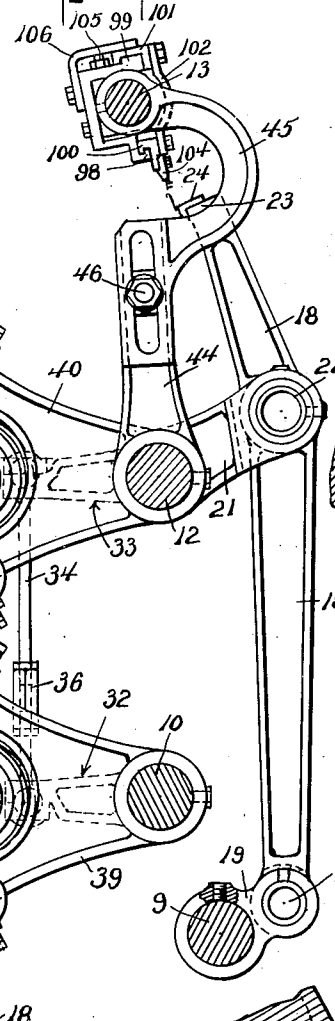


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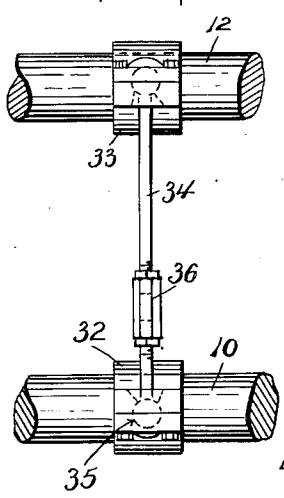


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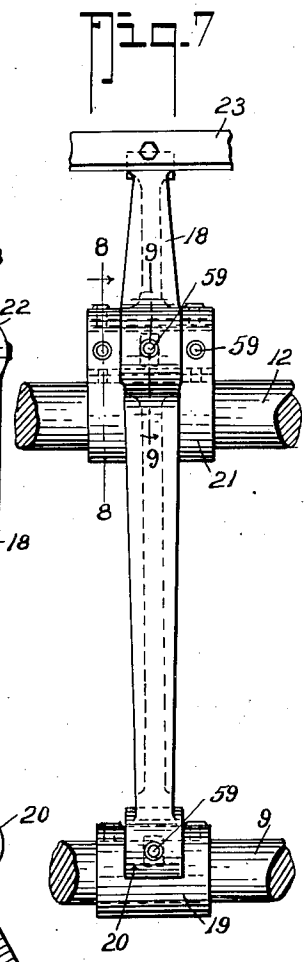


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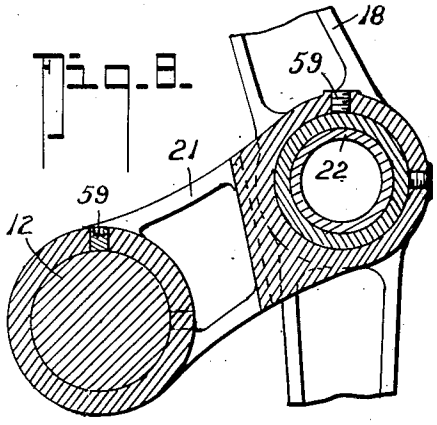
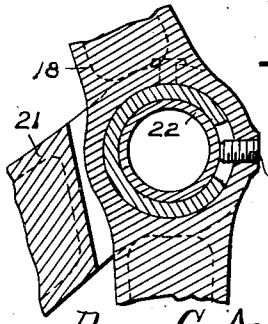


Fig. 8.



Inventor,

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By Albert E. Dieterich,

Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 6

Fig. 10.

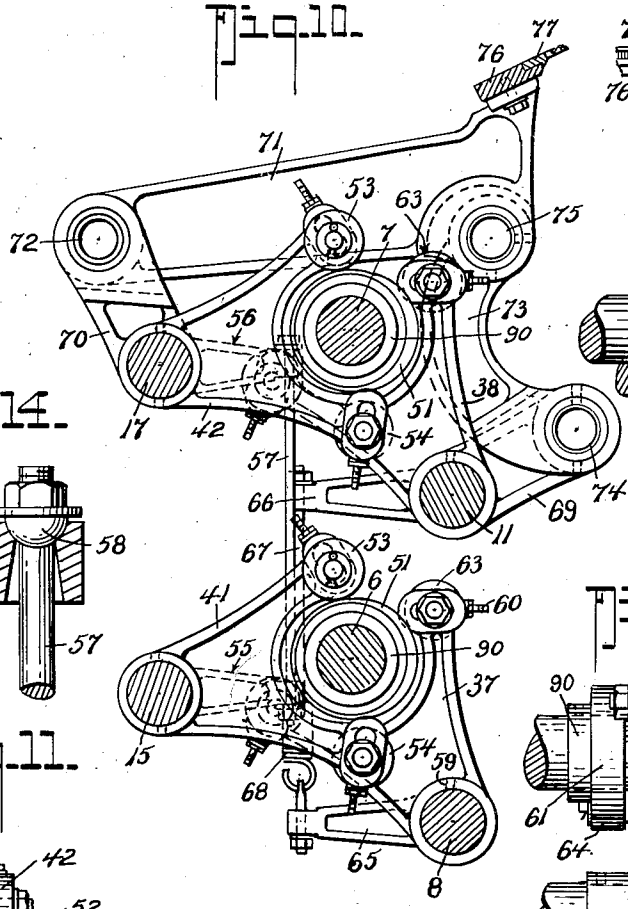


Fig. 13.

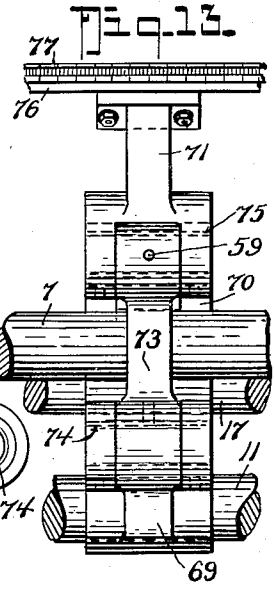


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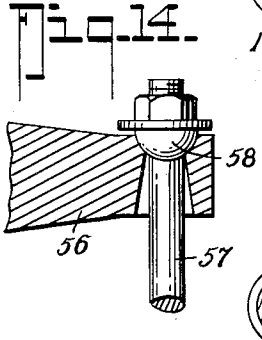


Fig. 11.

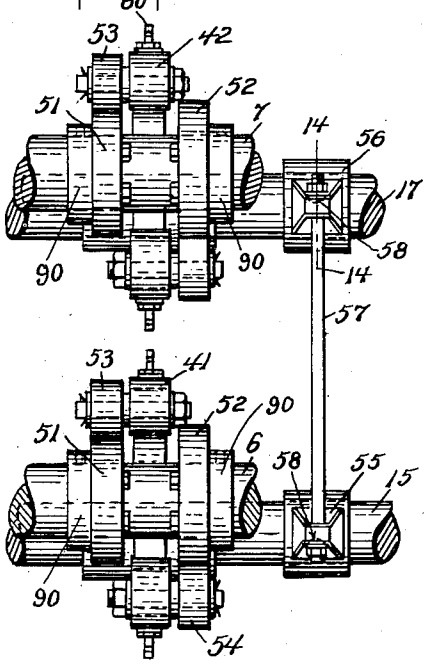
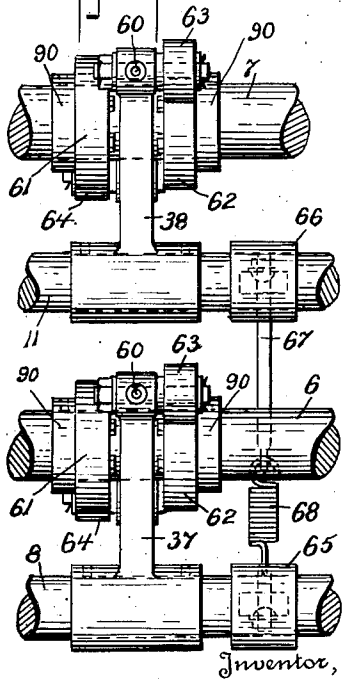


Fig. 12.



Inventor,

Roy C. Amidon,

By Albert E. Dieterich

Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 7

Fig. 16.

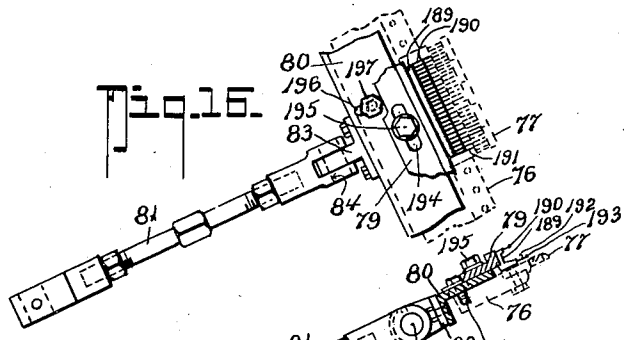


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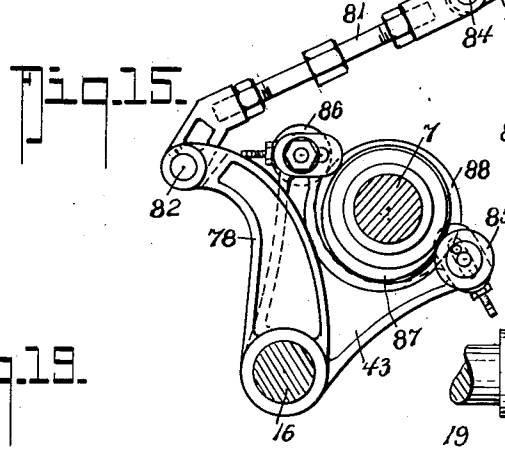


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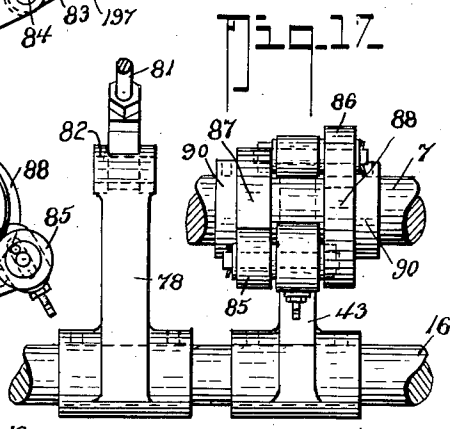


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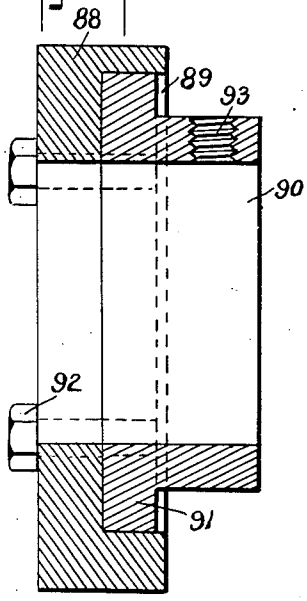
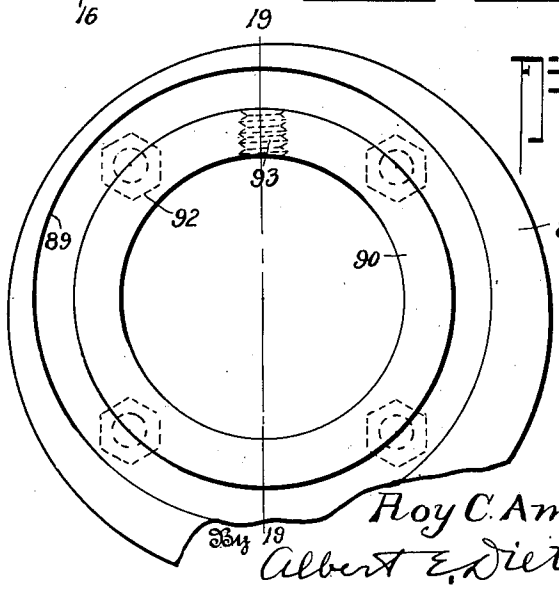


Fig. 18.



Inventor,
Roy C. Amidon,
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May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 8

Fig. 20.

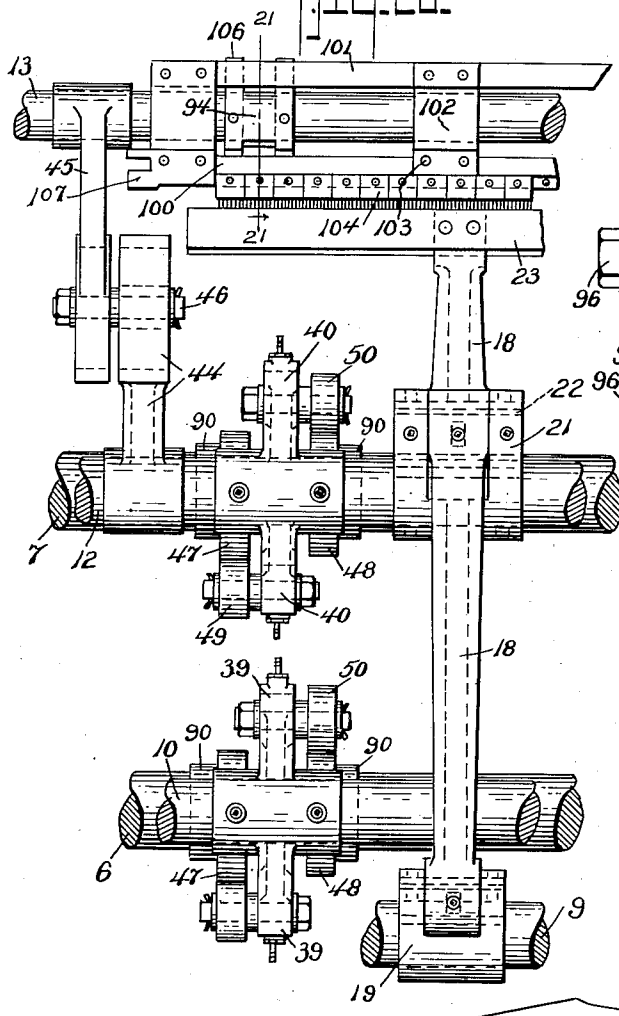


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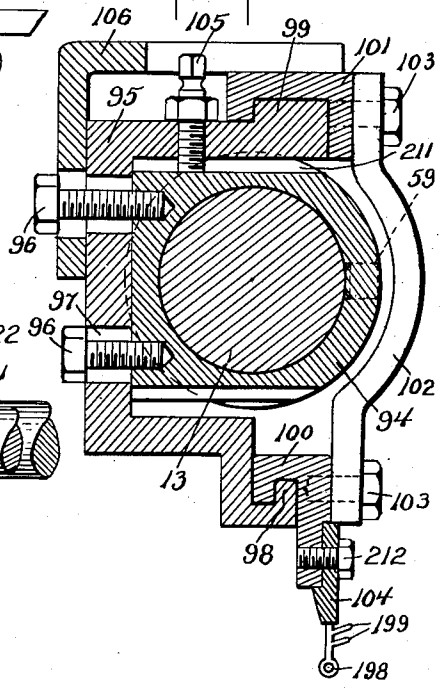


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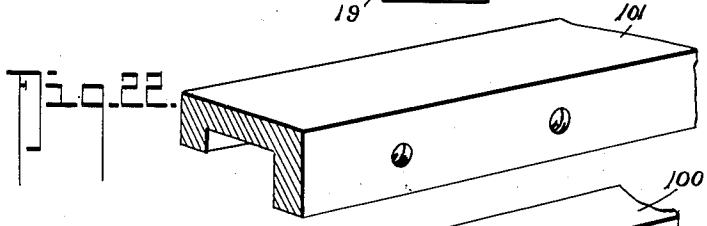
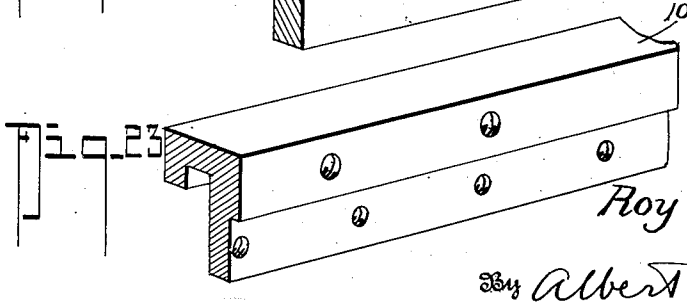


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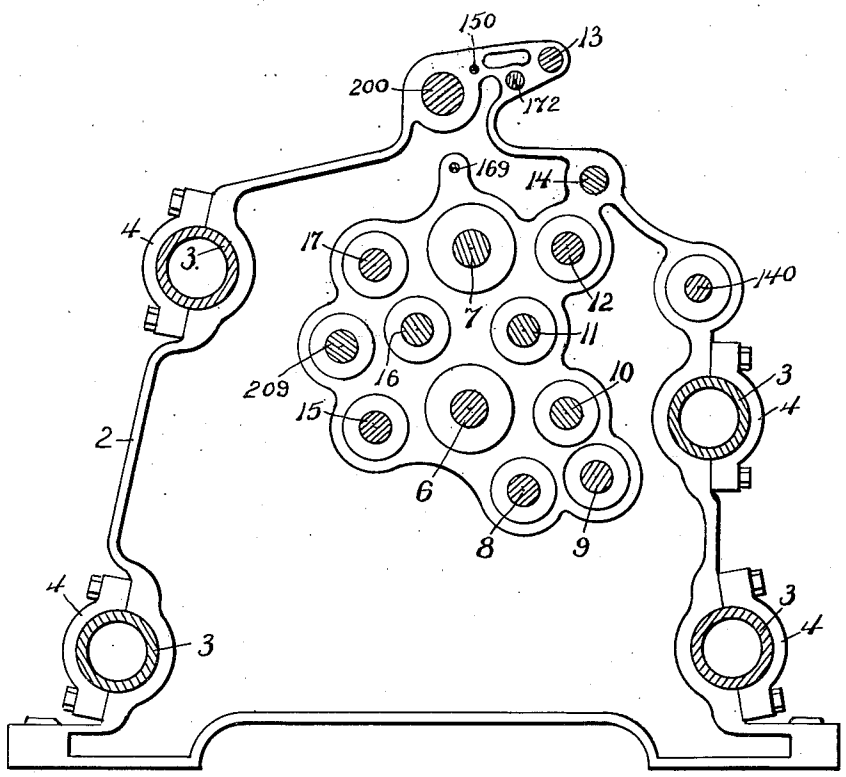
Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 9

Fig. 24.



Inventor,

Roy C. Amidon,

By Albert R. Dieterich,

Attorney,

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 10

Fig. 26

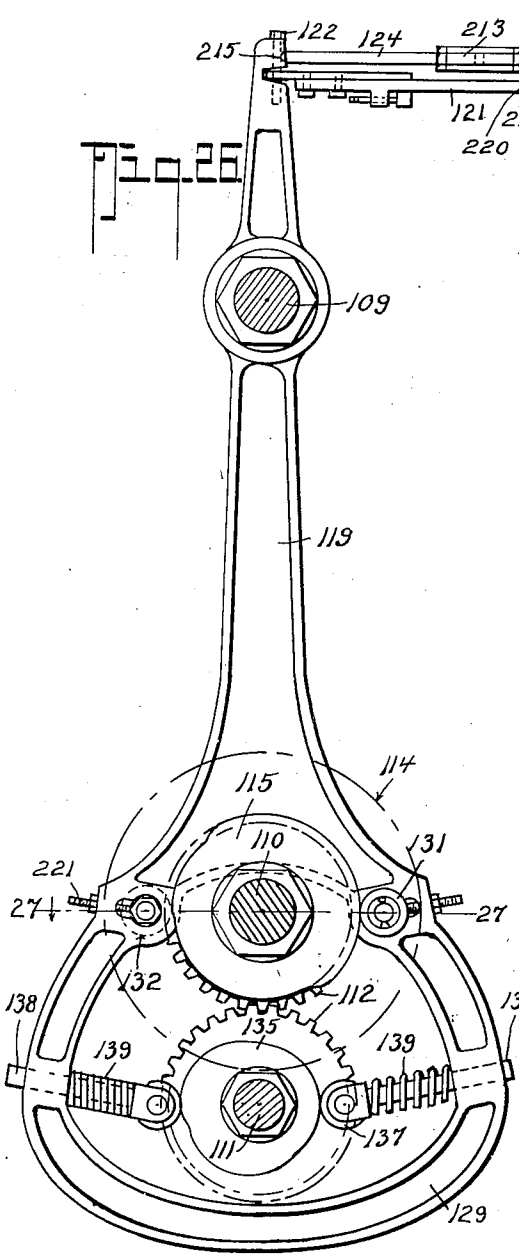


Fig. 28.

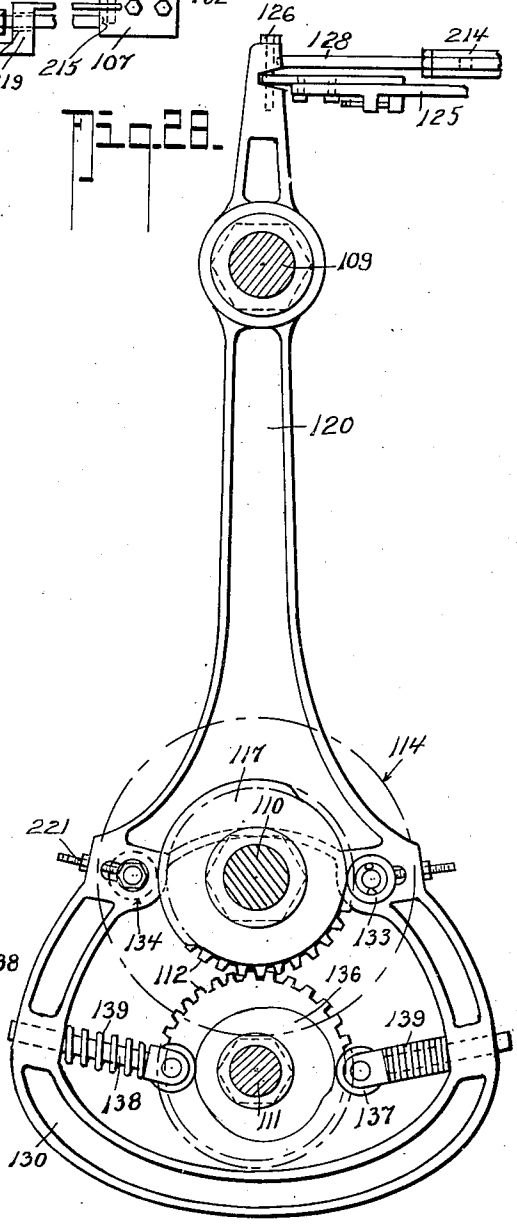
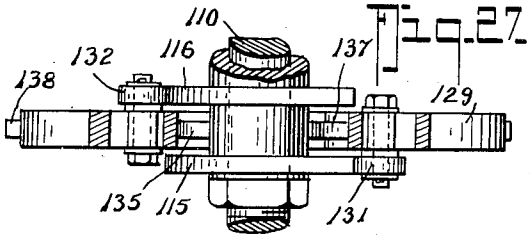


Fig. 27.



Inventor,

Roy C. Amidon,

By Albert E. Dieterich,

Attorney

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943

19 Sheets-Sheet 11

Fig. 29.

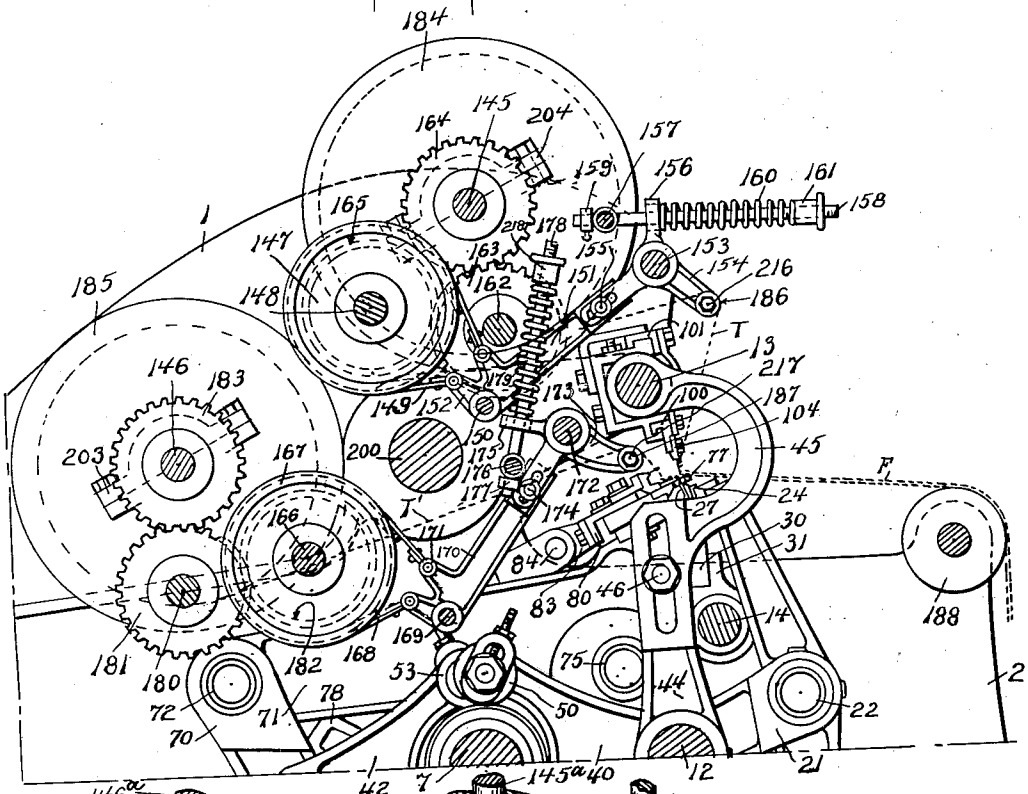
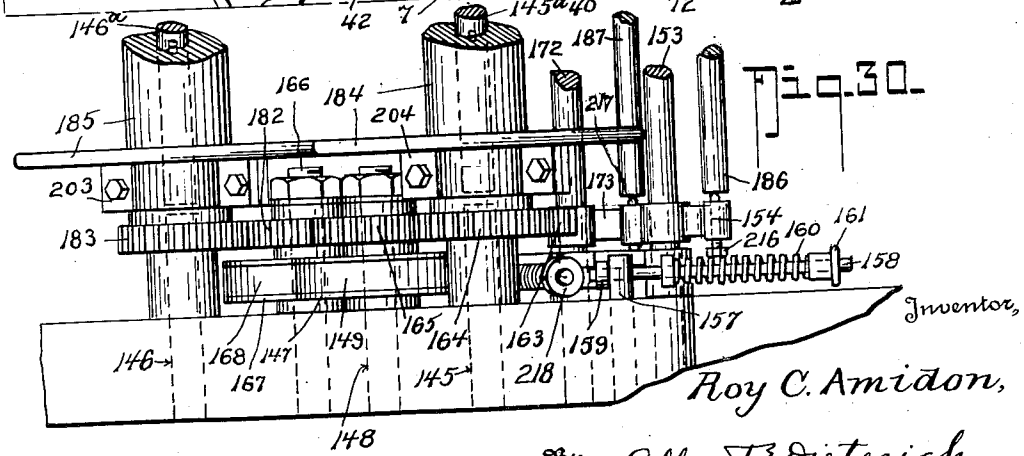


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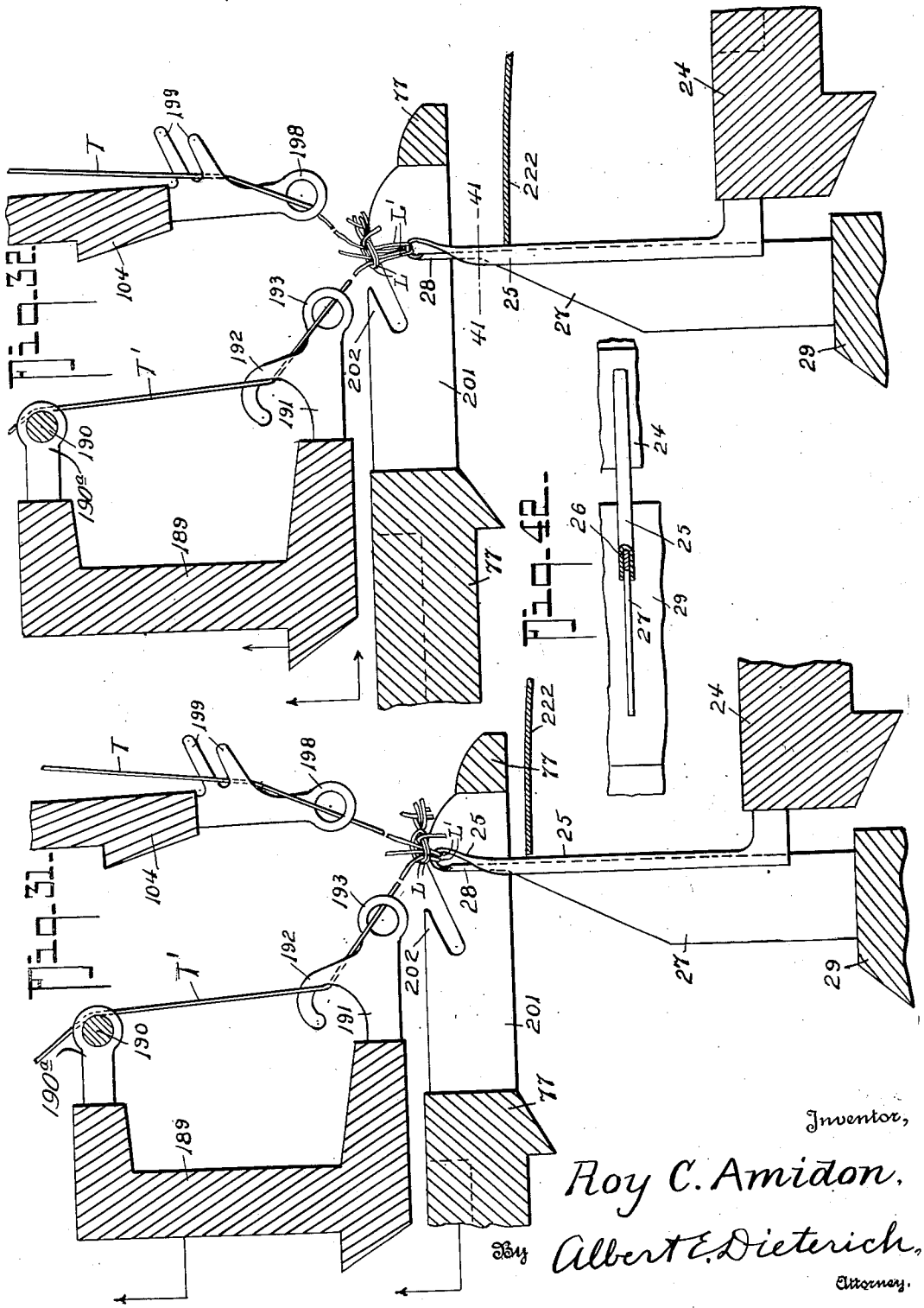


Inventor,
Roy C. Amidon,
By Albert T. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 12



Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 13

Fig. 34.

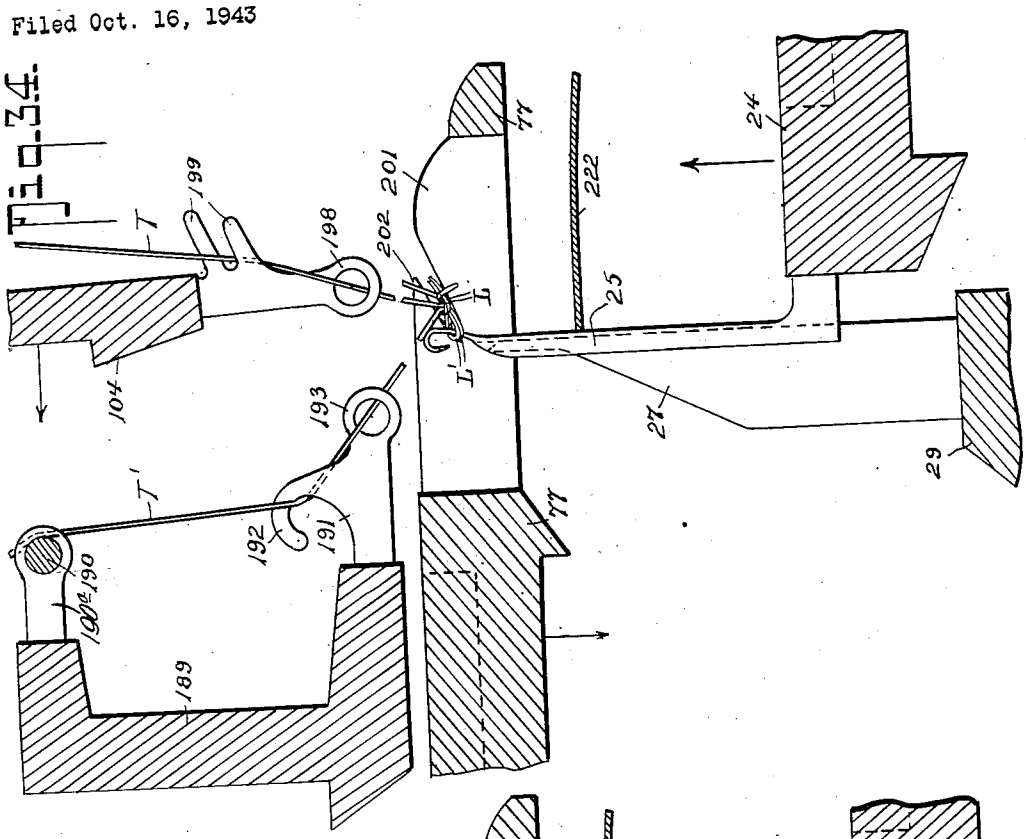
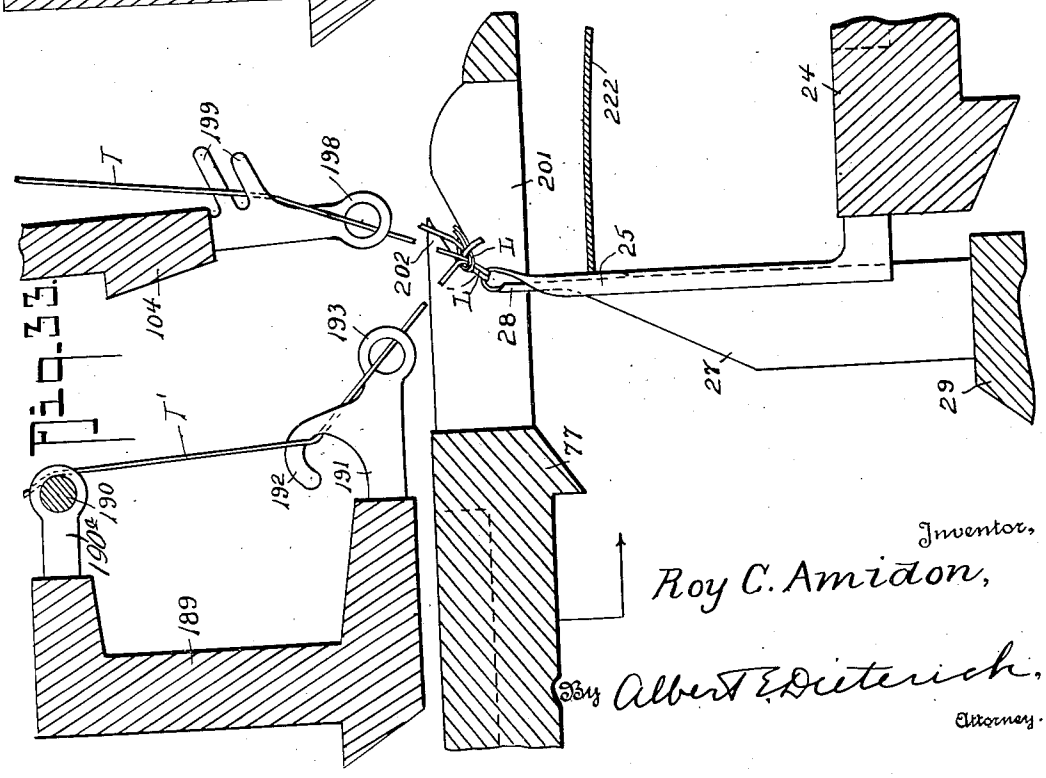


Fig. 35.



Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
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May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943

19 Sheets-Sheet 14

Fig. 35.

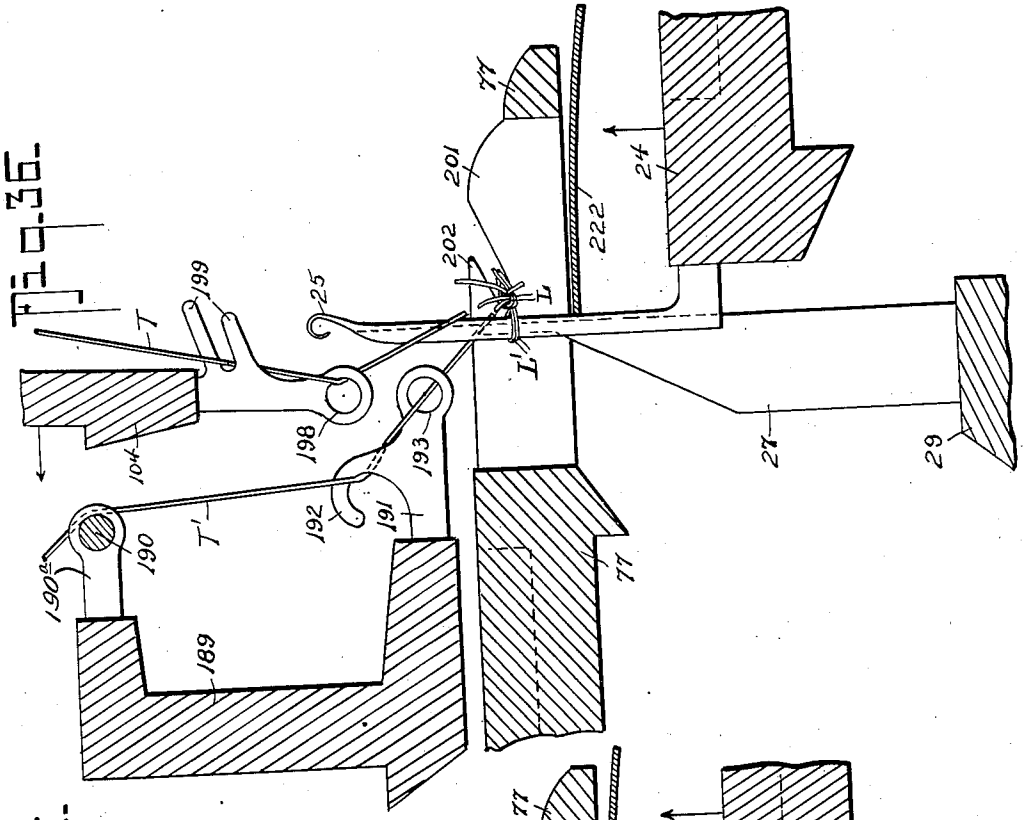
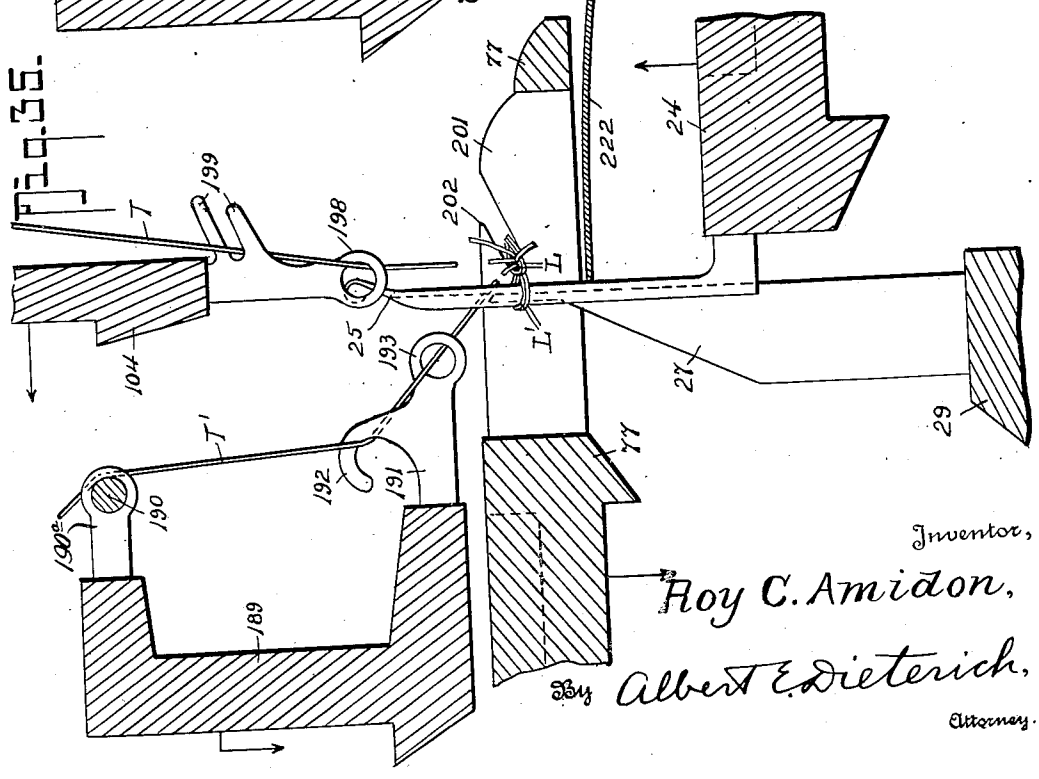


Fig. 35.



Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 15

Fig. 38.

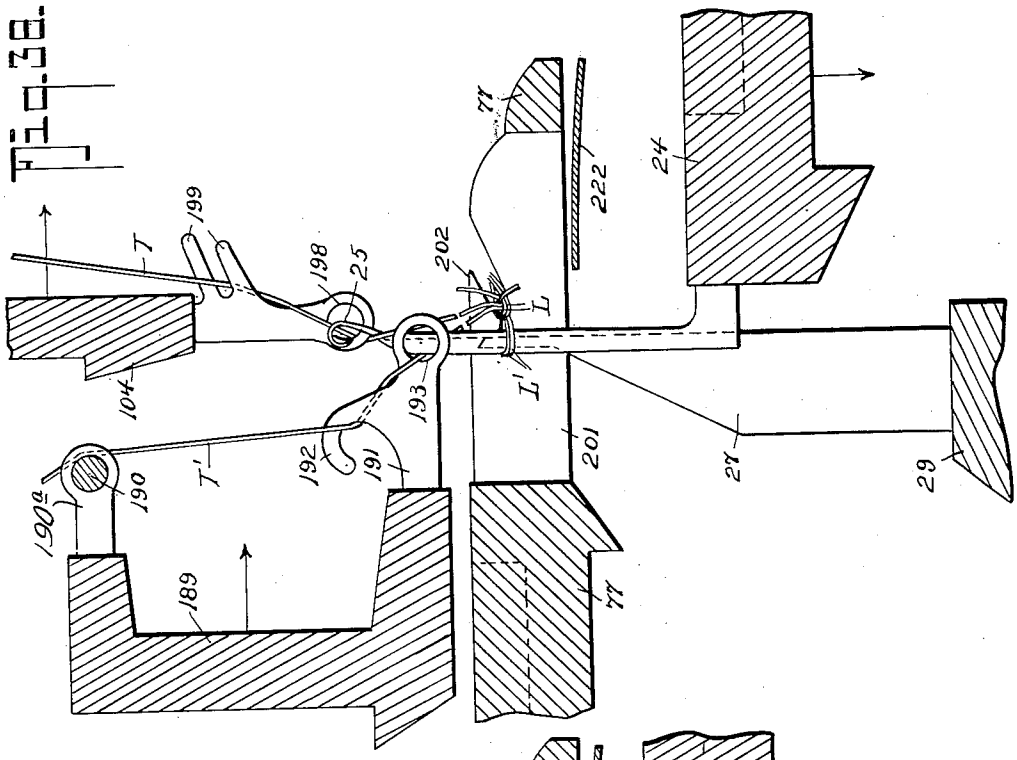
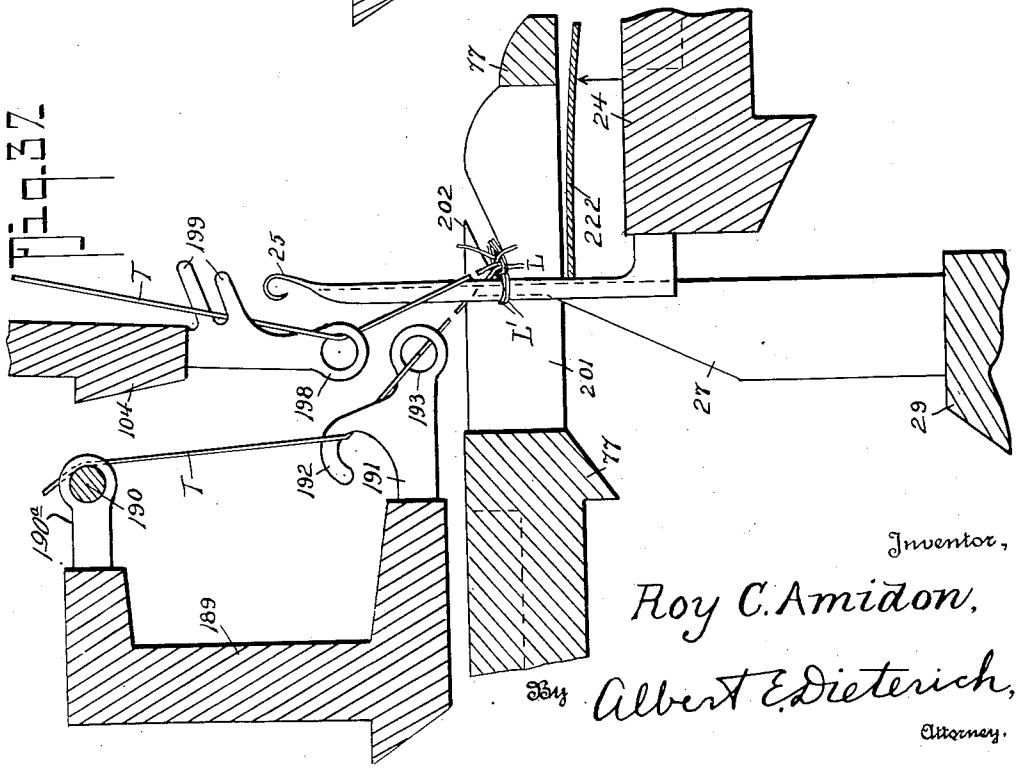


Fig. 37.



Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
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May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943

19 Sheets-Sheet 16

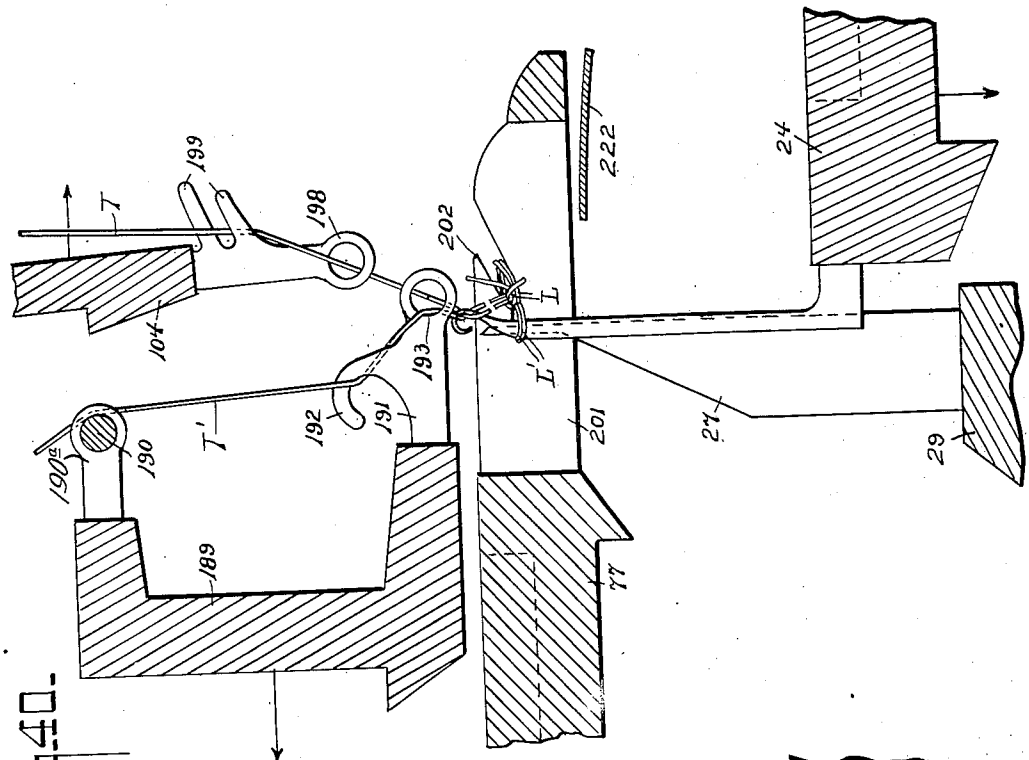


Fig. 40.

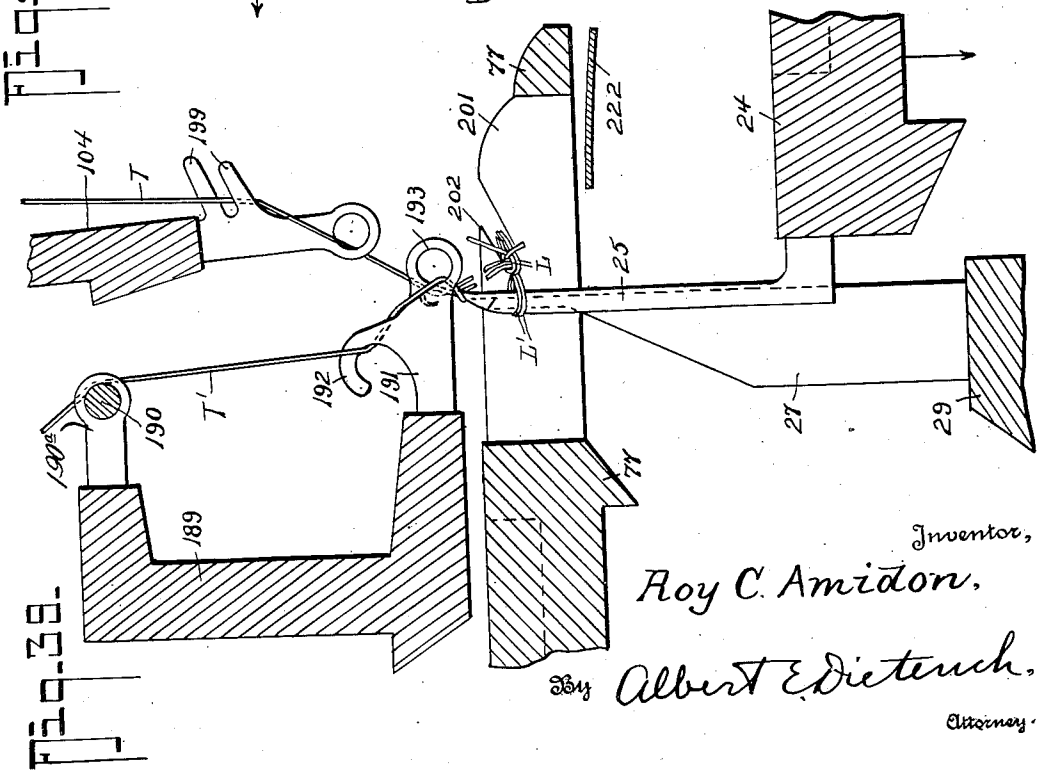


Fig. 39.

Inventor,
Roy C. Amidon,
By Albert E. Dietench,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 17

Fig. 45.

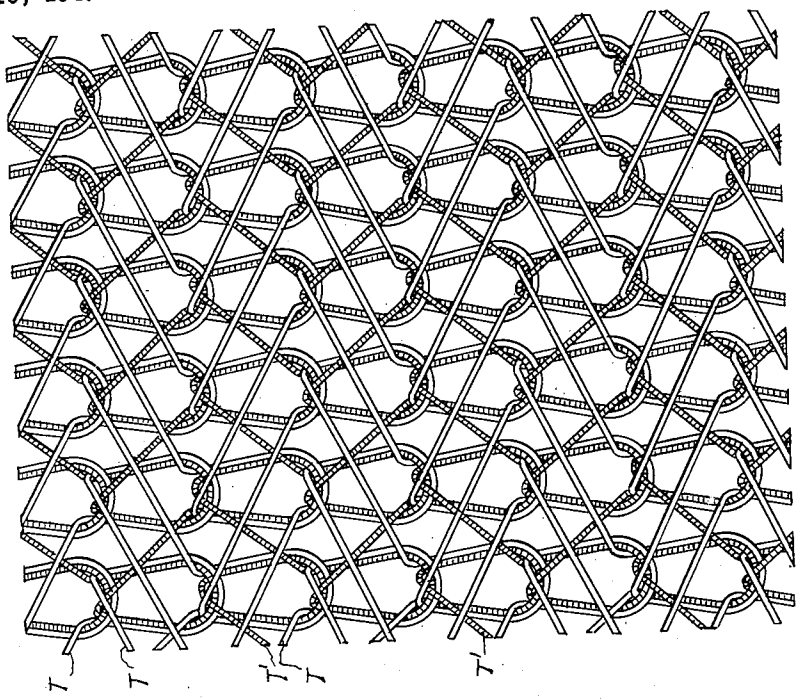
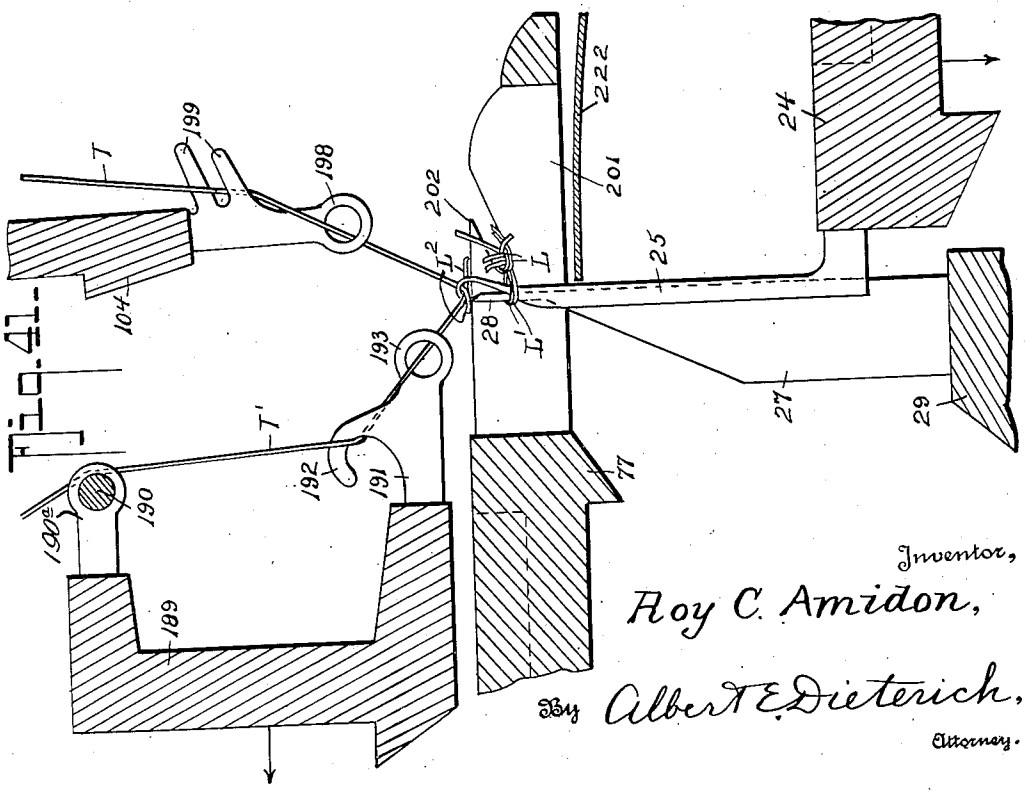


Fig. 41.



Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 18

Fig. 47.

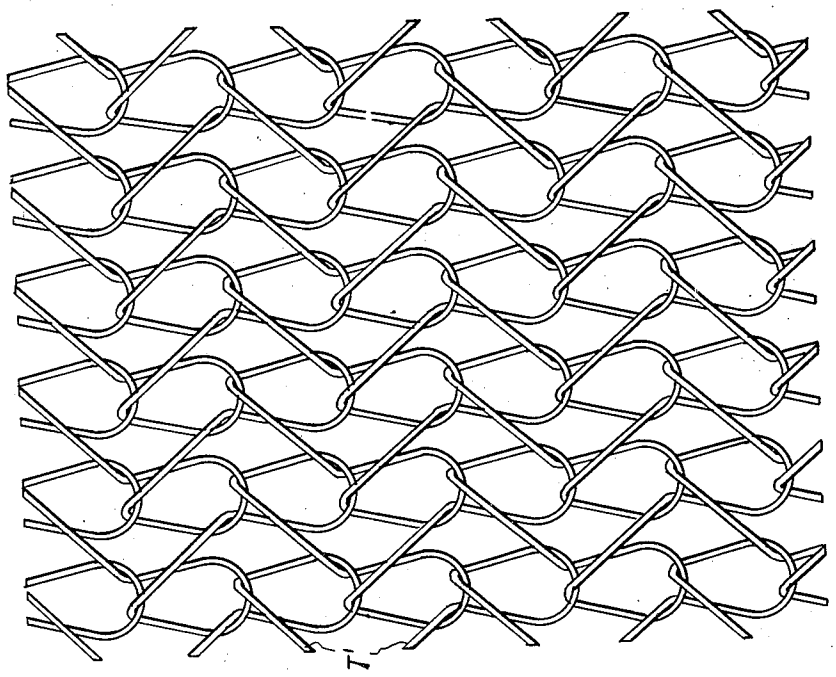
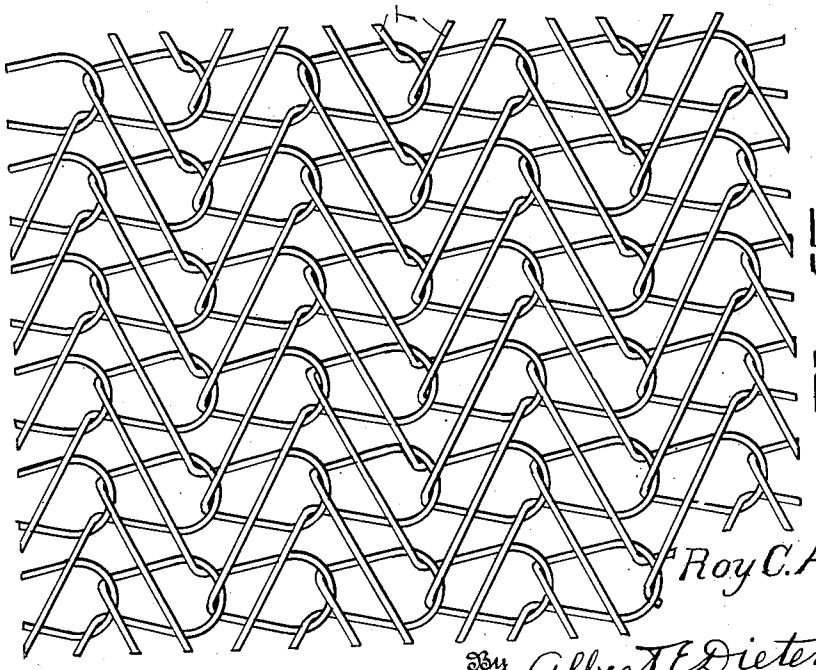


Fig. 46.



Inventor,
Roy C. Amidon,
By Albert E. Dieterich,
Attorney.

May 10, 1949. R. C. AMIDON 2,469,360

KNITTING MACHINE

Filed Oct. 16, 1943 19 Sheets-Sheet 19

Fig. 48.

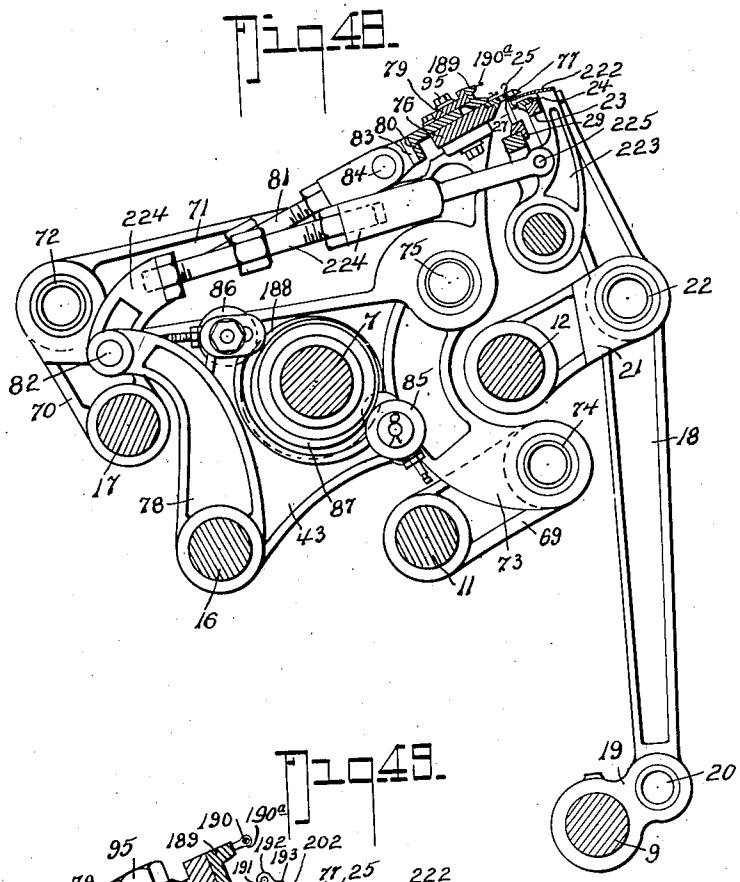
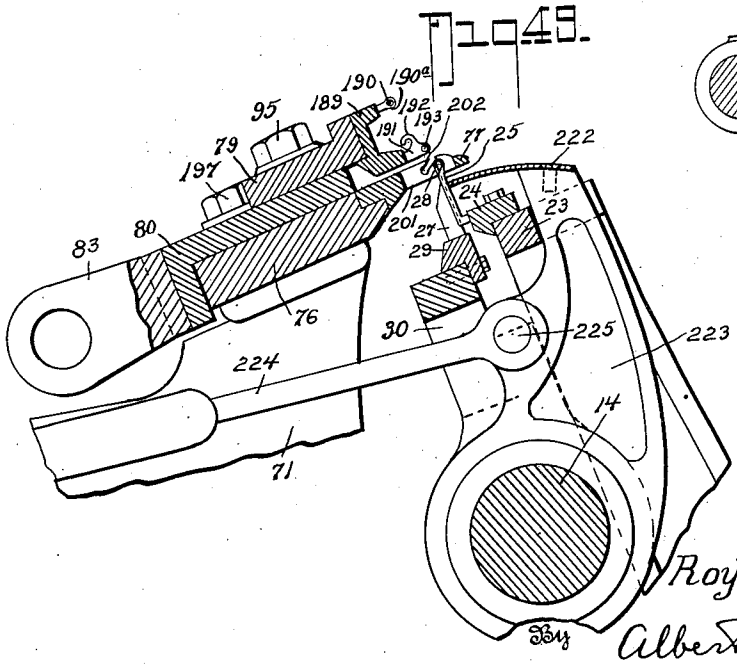


Fig. 49.



Inventor,

Roy C. Amidon,

By Albert E. Dieterich,

Attorney.

Patented May 10, 1949

2,469,360

UNITED STATES PATENT OFFICE

2,469,360

KNITTING MACHINE

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

Application October 16, 1943, Serial No. 506,561

48 Claims. (Cl. 66—86)

1

My present invention relates to the art of warp knitting known as tricot knitting and it particularly has for its object to provide a machine which permits fabrics to be produced at a much greater speed than has been found possible with warp knitting or tricot machines, heretofore known.

In some heretofore known tricot-type knitting machines bearded needles are used, the needles being set in line and attached to a bar called the needle bar. The needles are extended upward and in the knitting process are lifted to a position where the thread guides are made to pass between and in back of the needles, (the thread guides being attached to a bar called the guide bar) and are placed in line. When more than one guide bar is used, the guides are arranged on one bar in front of another. This makes it necessary, in passing the thread guides between and in back of the needles and returning the same to the starting position, for the guides to be set at a depth that allows the threads to be drawn between the needles and not hook the thread at the top of the guide hole as the threads are being drawn through the guides from one side to the other. Consequently the needles have to remain in a dwell until the one or more sets of guides have passed backwardly between the needles and made their respective changes in back of the needles and again passed between the needles to the front. The needles are then extended upward to a position where the threads which have passed between the needles will be drawn under the needle beards as the needle bar continues its downward movement. At the point where the needle beards enter the sinkers the needles again come to a dwell and the beard pressers are advanced to a position where they have closed the needle beards. The sinkers are then moved to a position where the closed needle beards have passed through the previously made stitch and into the knock-over position of the sinkers. The needles are then moved to the knock-over position and the sinkers are advanced to their starting position or their longest dwell period whereupon the needles are ready for their upward movement.

Another kind of tricot machine employs needles whose movement up and down is continuous, i. e., without periods of dwell, the beard

2

pressers closing the needle beards within the spaces between the nib portion of the sinkers and holding the needle beards closed until the beard ends have passed by the open portions of the sinkers between the nibs and the knock-over sections and through the previously made thread-loops. The beard pressers then release the beards and return to their starting position.

In the above described machines, it will be seen that the needles must necessarily have long strokes in the up and down movements in order that the threads may be placed under the needle beards. Also a long dwell in the needle movement is usually necessary in order that the, one or more, guide formations may be passed between and in back of the needles and again pass between the needles to the guide-starting position.

Some heretofore known machines use a hook with a sliding tongue in place of a bearded needle. In these machines the same general procedure has been followed, with the tongue sliding in the needle groove to close the hook opening so that the threads which have been placed in the needle hook may be drawn through the previously made thread-loops.

In my Patent Number 2,336,455, issued December 14, 1943, still another type of tricot machine is disclosed.

In tricot machines heretofore known the movement of the thread guide bars to place the thread under the needle beard or within the hook of the needle is accomplished by having the guide bars actuated by an arm which receives its motion from a pattern cam and roller, the roller being held on the pattern cam by spring action, the guide bar being placed between the needles by steps upon the cam and actuated in one direction by the direct push of the arm in the opposite direction by the spring action holding the arm roller to the cam. The type of thread guide that is used is one where the guides are cast in blocks which blocks are attached to the guide bar, the thread extending in a direct line from the tension rod to the eye of the guide and in some cases between the slay joint.

It is therefore an object of my present invention to provide a machine which obviates the objectionable features of prior machines and enables much faster knitting to be done than has heretofore been possible. To that end the pres-

ent machine uses hooked needles and stationary tongues, which needles are actuated in timed relation to a sinker that has up and down movement as well as the usual in and out or back and front movement. The needle in its movement has but one dwell, which takes place after the needle hook has entered the nib portion of the sinker and the needle hook closed by the engagement of the hook end with the stationary tongue; the sinker, in its movement to allow the cross threads to fall under the nibs, is continued upward to allow the threads within the needle hook to be drawn through the previously made loop and into the knock-over portion of the sinker. The needle is then ready to start its upward movement. At the same time that the needle starts to move upwardly the sinker starts to move downwardly to its point of dwell. By this construction and method of operation the length of the up and down movement of the needle is decreased from that of any other machine. When two thread guide bars are employed the needles and the front guide bar are actuated from one set of cams and in timed relation one to the other, the guide bar starting its backward movement as the needles start up; the guides pass between the needles in one direction as the needles are moved upward and again passing out between the needles during their downward movement; the thread guide passes in back of the needles as the guide reaches the end of its backward movement. The back thread guide bar is attached to the sinker bar and is moved into position to place the thread within the hooks of the needles by a forward movement as the needles are being moved downward.

Another object of my present invention is to improve the racking means used on tricot machines and to that end the thread guide bars are actuated in their racking movement by a pattern wheel or cam and a racking lever so as to move the guide bar in one direction while another pattern wheel or cam moves the same bar in the other direction, one pattern wheel or cam acting as a counter or follower for the other pattern wheel or cam, the acting cam being supported, in addition to its counter, by spring pressure. The connections between the racking lever and the guide bar are so arranged that there is a direct contact between the two so that when the bar is moved in one direction it is pushed and held in position by its counter connection and in the reverse direction it is pulled and held in position by its pushing support. The needle guide and sinker motions are controlled by two sets of actuating cams each set comprising an actuating cam and a counter or follower cam for each motion, the cams and counter cams being driven one in timed relation to the other, from one driving gear or first motion shaft; the dual sets of cams are connected by corresponding connections which allow one set to act as counter to the other, for instance, the counter cams of one set carry the weight of the bars, arms, etc., of the actuating parts of any of the motions mentioned, the cam acting to steady the counter, leaving the other set to actuate the knitting function.

Another object of my invention is to provide means to brace the needles while the threads are being pulled through loops and while the loops are being knocked-over by the sinkers, thereby preventing the needles from being pulled or bent away from the tongues and preventing the threads from catching on the ends of the tongues.

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 arrangements 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 the accompanying drawings:

Fig. 1 is a front elevation of a portion of the machine.

Fig. 2 is an end elevation of the same.

Fig. 3 is an elevation of the other end of the machine.

Fig. 4 is a transverse section of a portion of the machine taken on approximately the line 4—4 of Fig. 1, the tension mechanism for the threads being omitted.

Fig. 5 is a transverse section similar to Fig. 4 but only showing the front thread guide and the needle operating mechanism.

Fig. 6 is a detail rear elevation of the connection between the two rockshafts shown in Fig. 5.

Fig. 7 is a front elevation of the needle bar carrier and its mounting means.

Fig. 8 is an enlarged detail section on the line 8—8 of Fig. 7.

Fig. 9 is an enlarged detail section on the line 9—9 of Fig. 7.

Fig. 10 is a detail transverse section on the line 10—10 of Fig. 1 showing the sinker mechanism.

Fig. 11 is a detail front elevation of the sinker advancing and retracting cam mechanism and the means of connecting the two rock shafts on which the cam-roller-carrying carriages are mounted.

Fig. 12 is a detail front elevation of the sinker raising and lowering cam mechanism and the means for connecting the two shafts on which the cam-roller-carriages are mounted.

Fig. 13 is a front elevation of the sinker carrying means.

Fig. 14 is a detail section on the line 14—14 of Fig. 11.

Fig. 15 is a detail transverse section of the back thread guide mechanism.

Fig. 16 is a detail plan view of a portion thereof.

Fig. 17 is a front elevation of a portion of the mechanism shown in Fig. 15.

Fig. 18 is an enlarged detail view of one of the cams.

Fig. 19 is a cross section on the line 19—19 of Fig. 18.

Fig. 20 is a front elevation of the parts shown in Fig. 5 with the parts shown in Fig. 6 omitted.

Fig. 21 is an enlarged detail cross section on the line 21—21 of Fig. 20.

Fig. 22 is a detail perspective view of a portion of the upper bar of the front thread guide carrying frame.

Fig. 23 is a similar view of the lower bar of the same.

Fig. 24 is a cross section on the line 24—24 of Fig. 1, showing the intermediate frame and the parts carried thereby.

Fig. 25 is a detail elevation of the end bracket indicated in Fig. 3.

Fig. 26 is an enlarged detail section on the line 26—26 of Fig. 2.

Fig. 27 is a section on the line 27—27 of Fig. 26.

Fig. 28 is a detail section on the line 28—28 of Fig. 2.

Fig. 29 is a detail transverse section on the

line 4—4 of Fig. 1, showing the tension mechanism.

Fig. 30 is a top plan view of the tension mechanism shown in Fig. 29.

Figs. 31 to 41 inclusive are diagrammatic views showing the movements and positions of the needles, thread guides, sinkers and needle guides through a complete cycle of operation.

Fig. 42 is a detail section on the line 42—42 of Fig. 32.

Figs. 43 and 44 are detail views of modifications hereinafter specifically referred to.

Fig. 45 is a view illustrating a two thread fabric knit on this machine.

Fig. 46 is a view of the fabric knit when only the front thread guide and thread are employed.

Fig. 47 is a view of the fabric knit when only the back thread guide and thread are used.

Fig. 48 is a detail view of a portion of the mechanism showing the means for actuating the needle brace plate.

Fig. 49 is an enlarged detail view of a portion of the same.

In the drawings in which like numerals and letters of reference indicate like parts in all the figures,

1 represents the end frames, 2 the intermediate frame and 3 the longitudinal pipes, secured to the frames 1 and 2, by clamps 4, see Figs. 1, 2, and 24. A bar 200 also stiffens the upper part of the frames. At one end of the machine there are two longitudinal brackets 5 secured to the end frame (Figs. 1 and 3) the purpose of which will later appear.

Mounted in the end and intermediate frames 1, 2, and 3 are two cam shafts 6 and 7 one directly above the other (Fig. 4). Mounted in bearings in the end and intermediate frames 1 and 2, and forwardly of the cam shafts 6 and 7 are rock shafts 8, 9, 10, 11, 12, and 13, hereinafter called the lower front rock shaft, the second front rock shaft, the third front rock shaft, the fourth front rock shaft, the fifth front rock shaft and the upper front rock shaft, respectively. There is also located forwardly of the cam shafts, a stationary shaft 14.

Also mounted in suitable bearings in the end and intermediate frames 1 and 2, and rearwardly of the cam shafts 6 and 7 are rock shafts 15, 16, and 17, hereinafter called the lower back rock shaft, the intermediate back rock shaft and the upper back rock shaft, respectively.

Two or more short arms 19 are secured to and rock with the second front rock shaft 9. To these arms 19 needle-bar-carrying arms 18 are pivoted, as at 20. The arms 18 are also pivoted, at 22, to the longer arms 21 which are secured to and rock with the fifth front rock shaft 12. Secured to the upper free ends of the needle-bar-carrying arms 18 is a needle bar 23 (see Figs. 5 and 7), to which the needle blocks 24 are removably secured. As best shown in Figs. 31 to 41 the needle blocks 24 have offset, hook-type needles 25 that have longitudinal slots 26 to receive the needle guides 27. The guides 27 have tongues 28 that cooperate with the needles to close the entrances of the hooks during a part of the cycle of operation as will later clearly appear. The tongues and hooks may be so designed that the end of the hook 25 will rest on the top of the tongue (Fig. 31 et seq.), or the upper end of the tongue may have a depression 28^a (Fig. 43) into which the end of the hook may seat, or the arrangement may be such that the end of the hook 25 will slide past the end of the tongue as at 28^x in Fig. 44. The needle guides 27 are carried by needle guide blocks 29 that are removably secured to the needle-guide-carrying bar 30 which is fixed to brackets 31 that are rigidly secured to the stationary shaft 14 (see Figs. 4, 29 and 31).

As best shown in Figs. 4, 5, and 6, there is a rearwardly projecting arm 32 secured to the third front rock shaft 10 and a similar arm 33 secured to the fifth front rock shaft 12. These arms 32 and 33 are adjustably connected by a two-piece connecting rod 34 having ball and socket connection 35 with the respective arms 32 and 33 and joined together by a turnbuckle 36.

As best shown in Fig. 4, there is a roller carriage 37 secured to the lower front rock shaft 8, a roller carriage 39 secured to the third front rock shaft 10, a roller carriage 38 secured to the fourth front rock shaft 11 and a roller carriage 40 secured to the fifth front rock shaft 12. By referring particularly to Figs. 4 and 5, it will be seen that the carriages 39 and 40 have forked ends on which, at opposite sides of the carriage, cam-engaging rollers 49 and 50 are mounted so as to engage the master cams 47 and follower cams 48 (see Fig. 20). A roller carriage 41 is secured to the lower back rock shaft 15 and a roller carriage 42 is secured to the upper back rock shaft 17 (see Figs. 4, 10, and 11). These carriages have rollers 53 and 54 on opposite sides to engage with the master cams 51 and follower cams 52, respectively. There is also a roller carriage 43 secured to the intermediate rock shaft 16, which has rollers 85 and 86 on opposite sides to engage the master cam 87 and follower cam 88, respectively (see Figs. 15 and 17). The roller carriages 37 and 38 have rollers 64 and 63 to engage the master cams 61 and 62, respectively, as best shown in Fig. 12.

Secured to the fifth front rock shaft 12 is an arm 44 which has a sliding pin and slot connection 46 with a curved arm 45 that is secured to the upper front rock shaft 13 (Figs. 4, 5, and 20). The several arms and carriages which are secured to the several rock shafts may be secured, adjustably, by set screws 59 while the rollers that engage the cams are adjusted by means of screws and lock nuts 60.

A forwardly projecting arm 55 is secured to the lower back rock shaft 15 and a similar arm 56 is secured to the upper back rock shaft 17. These arms are connected by a connecting rod 57 having ball and socket connections as at 58 (Figs. 10 and 11). A rearwardly projecting arm 65 is secured to the lower front rock shaft 8 and a similar arm 66 is secured to the fourth front rock shaft 11. These arms are joined by a connecting rod 67 and spring 68 for a purpose later to appear.

Projecting upwardly forwardly from and secured to the fourth front rock shaft 11, are rocker arms 69, to the front ends of which links 72 are pivoted at 74 (Figs. 4 and 10), while rocker arms 70 are pivoted to the upper back rock shaft 17. Sinker-bar-carrying arms 71 are pivoted at 72 to the arms 70 and at 75 to the links 73. The arms 71 (of which, of course, there are two or more in the length of the machine) carry the sinker bar 76 to which the knock-over sinkers are removably attached in any well known way. Each sinker comprises a blade 201 having a nib 202, two or more sinker blades with their nibs being mounted in lead blocks 77. The blades are spaced apart so that only one needle 25 and its guide 27 operates between two adjacent sinkers. In other words only one sinker (blade and nib) extends between adjacent needles.

Rocker arms 78 are secured to the intermediate back rock shaft 16 (Figs. 15 and 16). To these rocker arms 78 are pivoted, at 82, longitudinally adjustably connecting rods 81 that are also pivoted, at 84, to the brackets 83. The brackets 83 are firmly secured to the racking bar carrier 80, which is mounted on the sinker bar 76 by cap screws 197 passing through slots 196 so that the carrier 80 may be moved back and forth, bodily, on the bar 76 for a purpose later to appear.

Mounted on the racking bar carrier 80 for longitudinal movement thereon, is the back thread guide racking bar 79. The bar 79 is mounted on the carrier 80 by means of cap screws 195 passing through slots 194 (Figs. 15 and 16). The back thread-guide blocks 189 are removably secured, in any approved way, to the bar 79 and carry upper guide rods 190 (see Figs. 31 to 38, inclusive) and lower guide members 191 each of which members 191 has a hook 192 and an eye 193 for guiding the back thread T' (see Fig. 31). The rod 190 is carried by the upper arms or blades 190a between which the threads T' pass.

The various cams that are located on the cam shafts 6 and 7 may be constructed as shown in detail in Figs. 18 and 19, or in any other suitable way. By reference to Figs. 18 and 19 it will be seen that the cam proper 88 has a recess 89 to receive the flange 91 of the collar 90, which is tapped, at 93, to receive a set screw. The collar and cam proper are secured together by cap screws 92. The bore of the cam proper and of the sleeve is such as to fit the cam shaft snugly, although the cam proper may have a slightly larger bore than the sleeve, if desired, to the more readily slip off the shaft when necessary for repairs or replacement.

Referring now particularly to Figs. 1 and 20 to 23, it will be observed that a number of sleeves 94 are secured at intervals along and to the upper front rock shaft 13, by set screws 59. These sleeves 94 have slots 211 to receive adjusting screws 105 that are carried by brackets 95 which are fastened in a vertically adjustable manner, by cap screws 96 passing through slots 97 into the sleeves 94. The brackets 95 have upper, 99, and lower, 98, tracks on which the upper and lower bars, 101 and 100, respectively, of the front racking frame slide and are supported. Yokes 102 are secured, by cap screws 103, to the bars 100 and 101 as best shown in Fig. 21. The front thread guide element blocks 104 are removably mounted in any suitable way, as by cap screws 212. The front thread guides each has a fork 199 and an eye 198, for guiding the front thread T. The front thread guide racking frame is held on its tracks 98, 99 by angle bars 106 vertically adjustably held by cap screws 96.

Referring now to Figs. 1 and 2, it will be observed that the racking bar 100 has a fitting 107 attached to it at one end. The back racking bar 79 also has a similar fitting 108 at the corresponding end. Mounted, one above the other, in the brackets 5 are shafts 109, 110, 111 (Figs. 1, 2, 26, 27, 28), the shaft 110 being the master pattern wheel shaft, and the shaft 109 being a shaft on which the racking levers 119 and 120 are rockably mounted. The shafts 110 and 111 are geared together by spur gears 112 and the shaft 110 is driven from cam shaft 6 through worm gears 113 and 114. 115 indicates the master pattern wheel and 116 the follower pattern wheel which contact, respectively, the rollers 131 and 132 on the yoke 129 of the lever 119. The rollers 133 and 134 on the yoke 130 of the lever 120, cooperate, respectively, with the master pattern wheel 117 and follower pattern wheel 118 (Fig. 2) on the shaft 110.

A longitudinally adjustable connecting rod 121 has one end pivoted at 122 to the lever 119 and its other end pivoted at 123 to the fitting 107. A two piece push rod 124 having a turnbuckle connection 213 has its ends of semi-spherical shape to fit corresponding sockets in the lever 119 and in the fitting 107 (see dotted lines 215 in Fig. 26). By this construction any play which might take place between the lever 119 and the front thread guide frame can be taken up. A longitudinally adjustable connecting rod 125 is pivoted at one end, as at 126, to the lever 120 and at the other end, as at 127, to the fitting 108 of the back thread guide bar (Fig. 1). A two piece push rod 128, having a turnbuckle 214, has its semi-spherical ends set into corresponding sockets, (similar to the rod 124) in the lever 120 and the fitting 108.

The yokes 129 and 130 each carries two slide rods 138 having rollers 137 and springs 139 which constantly force the rollers into contact with take-up cams 135 and 136, respectively.

Referring again to Figs. 26 and 28, it will be seen that the connecting or pull rod 121 is offset. The offset portion 219 is apertured as indicated by dotted lines 220 in Fig. 26, and the rod 124 passes through the aperture.

In order to permit the blades of the thread guides to be centered between the needles, I provide the means 221 shown in Figs. 26 and 28 for adjusting the rollers 131, 132, 133 and 134 to their respective cams. This adjustment may also be made, if desired, at the push-pull connection 121, 124.

By reference to Figs. 29 to 41 inclusive it will be seen that the front threads T are held taut and flat against the blades of the guides 104, by the fork 199, for a sufficient distance above the highest point reached by the needle 25 so as to prevent the needle accidentally picking up a thread from an adjacent guide blade. The forks 199 further serve to separate adjacent threads at points above the highest point reached by the needles; it sometimes happens that threads from the spools become twisted together somewhat and are only separated, with the usual heretofore-used guides, when they reach the eyes of the guides. This would be fatal in a high speed machine such as the present one. The back threads T' are also separated by the hooks 192 before reaching the eyes 193. Hence when the eyes of the guides are moved between the needles, the threads being held flat against the blades of the guides, the needles cannot pick up the wrong threads.

In order to prevent bending the needles, because of the tension that is placed upon them while drawing the thread through previously formed loops and while the loops are being knocked-over by the sinkers, I provide a plate 222 mounted on an arm 223 that may be pivoted on the shaft 14 and connected with the back thread guide operating arm 78 by a longitudinally adjustable connecting rod 224 pivoted at one end to the arm 78, as at 82, and at the other end to the arm 223, as at 225. Thus the movements of the plate 222 and back thread guide 189 are coincidental.

140 is a hand wheel shaft that is mounted in suitable bearings in the frames 1 and 2. This shaft may be turned by a hand wheel 141 and is connected with the shaft 6 by a sprocket and chain connection 142, 143, 144 as shown in Fig. 3. As shown in this figure the cam shafts 6 and 7 are driven to turn in the same direction, from

the first motion (motor) shaft 209, through gears 206, 207, 208, and 210, the gear 206 being keyed to the shaft 7, the gear 207 to the shaft 6 and the gear 210 to the shaft 209, while the gear 208 runs free on the shaft 16. A bracket 205 is secured to the end frame and has suitable bearings for the shafts 6, 7, 16 and 209.

In order to counteract the effect of the weight of the needle-bar-carrier 18 on the cam 47 on shaft 7, the following structure is provided, namely, arms 32 and 33 on the shafts 10 and 12, respectively, extend in the direction opposite to arm 21 and are connected by a rod 34 with turnbuckle 36. The shaft 10 is provided with a roller carriage 39 whose rollers 49 and 50 engage cams 47 and 48 on a shaft 6. By adjusting the turnbuckle 36 so that the rollers 49 and 50, which are carried by the roller carriage 40, engage respectively cams 47 and 48 lightly, the pull caused by the overweight of the needle-bar-carrier 18 is applied to the cams on shaft 6 rather than to the cams on shaft 7. In this way vibration is reduced and cam and roller wear at high speeds becomes less than would otherwise be the case.

In setting up the machine, the rollers 49 and 50 on the carriage 39 are first adjusted to the cams 47 and 48 respectively, on the cam shaft 6 and the turnbuckle 36 is adjusted properly to position the needles 25. This enables the weight of the needle-bar-carrying arms 18, needle bar 24, arms 19 and 21 to be supported by the cam shaft 6, leaving the cams 47 and 48 on the cam shaft 7 free to take the strains of the knitting operations through the rollers 49 and 50 on the carriage 40.

Likewise the rollers 53 and 54 and 63 and 64 on the carriages 41 and 37, are first adjusted to the cams 51 and 52 and 62 and 61, respectively, on the shaft 6, and the rods 57 and 67 are adjusted to balance the weight of the arms 70, 71, 69 and the links 73, leaving the cams 51 and 52 and 62 and 61, respectively, on shaft 7 free to take the strains of the knitting operations through the rollers 53, 54, 63, 64 and the carriages 42 and 38.

After balancing the parts as just described, the rollers that engage the various cams on the shaft 7 are brought into working engagement with the respective cams, for effecting the knitting operations.

It should be understood that the cams on the shafts 6 and 7 are duplicates, and the carriages 39 and 40, 41 and 42, and 37 and 38 are also duplicates.

Referring now particularly to Fig. 29 of the drawings, it will be seen that 145 designates a stub shaft, secured to the end frame 1 and on which shaft is mounted a spur gear 164 whose hub is integral with one half of a split clamp 204 that clamps to an end of the spool-carrying shaft 145a. On a stub shaft 143 secured in the end support 1 is a brake drum 147 whose hub carries a spur gear 165 that meshes with a gear 163 that is journalled on a stub shaft 162. The gear 162, in turn, meshes with the gear 164.

A brake band 149 passes over the brake drum 147 and has its ends anchored to the furcations 152 of a brake lever 151 that is pivoted on a stud 150 carried by the end frame 1. The brake lever 151 has a pin and slot connection 155 with one arm of a bell crank lever 154 that is pivoted on a shaft 153. The other arm of the bell crank lever 151 has a pointed screw 216 to engage an end of the front thread guide rod 186.

An apertured ear 156 is secured to the shaft 153, through which ear a tension rod 158 passes. The rod 158 carries a spring 160 and an adjusting nut 161 and has one end passing through a hole in an apertured lug 157 that is mounted in the end frame 1. A stop collar 159 is adjustably secured to the end of the rod 158 which projects through the lug 156.

A spur gear 183 is mounted on a stub shaft 146 held in the end frame 1. The hub of gear 183 carries one half of a clamp to receive an end of the back spool shaft 146a, which end is secured to turn with the gear 183 by the two half clamp members 203 (Figs. 29 and 30). The gear 183 meshes with a gear 181 on a stub shaft 180 that is held in end frame 1. The gear 181, in turn, meshes with a gear 182 on the hub of a brake drum 167 that is mounted on a stub shaft 166. The brake band 168, which passes over the drum 167, has its end anchored to the furcations 171 of the brake lever 170 that is mounted on the stud 169 and has a pin and slot connection 174 with one arm of a bell crank lever 173 that is mounted on a shaft 172 that rocks in bearings in the end and middle frames. The other arm of the bell crank lever 173 carries a pointed screw 217 that engages an end of the back thread guide rod 187. An apertured ear 175 is secured to the shaft 172. A tension rod 178, having a spring 179 and an adjusting nut 218, passes through the ear 175 and through an apertured lug 176 fastened to frame 1 and carries an adjustable stop collar 177.

The front thread carrying spool 184 is keyed to shaft 145a while the back thread carrying spool 185 is keyed to shaft 146a (see Fig. 30).

The knit fabric, F, passes over a guide roll 188, to the fabric wind-up devices. As the wind-up devices are per se no part of the present invention and may be of the construction disclosed in my Patent No. 2,312,725, issued March 16, 1943, they have not been illustrated in the accompanying drawings.

As shown in Fig. 29, the threads T from spool 184 pass over the guide rod 186 to the respective front thread guides where they pass between the furcations 199 and through the eyes of 198 of the respective guides while the threads T' from spool 185 pass over guide rod 187 to the respective back thread guide, over the rods 190, around hooks 192 and through the eyes of the respective rear thread guides 189 etc.

Operation

Assume the thread guide, sinker, needle and stationary needle guide to be positioned as in Fig. 31. At this time the needle 25 is stationary, the front thread guide 104 is stationary, the back thread guide is moving backwardly-upwardly and is about to stop its backward movement; the plate 222 is just about to contact the needles lightly; and the sinker is moving backwardly-upwardly at about the same speed as the back thread guide, the sinker having about reached the limit of its backward movement. At this time (Fig. 31) the previously knit loops or stitches L will have been knocked over and the next loop is being drawn through it.

Continuing further the parts reach the position of Fig. 32 at which time the back thread guide 189 has reached its farthest back position but is still moving upwardly and the plate 222 is in light contact with the needles; the front thread guide 104 is still at a standstill and the sinker is now moving forwardly-upwardly to lo-

cate the knit stitch in the slot beneath the sinker nib 202.

Continuing from position Fig. 32 to position Fig. 33, as the parts reach the position of Fig. 33 both thread guides, 104, 189, the plate 222, and the needle 25 will be at rest, while the sinker has just about reached its farthest forward position and is about to come to rest.

Continuing from position of Fig. 33 to that of Fig. 34, the back thread guide 189 and the plate 222 remain stationary, the sinker is at rest, the front guide 105 has commenced its backward swing and the needle 25 has started on its upward journey through the second knit loops L'.

Continuing further the front thread guide 104 continues its backward movement to pass the thread T over the near side (facing Fig. 35) of the needle 25 which, by the time the position of Fig. 35 has been reached, is alongside the needle guide eye 198. The back thread guide and the sinker are moving downwardly and have about reached the limit of their downward movement. The thread from the back thread guide lies to the far side (facing Fig. 35), of the needle and the needle is still moving upwardly. The plate 222 remains stationary.

By the time the position of Fig. 36 is reached the back thread guide 189 and the sinker will have been stopped while the front thread guide continues its backward movement and the needle 25 its upward movement.

On passing from the position of Fig. 36 to position of Fig. 37, the back thread guide 189, the plate 222, and sinker remain at rest, the front thread guide comes to rest and the needle has just about reached its highest position.

As the thread guides reach the position of Fig. 37 they are racked in opposite directions, so that in passing from position Fig. 37 to position Fig. 38 the threads will be laid around the needle which on leaving position Fig. 37 starts its downward course. On leaving the position Fig. 37 both thread guides, after racking, move forwardly, carrying the threads around the needle. The sinker remains at rest. The plate 222 moves forwardly with the back thread guide and disengages the needle to reduce friction.

As the needle comes down through position Fig. 38 to position Fig. 39 it catches the front thread in its hook. By this time both thread guides and plate 222 have reached their forward limits of movement. The sinker remains at rest.

Passing from position Fig. 39 to position Fig. 40, the needle 25 continues down, catching also the back thread T' in its hook.

Passing from position Fig. 40 to position Fig. 41, the needle will have reached its lowermost position and the tongue 28 will be in engagement with the hook to close the hook; the front thread guide will have stopped and the back thread guide and plate 222 will have about reached their farthest back position. The sinker is still at rest. The thread guides are now again racked and on passing from the position of Fig. 41 back to the position of Fig. 31, sinker starts backwardly-upwardly, as also the back thread guide to draw new loops L^2 through the loops L^1, and complete the cycle of operation.

Attention is called to the fact that while the needle 25 is pulling the loops down between adjacent sinkers, see Figs. 31 and 32, the thread guides 193 and 198 lie at approximately equal distances from the axis of the needle. In this way the pull on the front thread and the pull on the back thread are equalized so that danger of bending the needle away from the tongue 28 or of drawing the needle into tight frictional contact with the guide 27 and its tongue 28 is minimized. As a further precaution against bending the needle away from the tongue while the parts are in the positions shown in Figs. 31 to 37 inclusive I have provided the needle bracing plate 222 hereinbefore referred to.

It should be understood that the individual thread guides in Figs. 31–45 are not necessarily the same ones in all these figures and for that reason the threads are shown broken, since the racking usually takes place over a first and a third needle, as to thread T, and over a first and a second needle, as to thread T', for example, see Figs. 45, 46 and 47. It will of course be understood that the number of needles by-passed in racking will depend on the pattern being knit.

Power is applied to turn continuously shaft 6 (or 110 or 111 if desired) as a first motion shaft, by any well known means not, per se, a part of my invention and hence not illustrated in the drawings.

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

What I claim is:

1. In a flat knitting machine: two knock-over sinkers spaced apart and each including a blade and a nib; a stationary needle guide located below the sinkers and having a tongue, the end of which is held in the space between the sinkers; a needle having a hook disposed to cooperate with said tongue for effecting closure of the needle; means for reciprocating said needle to pass its hook end into and out of the space between said sinkers; at least one thread guide for placing a thread on said needle; means to actuate said thread guide; and means to move said sinkers in the general longitudinal direction of the axis of the needle and back and forth in a direction generally normal to said axis.

2. In a flat knitting machine; a pair of knock-over sinkers each having a blade and a nib and being spaced apart, means for mounting said sinkers for movement in a horizontal plane and in a vertical plane; means to impart operative movement to said sinkers; a stationarily held needle guide having a tongue which projects into the space between the sinkers; a hook needle guided by said guide to cause its hook to project through between the sinkers and return into the same; means to operate said needle; at least one thread guide; means to swing said guide back and forth past said needle; means to rack said guide; and means to time the actions of all said means to effect a knitting operation.

3. In a flat knitting machine: stationary needle guides having tongues; knock-over sinkers spaced apart and into which spaces the ends of said tongues project; needles cooperatively disposed with respect to said guides and having hooks closable by said tongues when said needles are at one end of their strokes; two thread guides cooperatively disposed with respect to said needles; and means to impart motion to said needles, said sinkers and said thread guides in timed relation to effect knitting operations.

4. In a flat knitting machine: a stationary needle guide having at least one tongue; a movable sinker bar, at least one thread guide for at least two knock-over sinkers mounted on said sinker bar and spaced apart and into which space

the free end of said tongue projects; a needle bar carrying at least one needle, which needle is guided by said needle guide, said needle having a hook and being operable through the space between said sinkers conducting thread to said needle; and means for operating said needle bar, said sinker and said thread guide in timed relation to effect a knitting operation.

5. A flat knitting machine according to claim 4 wherein the thread guide operating means includes mechanism for moving the thread guide forward and backward and laterally to lay the thread about the needle.

6. A flat knitting machine according to claim 4 wherein the thread guide operating means includes an upper and a lower cam shaft, a rock shaft associated with each cam shaft, a roller carriage with rollers on each rock shaft, a cam on each cam shaft with which the rollers on the carriages, respectively, engage, an arm fixed on one of said rock shafts, an upper rock shaft, an arm on said upper rock shaft, a pin and slot connection between said arms, and means for mounting said thread guide on said upper rock shaft to rock with the same and means to rack said thread guide.

7. A flat knitting machine according to claim 4 wherein the thread guide operating means includes an upper and a lower cam shaft, a rock shaft associated with each cam shaft, a roller carriage with rollers on each rock shaft, a cam on each cam shaft with which the rollers on the carriages, respectively, engage, an arm fixed on one of said rock shafts, an upper rock shaft, an arm on said upper rock shaft, a pin and slot connection between said arms, and means for mounting said thread guide on said upper rock shaft to rock with the same and means to rack said thread guide, the aforesaid mounting and racking means including a frame on which thread guides proper are mounted, and means to move said frame along said upper rock shaft.

8. A flat knitting machine according to claim 4 wherein the thread guide operating means includes an upper and a lower cam shaft, a rock shaft associated with each cam shaft, a roller carriage with rollers on each rock shaft, a cam on each cam shaft with which the rollers on the carriages, respectively, engage, an arm fixed on one of said rock shafts, an upper rock shaft, an arm on said upper rock shaft, a pin and slot connection between said arms, and means for mounting said thread guide on said upper rock shaft to rock with the same and means to rack said thread guide, the aforesaid mounting means including a frame on which thread guides proper are mounted, and the aforesaid racking means including a pattern-wheel-operated lever connected with said frame, a pattern-wheel shaft, a pattern wheel on said shaft, and means to turn said pattern-wheel shaft.

9. A flat knitting machine according to claim 4 wherein the thread guide operating means includes an upper and a lower cam shaft, a rock shaft associated with each cam shaft, a roller carriage with rollers on each rock shaft, a cam on each cam shaft with which the roller on the carriages, respectively, engage, an arm fixed on one of said rock shafts, an upper rock shaft, an arm on said upper rock shaft, a pin and slot connection between said arms, and means for mounting said thread guide on said upper rock shaft to rock with the same and means to rack said thread guide, an arm secured to each of said associated rock shafts and an adjustable connecting rod joining said arms and causing said associated rock shafts to rock in unison.

10. A flat knitting machine according to claim 4 wherein the needle bar operating means includes an upper and a lower cam shaft, a rock shaft associated with each cam shaft, a roller carriage with rollers secured to each rock shaft, cams on each cam shaft with which the rollers on the respective carriages, respectively, engage, an arm mounted on the upper one of said associated rock shafts, another rock shaft below said upper associated rock shaft, an arm on said another rock shaft, and a needle-bar-carrying arm pivoted to said rock shaft arms and having an extended portion above the upper rock shaft, said needle bar being secured to said extended portion.

11. A flat knitting machine according to claim 4 wherein the needle bar operating means includes an upper and a lower cam shaft, a rock shaft associated with each cam shaft, a roller carriage with rollers secured to each rock shaft, cams on each cam shaft with which the rollers on the respective carriages, respectively, engage, an arm mounted on the upper one of said associated rock shafts, another rock shaft below said upper associated rock shaft, an arm on said another rock shaft, and a needle-bar-carrying arm pivoted to said rock shaft arms and having an extended portion above the upper rock shaft, said needle bar being secured to said extended portion, and a connection between said associated rock shafts by virtue of which the weight of said needle-bar-carrying arm is carried substantially by the lower cam shaft.

12. In a flat knitting machine: a stationary needle guide having at least one tongue; a movable sinker bar, a pair of spaced apart knock-over sinkers mounted on said sinker bar and providing spaces into which the free end of said tongue projects; a needle bar carrying at least one needle which needle is guided by said guide, which needle has a hook and is operable through the space between said sinkers, at least one thread guide for conducting thread to said needle; an upper and a lower cam shaft with cams on said cam shafts; means to operate said sinkers from said cam shafts; and means to operate said needle guide and said needle bar from said cam shafts.

13. A flat knitting machine according to claim 12 wherein the last named means includes a rock shaft associated with each cam shaft, a roller carriage with rollers mounted on each rock shaft with their rollers engaging the respective cams, an arm fixed on the upper one of said associated rock shafts, an upper rock shaft, an arm on said upper rock shaft, an articulated connection between said arms, a thread guide frame mounted on said upper rock shaft to rock therewith and be longitudinally movable along the same to rack the thread, a second arm on the upper one of said associated rock shafts, a needle-bar-carrying arm pivoted to said second arm to which arm said needle bar is attached, another rock shaft with an arm to which said needle-bar-carrying arm is pivoted, and means to move said thread guide frame for racking purposes.

14. A flat knitting machine according to claim 12 wherein the last named means includes a rock shaft associated with each cam shaft, a roller carriage with rollers mounted on each rock shaft with their rollers engaging the respective cams, an arm fixed on the upper one of said associated

rock shafts, an upper rock shaft, an arm on said upper rock shaft, an articulated connection between said arms, a thread guide frame mounted on said upper rock shaft to rock therewith and be longitudinally movable along the same to rack the thread, a second arm on the upper one of said associated rock shafts, a needle-bar-carrying arm pivoted to said second arm to which arm said needle bar is attached, another rock shaft with an arm to which said needle-bar-carrying arm is pivoted, and means to move said thread guide frame for racking purposes; and wherein is provided arms on said cam shafts and a connecting rod between said arms so constructed that the weight of the needle-bar-carrying arm and the arms on which it is pivoted shall be borne by the lower cam shaft and the rocking of the rock shafts for knitting shall be principally accomplished by the upper cam shaft and its cam.

15. In a flat knitting machine: a stationary needle guide having at least one tongue; a movable sinker bar, a pair of knock-over sinkers spaced apart and mounted on said sinker bar and into which space said tongue projects; a needle bar carrying at least one needle guided by said guide, which needle has a hook and is operable through the space between said sinkers; at least one thread guide for conducting thread to said needle; and means for operating said needle bar, said sinker and said thread guide in timed relation to effect a knitting operation, the sinker operating means including an upper and a lower cam shaft, a front rock shaft associated with each cam shaft, a back rock shaft associated with each cam shaft, a roller carriage with rollers mounted on each rock shaft, cams on said upper cam shaft with which the rollers of the upper carriages engage, cams on the lower cam shaft with which the rollers on the lower carriages engage, arms on the front rock shafts, a connection between said arms, arms on the back rock shafts, a connecting rod between the last named arms, another arm on the associated upper front rock shaft, another arm on the upper back rock shaft, a sinker-bar-carrying arm pivoted at its back end to said another arm on the upper back rock shaft, and a link pivoted to the front part of said sinker-bar-carrying arm and to said another arm on the front upper rock shaft.

16. A flat knitting machine according to claim 15 wherein the connection between the arms on the front rock shafts is resilient, and said connecting rod is adjustable so that the weight of said sinker-bar-carrying arm and the arms and link to which it and the link are pivoted is taken principally by the lower cam shaft.

17. In a flat knitting machine: a stationary needle guide having at least one tongue; a movable sinker bar, a pair of knock-over sinkers spaced apart and mounted on said sinker bar and into which space said tongue projects; a needle bar carrying at least one needle, which needle is guided by said guide and has a hook and is operable through said space; at least one thread guide for conducting thread to said needle; and means for operating said needle bar, said sinkers and said thread guide in timed relation to effect a knitting operation, the thread guide operating means including a rock shaft, a roller carriage on said rock shaft and having rollers, a cam shaft with cams engaged by said rollers, an arm on said rock shaft, a racking bar carrier mounted for back and forth movement on said sinker bar, a connecting rod between said arm and said racking bar carrier, a racking bar movably mounted on said racking bar carrier, a thread guide secured to said racking bar, and means to operate said racking bar for racking purposes.

18. In a flat knitting machine: a stationary needle guide having at least one tongue; a movable sinker bar, a pair of knock-over sinkers spaced apart and mounted on said sinker bar and into which space said tongue projects; a needle bar carrying at least one needle, which needle is guided by said guide and has a hook and is operable through said space; at least one thread guide for conducting thread to said needle; and means for operating said needle bar, said sinkers and said thread guide in timed relation to effect a knitting operation, the sinker operating means including an upper and a lower cam shaft, a front rock shaft associated with each cam shaft, a back rock shaft associated with each cam shaft, a roller carriage with rollers mounted on each rock shaft, cams on said upper cam shaft with which the rollers of the upper carriages engage, cams on the lower cam shaft with which the rollers on the lower carriages engage, arms on the front rock shafts, a connection between said arms, arms on the back rock shafts, a connecting rod between the last named arms, another arm on the associated upper front rock shaft, another arm on the upper back rock shaft, a sinker-bar-carrying arm pivoted at its back end to said another arm on the upper back rock shaft, and a link pivoted to the front part of said sinker-bar-carrying arm and to said another arm on the front upper rock shaft, the thread guide operating means including a rock shaft, a roller carriage on said rock shaft, cams on one of said cam shafts with which the rollers of said last named rock shaft engage, an arm on said last named rock shaft, a racking bar carrier mounted for back and forth movement on said sinker bar, a connecting rod between said last named arm and said racking bar carrier, a racking bar movably mounted on said racking bar carrier, a thread guide secured to said racking bar, and means to operate said racking bar for racking purposes.

19. In a machine of the class described: a cam shaft; cams on said shaft; a rock shaft; a roller carriage with rollers engaging said cams; an arm on said rock shaft, projecting in a direction opposite to said roller carriage; another rock shaft; an arm on said another rock shaft; a needle bar carrier pivotally mounted on both said arms; and means other than said cam shaft to counteract the effect of the weight of said needle bar carrier and both said arms on said cams.

20. In a machine of the class described: a cam shaft; cams on said shaft; a rock shaft; a roller carriage with rollers engaging said cams; an arm on said rock shaft, projecting in a direction opposite to said roller carriage; another rock shaft; an arm on said another rock shaft; a needle bar carrier pivotally mounted on both said arms; and means other than said cam shaft to counteract the effect of the weight of said needle bar carrier and both said arms on said cams, said means comprising a second cam shaft with cams thereon, a third rock shaft, a roller carriage with rollers to engage said cams and mounted on said third rock shaft, an arm on said third rock shaft extending in the same direction as said roller carriages, an arm on the first rock shaft extending in the same direction as said roller

carriages, and a connecting rod between said last named arms for transmitting the weight of said needle bar carrier to said second cam shaft.

21. In a machine of the class described: an immovably held needle guide having a tongue; a longitudinally grooved needle to receive said guide, said needle having a hook constructed to engage with said tongue when the needle is in one position to close the needle hook and means to move the needle along said guide to open and close the needle hook.

22. In a machine of the class described: an immovably held needle guide having a tongue; a longitudinally grooved needle to receive said guide, said needle having a hook, said tongue having a recess in its tip and said needle having the end of its hook designed to seat in said recess when the needle is in one position to close the needle hook and means to move the needle along said guide to open and close the needle hook.

23. In a machine of the class described: an immovably held needle guide having a tongue; a longitudinally grooved needle to receive said guide, said needle having a hook, said needle having the end of its hook designed to move past the end of the tongue in contact with the same to close the hook when the needle is in one position and means to move the needle along said guide to open and close the needle hook.

24. In a machine of the class described: an immovably held needle guide block having thereon at least one flat needle guide with a straight edge; a needle block having at least one needle thereon, said needle having a hook and having a straight portion longitudinally grooved to receive said straight edge and having the opening of its hook positioned to be closed by said needle guide when the needle is in one position relative thereto and means to move the needle along said guide to open and close the needle hook.

25. A flat knitting machine which includes: an upper cam shaft; a lower cam shaft; power transmitting connections to said shafts; a lower front rock shaft; a second front rock shaft; a third front rock shaft; a fourth front rock shaft; a fifth front rock shaft; an upper front rock shaft; a lower back rock shaft; an upper back rock shaft; an intermediate back rock shaft; end frames having bearings for all said shafts; a roller carriage on each said first, third, fourth and fifth front rock shafts; a roller carriage on each said lower, intermediate and upper back rock shafts; cams on said lower cam shaft with which the rollers of said first and third front rock shaft carriages and said lower back rock shaft carriage operatively engage; cams on said upper cam shaft with which cams the rollers of said fourth and fifth front rock shaft carriages and said intermediate and upper back rock shaft carriages operatively engage; means to cause said third and fifth front rock shafts to rock in unison; means to cause said lower and upper back rock shafts to rock in unison; an articulated connection between said fifth front rock shaft and said upper front rock shaft; a front thread guide means mounted on said upper front rock shaft to rock with the same; arms on said second and fifth front rock shafts; a needle bar carrier pivotally mounted on said arms and carrying a needle bar and a hook needle; a stationary shaft carried by said end frames; a needle-guide-and-hook closer mounted on said stationary shaft in cooperative association with said needle; arms on said fourth front rock shaft and on said upper back rock shaft; a sinker-bar-carrying arm pivoted at one end to said arm on said upper back rock shaft; a link pivoted to said arm on said fourth front rock shaft and to the other end of said sinker-bar-carrying arm; a sinker bar mounted on said sinker-bar-carrying arm a sinker secured to said sinker bar for cooperation with said thread guide, said needle and said needle guide; an arm on said intermediate back rock shaft; a back thread guide means; means for supporting said back thread guide means in cooperative position with respect to said sinker, said needle and said front thread guide means; and a connecting rod between said back thread guide means and said arm on said intermediate back rock shaft; and means to rack said thread guide means according to the desired pattern to be knit.

26. A flat knitting machine which includes: an upper cam shaft; a lower cam shaft; power transmitting connections to said shafts to cause them to turn together; a lower front rock shaft; a second front rock shaft; a third front rock shaft; a fourth front rock shaft; a fifth front rock shaft; an upper front rock shaft; a lower back rock shaft; an upper back rock shaft; an intermediate back rock shaft; end frames having bearings for all said shafts; a roller carriage on each said first, third, fourth and fifth front rock shafts; a roller carriage on each said lower, intermediate and upper back rock shafts; cams on said lower cam shaft with which cams the rollers of said first and third front rock shaft carriages and said lower back rock shaft carriage cooperatively engage; cams on said upper cam shaft with which cams the rollers of said fourth and fifth front rock shaft carriages and said intermediate and upper back rock shaft carriages operatively engage; means to cause said third and fifth front rock shafts to rock in unison; means to cause said lower and upper back rock shafts to rock in unison; an articulated connection between said fifth front rock shaft and said upper front rock shaft; a front thread guide means mounted on said upper front rock shaft to rock with the same; arms on said second and fifth front rock shafts; a needle bar carrier pivotally mounted on said arms and carrying a needle bar and a hook needle; a stationary shaft carried by said end frames; a needle guide and hook-closer mounted on said stationary shaft in cooperative association with said needle; arms on said fourth front rock shaft and on said upper back rock shaft; a sinker-bar-carrying arm pivoted at one end to said arm on said upper back rock shaft; a link pivoted to said arm on said fourth front rock shaft and to the other end of said sinker-bar-carrying arm; a sinker bar mounted on said sinker-bar-carrying arm and having a sinker secured to said sinker bar for cooperating with said thread guide, said needle and said needle guide; an arm on said intermediate back rock shaft; a back thread guide means; means for supporting said back thread guide means in cooperative position with respect to said sinker, said needle and said front thread guide means; a connecting rod between said back thread guide means and said arm on said intermediate rock shaft; brackets mounted on one end frame; an upper shaft mounted in said brackets; a pattern wheel shaft mounted in said brackets and having pattern wheels; a driving connection between one of said cam shafts and said pattern wheel shaft; a lower shaft mounted in said brackets; cams on said lower shaft; a front thread-guide racking lever and a

back thread-guide racking lever mounted on said last named upper shaft, each of said thread-guide racking levers having pattern wheel engaging rollers to engage the respective pattern wheels on said pattern wheel shaft and having spring pressed rollers to engage the respective cams on said lower shaft; and push-pull connections between said racking levers and the respective thread guide means.

27. A knitting machine which includes: a pair of movable knock-over sinkers spaced apart; an immovably held needle-guide located below the sinkers and having a needle-hook-closing portion projecting into the space between said sinkers; a needle having a hook and being mounted below the sinkers, guided by said needle guide and operable through the space between the sinkers; at least one thread guide mounted above the sinkers; and means for operating the aforesaid parts to effect knitting operations.

28. A knitting machine which includes: a pair of movable knock-over sinkers spaced apart; an immovably held needle-guide located below the sinkers and having a needle-hook-closing portion projecting into the space between said sinkers; a needle having a hook and being mounted below the sinkers, guided by said needle guide and operable through the space between the sinkers; at least one thread guide mounted above the sinkers; means for raising and lowering said sinkers along said needle and needle guide; means for moving said sinkers longitudinally back and forth; means to operate said needle and said thread guide in cooperation with said sinkers raising and lowering and longitudinally moving means to effect knitting operations.

29. A knitting machine which includes: a pair of movable knock-over sinkers spaced apart; an immovably held needle-guide located below the sinkers and having a needle-hook-closing portion projecting into the space between said sinkers; a needle having a hook and being mounted below the sinkers, guided by said needle guide and operable through the space between the sinkers, said needle having a thread-receiving open slot closable by said needle guide when the needle is in one position; at least one thread guide mounted above the sinkers; and means for operating the aforesaid parts to effect knitting operations.

30. A knitting machine which includes; a pair of movable knock-over sinkers spaced apart; an immovably held needle-guide located below the sinkers and having a needle-hook-closing portion projecting into the space between said sinkers; a needle having a hook and being mounted below the sinkers, guided by said needle guide and operable through the space between the sinkers, said needle having a thread-receiving open slot closable by said needle guide when the needle is in one position; at least one thread guide mounted above the sinkers; means for raising and lowering said sinkers along said needle and guide; means for moving said sinkers longitudinally back and forth; means to operate said needle and said thread guide in cooperation with said sinker raising and lowering and longitudinally moving means to effect knitting operations.

31. A knitting machine which includes: a pair of movable knock-over sinkers spaced apart; an immovably held needle-guide located below the sinkers and having a needle-hook-closing portion projecting into the space between said sinkers; a needle having a hook and being mounted below the sinkers, guided by said needle guide and operable through the space between the sinkers, said needle having a thread-receiving open slot closable by said needle guide when the needle is in one position; at least one thread guide mounted above the sinker; means for raising and lowering and longitudinally moving back and forth said knock-over sinker; means for moving said thread guide back and forth parallel to said sinker; means to rack said thread guide; means to co-relate the operations of said thread guide, said sinker and said needle to effect knitting operations.

32. A knitting machine including: a bank of movable knock-over sinkers having blades and nibs, the sinkers being spaced apart; a bank of fixedly mounted needle guides located below the sinkers and having the tip portions of each guide projecting into a space between the sinkers; a bank of movable needles having hooks and being located below the sinkers and projecting upwardly through the spaces between said sinkers and being guided by said guides, said guides serving to close the needles when the hooks are within the sinkers; a bank of thread guides swingably and rackably mounted above the sinkers; and means to operate the aforesaid parts in timed relation to effect knitting operations.

33. A knitting machine which includes: a bank of knock-over sinkers movable bodily up and down and forward and backward and having spaces between adjacent sinkers; a bank of needle guides mounted below the sinkers and having tip portions projecting into said spaces; a bank of hook needles mounted below the sinkers and projecting upwardly through said spaces, said needles being guided by said needle guides, and said projecting portions of the needle guides serving to close the needle hooks while the needles are positioned with their hooks within said spaces; a bank of front thread guides mounted above the sinkers; a bank of back thread guides mounted above the sinkers; and means for operating said sinkers, said needles and said thread guides in timed relation to effect knitting operations.

34. A knitting machine which includes: a bank of knock-over sinkers movable bodily up and down and forward and backward and having spaces between adjacent sinkers; a bank of needle guides mounted below the sinkers and having tip portions projecting into said spaces; a bank of hook needles mounted below the sinkers and projecting upwardly through said spaces, said needles being guided by said needle guides and said projecting portions of the needle guides serving to close the needle hooks while the hooks are within the sinkers; a bank of front thread guides mounted above the sinkers; a bank of back thread guides mounted above the sinkers; means for operating the sinkers; means for operating the needles; means for swinging back and forth said front thread guides past said needles; means for reciprocating said back thread guides back and forth past said needles; means for racking said thread guides; and means co-ordinating the operations of said swinging and said reciprocating means and said sinker operating means and said needle operating means to effect knitting operations.

35. In a knitting machine wherein a knock-over sinker, a back thread guide and a front thread guide are employed; a needle operating along an axis between the positions of said thread guides; and means for moving said guides forwardly and backwardly to lay the threads about

the needle, said means being so timed that while the needle is pulling the threads down by the sinker the forward pull on the needle by the thread from the front thread guide will be approximately equalized by the rearward pull on the needle by the thread from the rear thread guide.

36. In a knitting machine wherein is provided a knock-over sinker, a front thread guide, a back thread guide, and a needle operating between said guides; the improvement which consists in so timing the movements of the thread guides that the needle, while pulling the threads by the sinker, will pull straight down and the pull on the front thread will be substantially equalized by the pull on the back thread.

37. In a knitting machine: a stationary tongue; a pair of forwardly and backwardly movable knock-over sinkers between which said tongue projects; a needle having a hook and a tongue-receiving longitudinal groove; a front thread guide; a back thread guide; and means to operate the aforesaid parts to effect knitting operations, the operations being timed so that while the needle is pulling the threads between the sinkers the pull exerted on the front thread will be approximately equalized by the pull on the back thread thereby preventing bending of the needle forwardly or backwardly.

38. In a knitting machine: the combination with a stationarily held tongue, a hooked needle movable along said tongue and grooved to receive said tongue, and means to reciprocate said needle along said tongue; of a needle brace, and means to apply said brace to the needle at predetermined times.

39. In a knitting machine: the combination with a stationarily held tongue, a hooked needle movable along said tongue and grooved to receive said tongue, and means to reciprocate said needle along said tongue; of a needle brace, and means to apply said brace to said needle during the time the needle is pulling loops through previously formed loops.

40. In a knitting machine: the combination with a stationarily held tongue, a hooked needle movable along said tongue and grooved to receive said tongue, and means to reciprocate said needle along said tongue; of a needle brace, and means to apply said brace to said needle during the time the needle is pulling loops through previously formed loops and while the loops are knocking over.

41. In a flat knitting machine: knock-over sinkers spaced apart; a stationarily mounted needle guide having a tongue extending into the space between adjacent sinkers; a needle having a hook disposed to cooperate with said tongue for effecting closure of the needle; means for reciprocating said needle to pass its hook end into and out of the said space; at least one thread guide for placing a thread on said needle; means to actuate said thread guide; a needle brace; means to apply said brace to the needle at the side opposite said needle guide; and means to move said sinkers in the general direction of the axis of said needle and back and forth in a direction generally normal to said axis.

42. In a flat knitting machine: stationary needle guides having tongues; knock-over sinkers between which said tongues project; needles cooperatively disposed with respect to said guides and having hooks closable by said tongues when said needles are at one end of their strokes; a needle brace engaging the needles on the side opposite the needle guide and adjacent the tongue thereof; at least one thread guide cooperatively disposed with respect to said needles; and means to impart motion to said needles, said sinkers and said thread guides in timed relation to effect knitting operations.

43. In a flat knitting machine: stationary needle guides having tongues; knock-over sinkers; needles cooperatively disposed with respect to said guides and having hooks closable by said tongues when said needles are at one end of their strokes; a needle brace engaging the needles on the side opposite said needle guide; at least one thread guide cooperatively disposed with respect to said needles; and means to impart motion to said needles, said sinkers, said needle brace and said thread guide in timed relation to effect knitting operations.

44. In a knitting machine: a stationary needle guide having a tongue; a movable sinker bar with knock-over sinkers between which sinker said tongue projects; a needle bar carrying a needle guided by said guide, which needle has a hook and is operable between said sinkers; a needle brace for engaging said needle on its side opposite that adjacent said needle guide; at least one thread guide for conducting thread to said needle; means for operating said needle bar, said sinkers and said thread guide in timed relation to effect a knitting operation, the thread guide operating means including mechanism for moving the thread guide forward and backward and laterally to lay the thread about the needle; and means including a part of said thread guide operating mechanism for operating said needle brace.

45. In a flat knitting machine: a stationary needle guide having a tongue; a needle reciprocatable along said guide; a needle brace; and means to apply said needle brace to said needle at predetermined times.

46. In a flat knitting machine: a stationary needle guide having a tongue; a needle reciprocatable along said guide; a needle brace; and means to apply said needle brace to said needle at predetermined times, said means including a cam shaft having a leader cam and a follower cam, a rock shaft, a roller carriage on said rock shaft having rollers to engage said cams, an arm on said rock shaft, a needle brace mounting means, and a connecting rod between said arm and said needle brace mounting means.

47. In a machine of the class described: a stationary needle guide having a tongue; a longitudinally grooved needle to receive said guide, said needle having a hook constructed to engage said tongue when the needle is in one position to close the needle hook; and a needle brace to engage said needle on the side thereof opposite that having the groove and hold the needle against bending away from said guide while under tension.

48. In a machine of the class described: a stationary needle guide having a tongue; a longitudinally grooved needle to receive said guide, said needle having a hook constructed to engage said tongue when the needle is in one position to close the needle hook; a needle brace to engage said needle on the side thereof opposite that having the groove and hold the needle against bending away from said guide while under tension; and means for applying said brace to and releasing it from the needle at predetermined times.

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