March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 1.

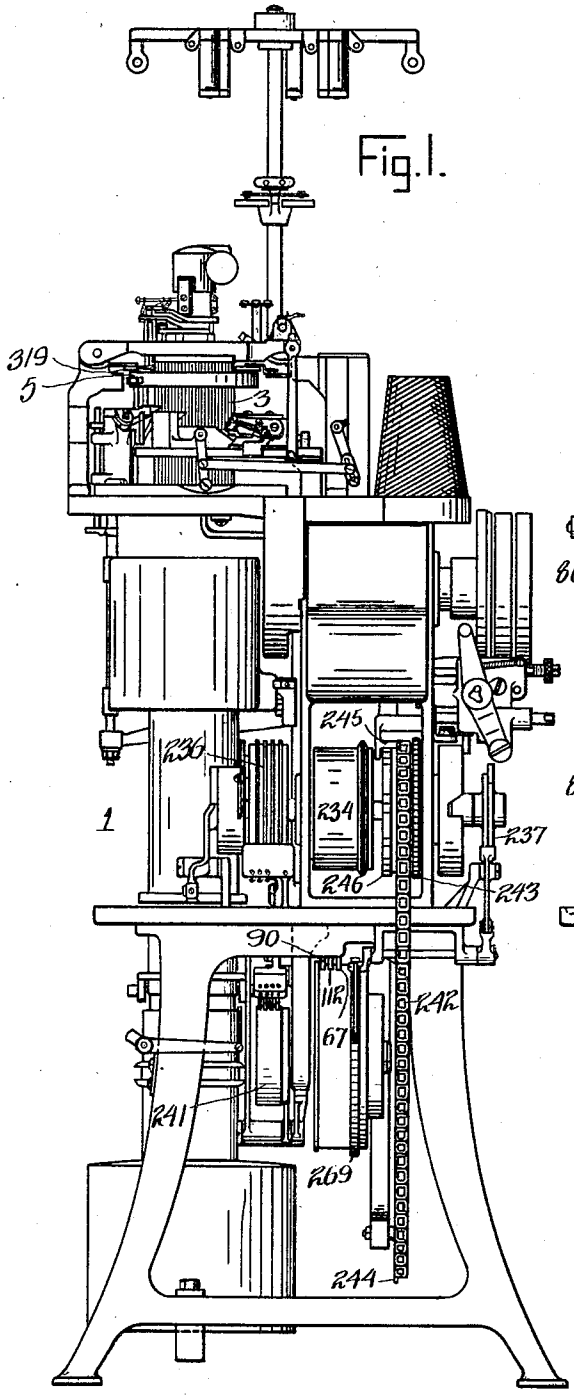
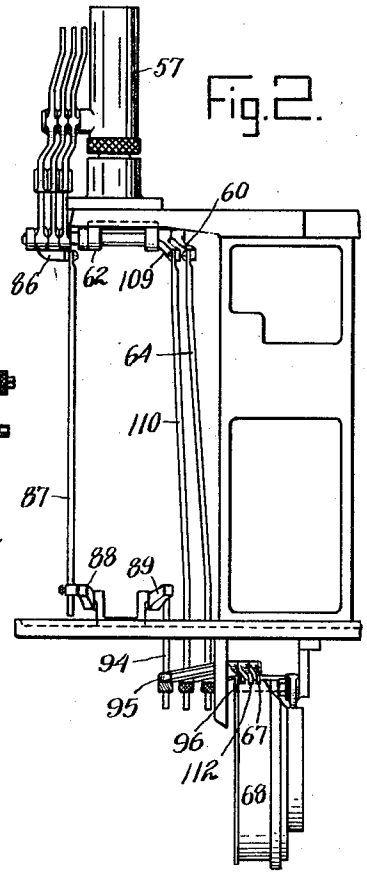


Fig. 2.



Inventors
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Robert H. Lawson

By

Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 3.

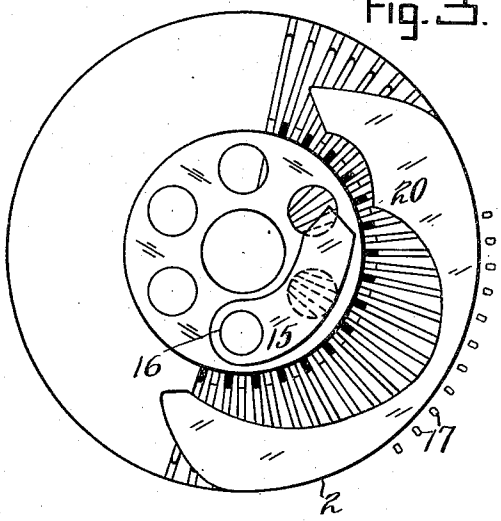


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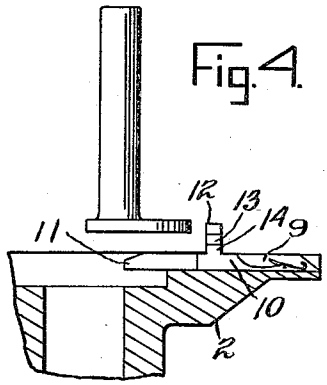


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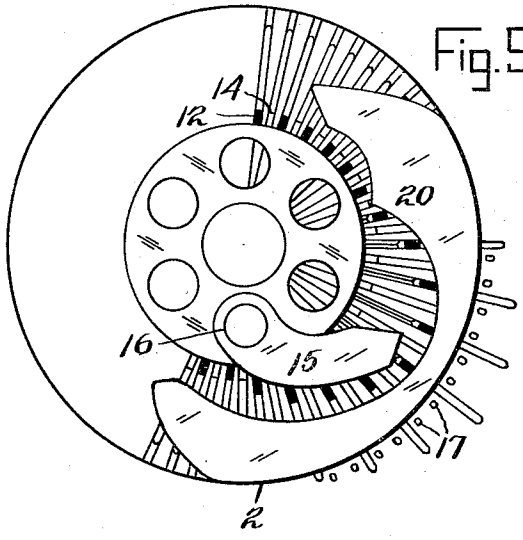
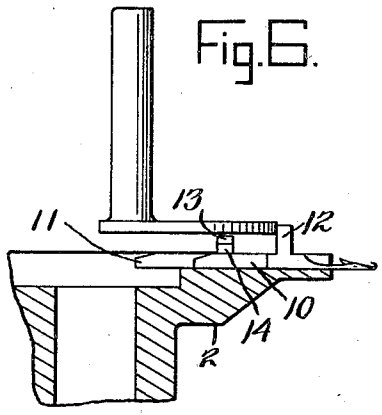


Fig. 6.



Inventors
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Attorneys

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 7

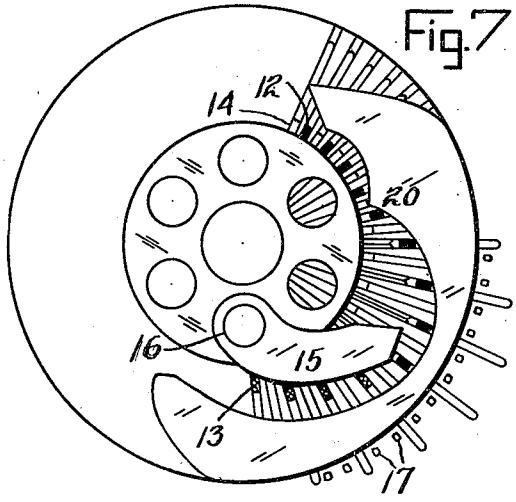


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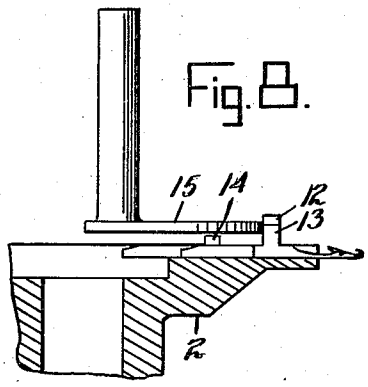


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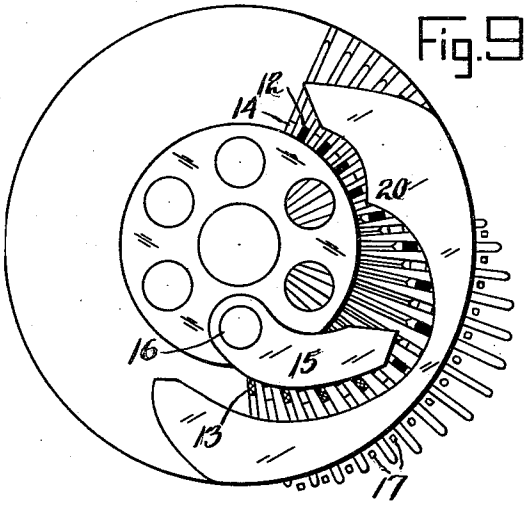
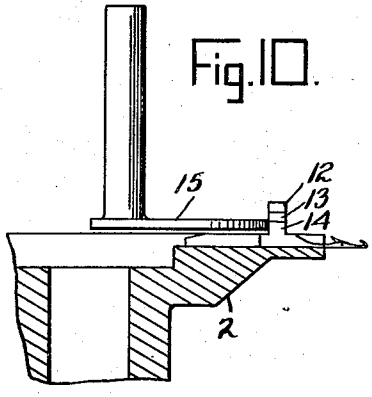


Fig. 10.



Inventors
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March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

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Fig. 11.

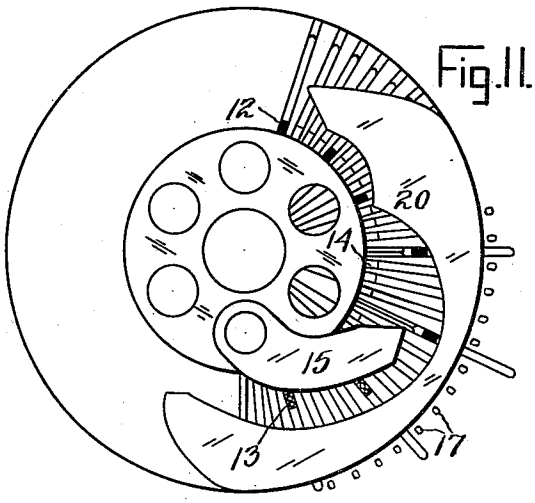


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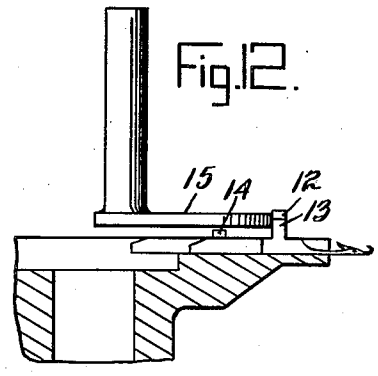


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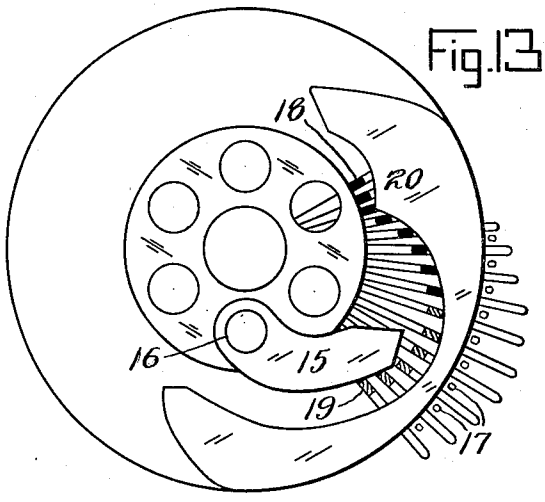
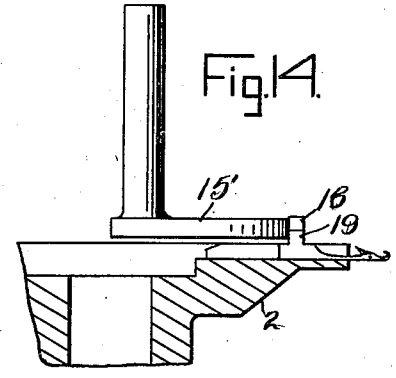


Fig. 14.



Inventors
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March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 15.

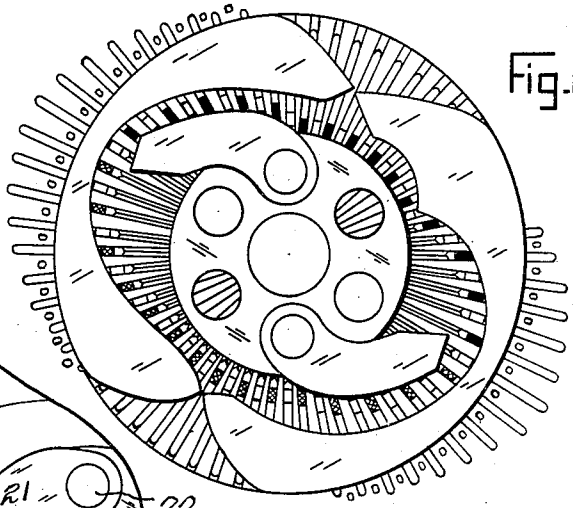


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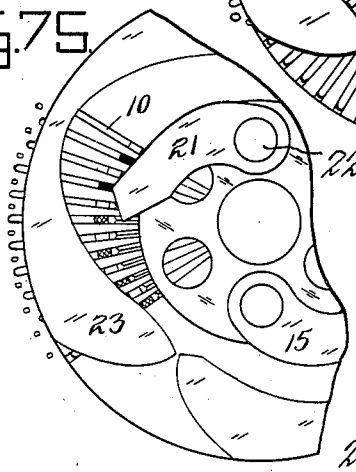


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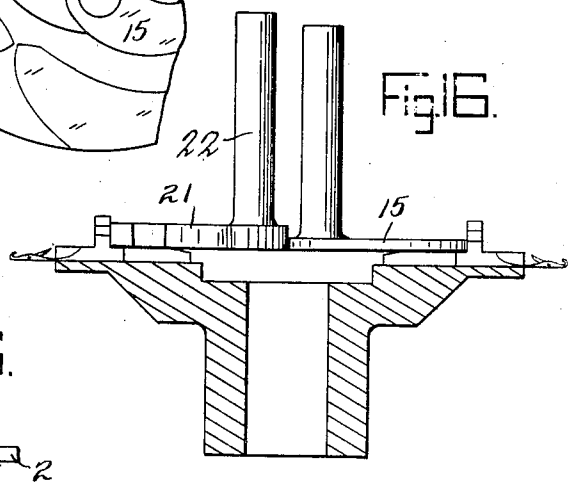
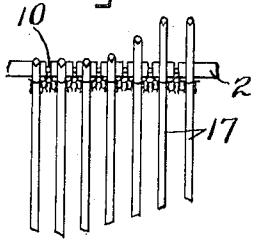


Fig. 76.



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March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

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—RIB INSTEP NEEDLES— —PLAIN SOLE NEEDLES—

Fig. 17.

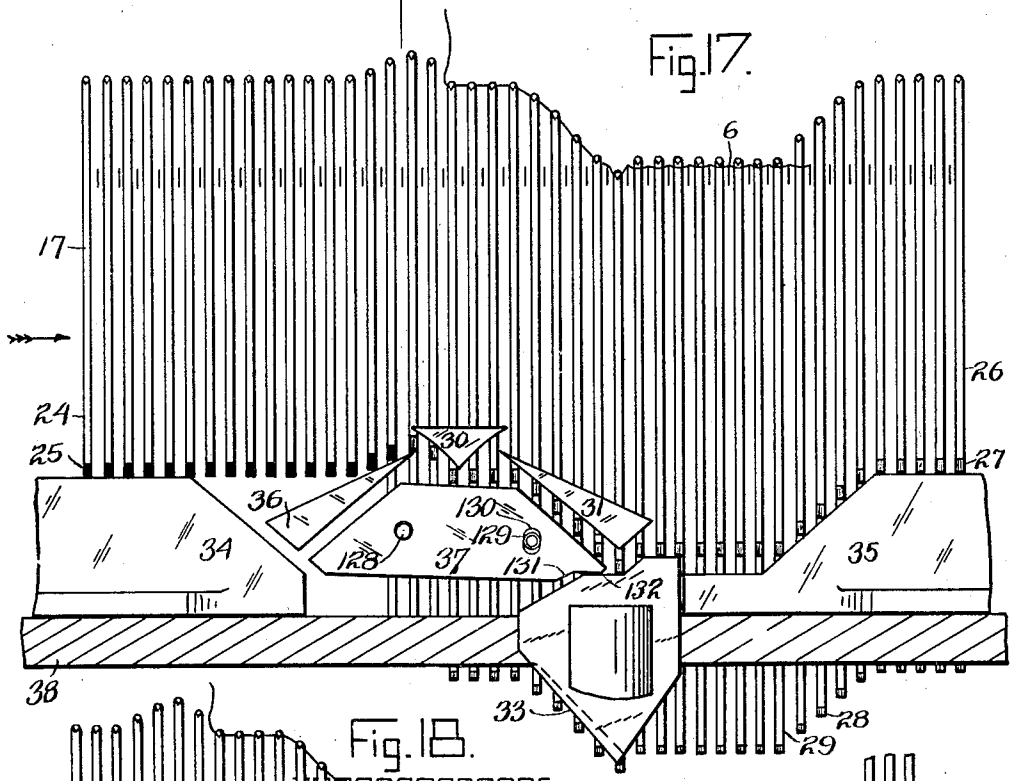


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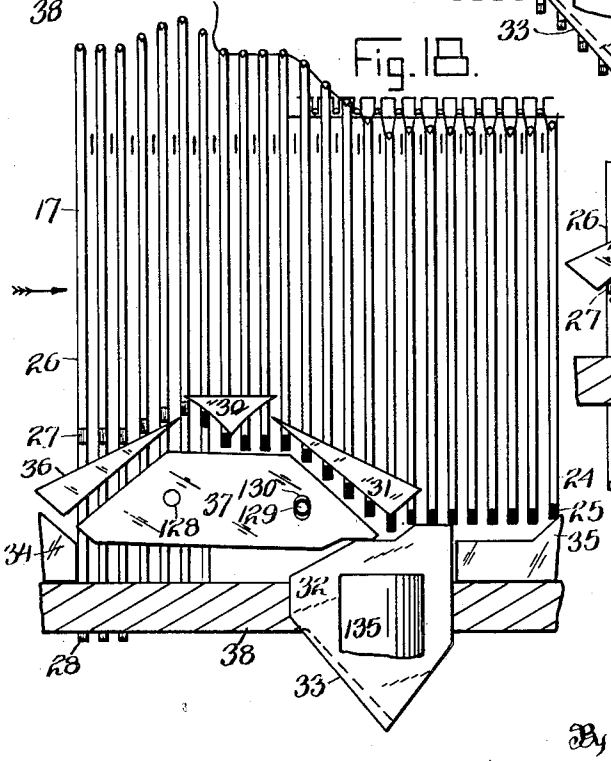
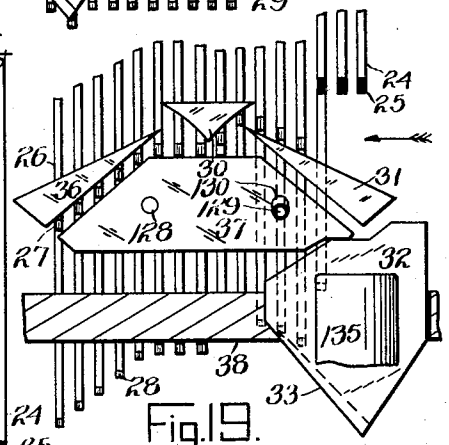


Fig. 19.



Inventors
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Robert H. Lawson

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March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

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Fig. 20.

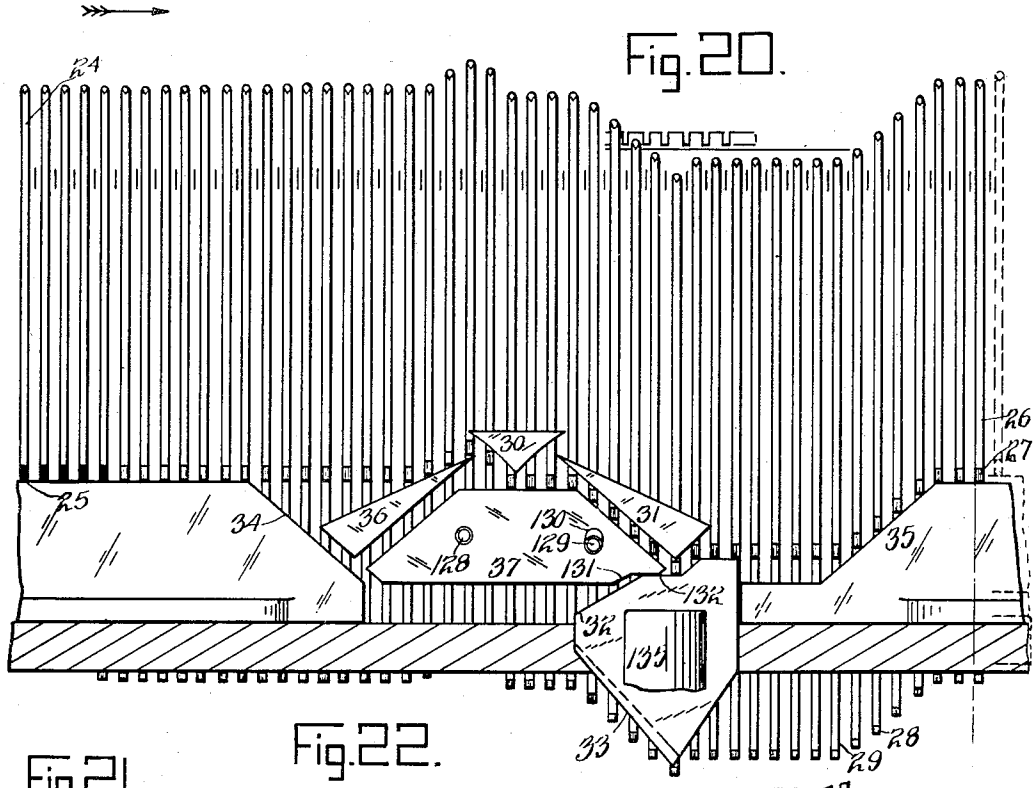


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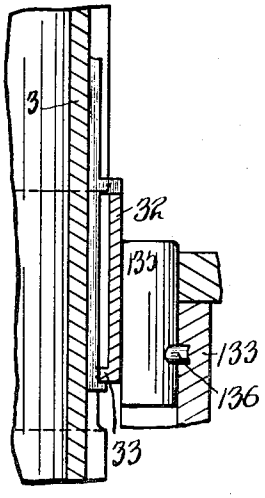


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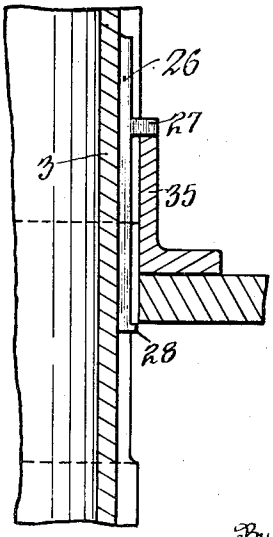
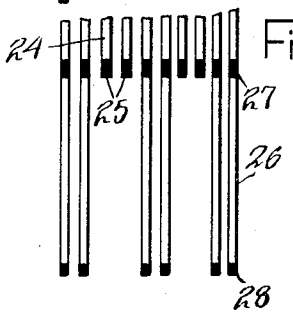


Fig. 23.



Inventors
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Attorney.

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

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Fig. 54

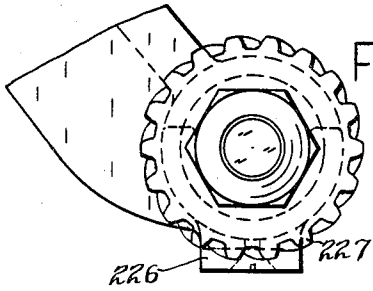


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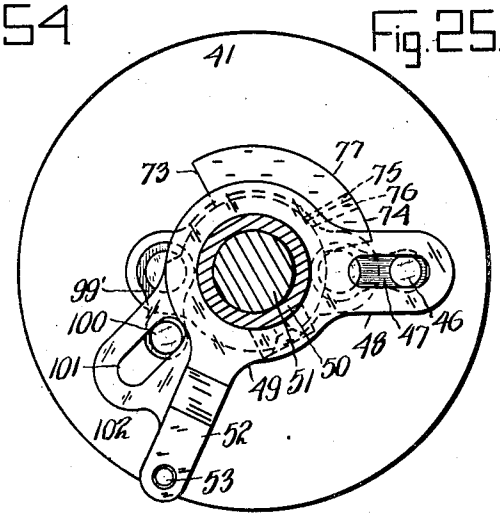


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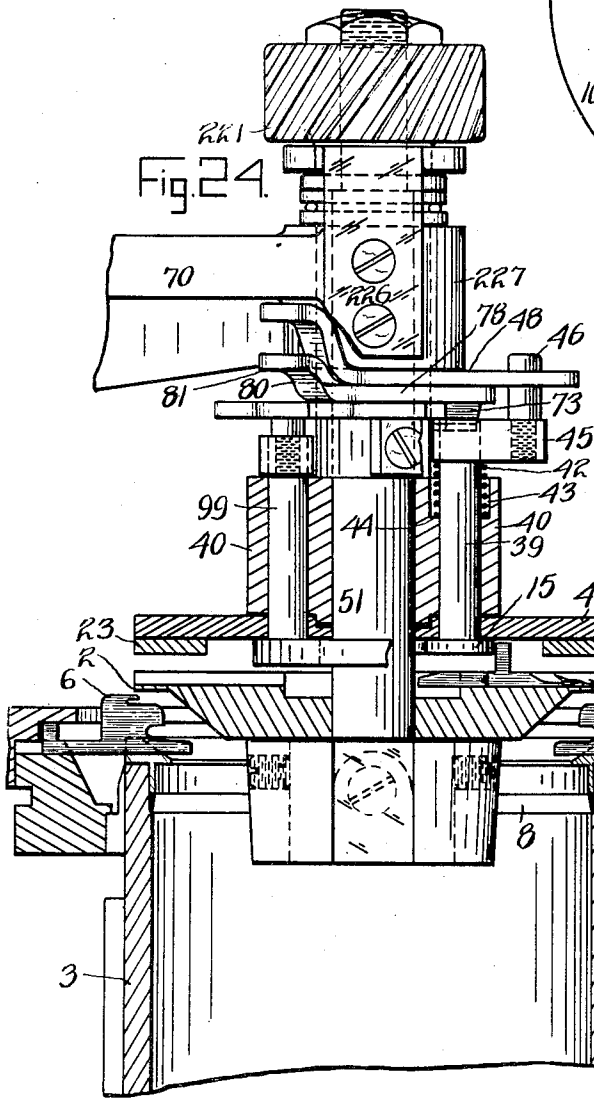
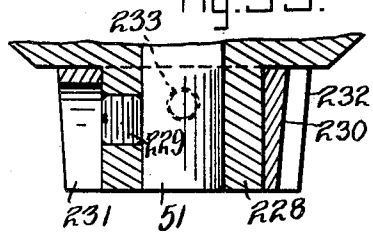


Fig. 55.



Inventors
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and Robert H. Lawson

By Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 26.

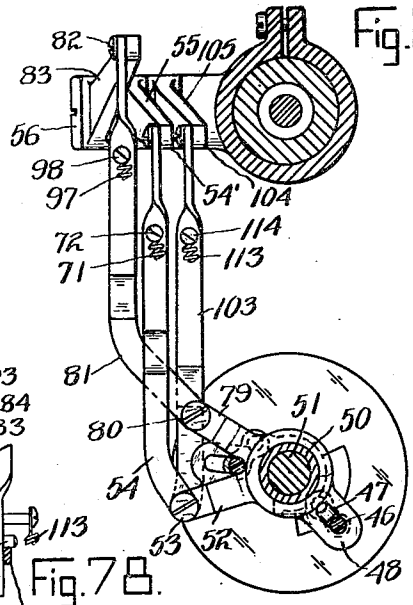


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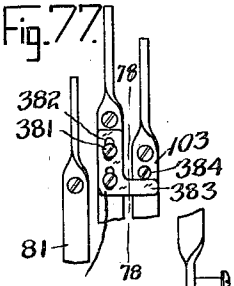


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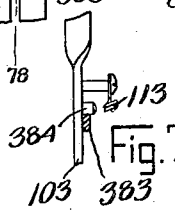


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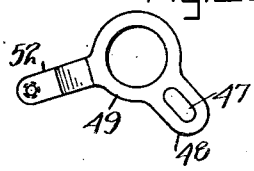


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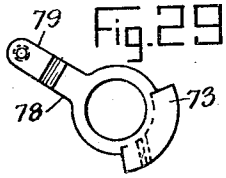




Fig. 30.

Fig. 27.

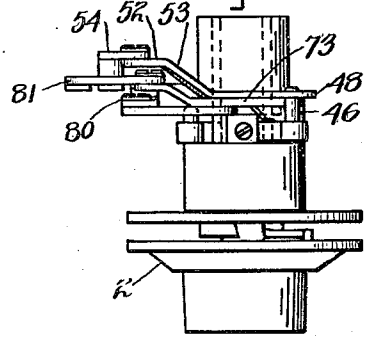
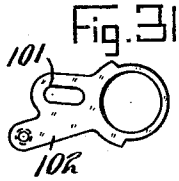


Fig. 31.



Inventors
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Robert H. Lawson

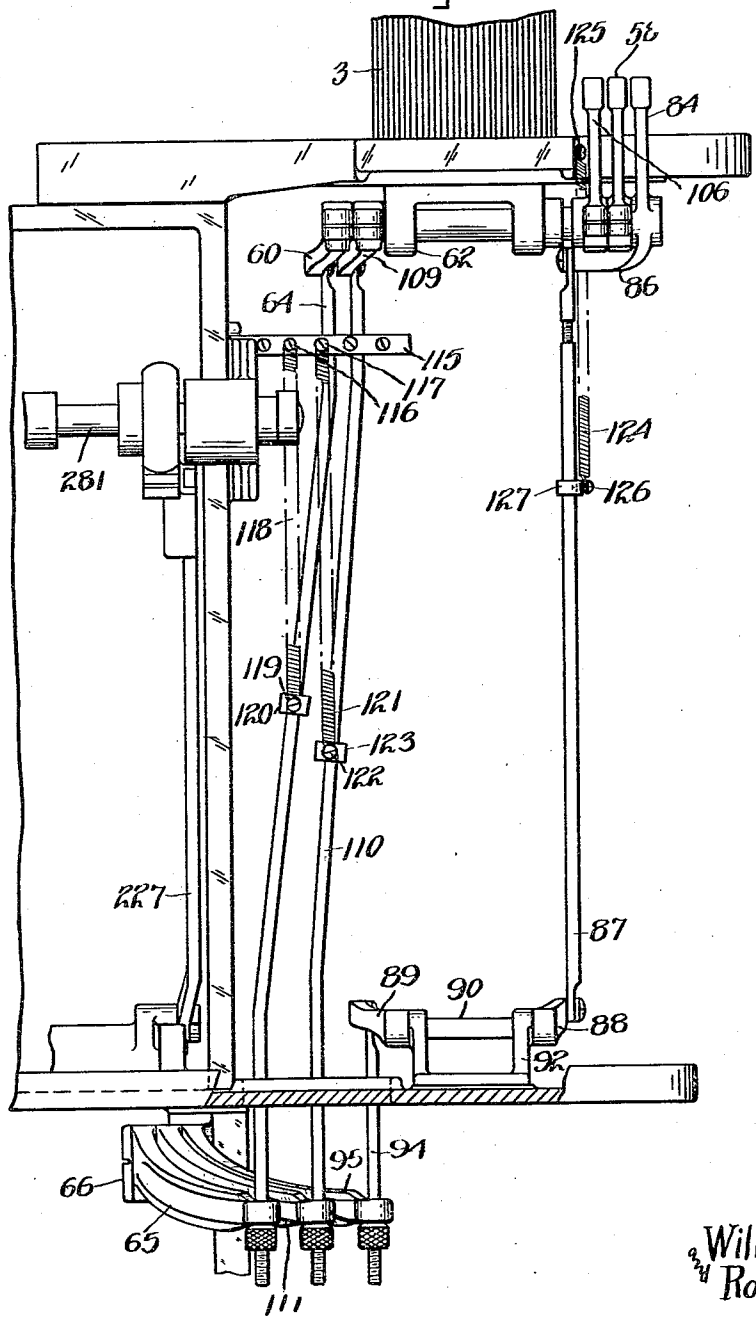
By E. Y. Bradford Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 32.



Inventors
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Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 33

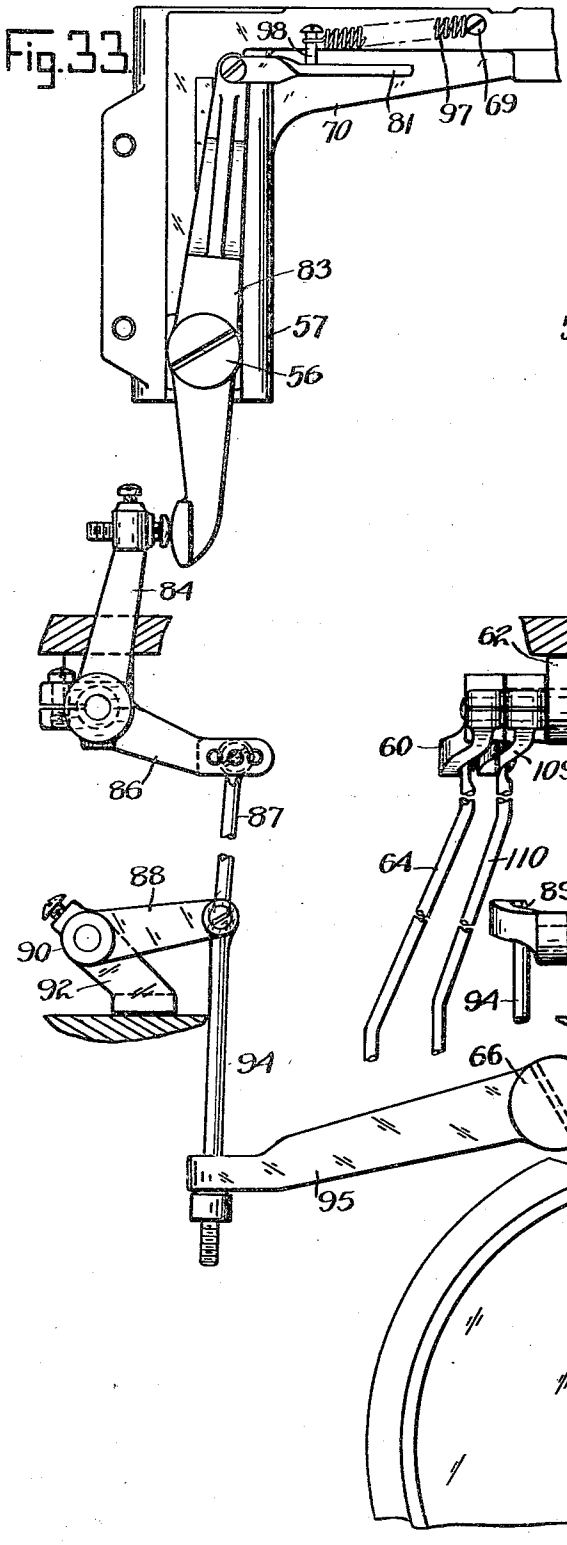
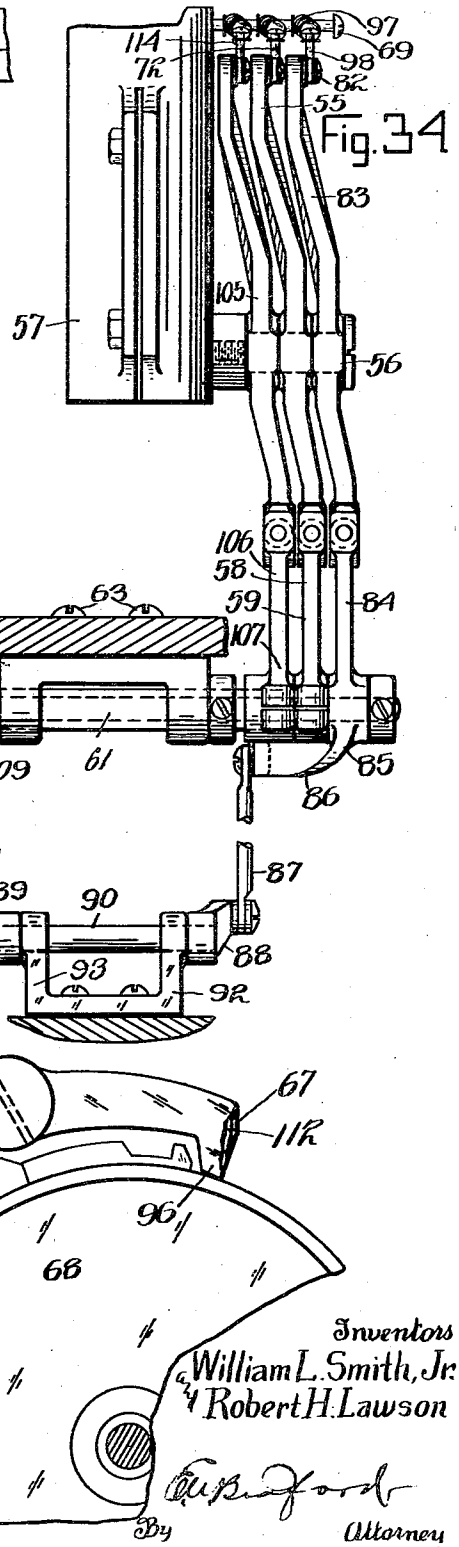


Fig. 34



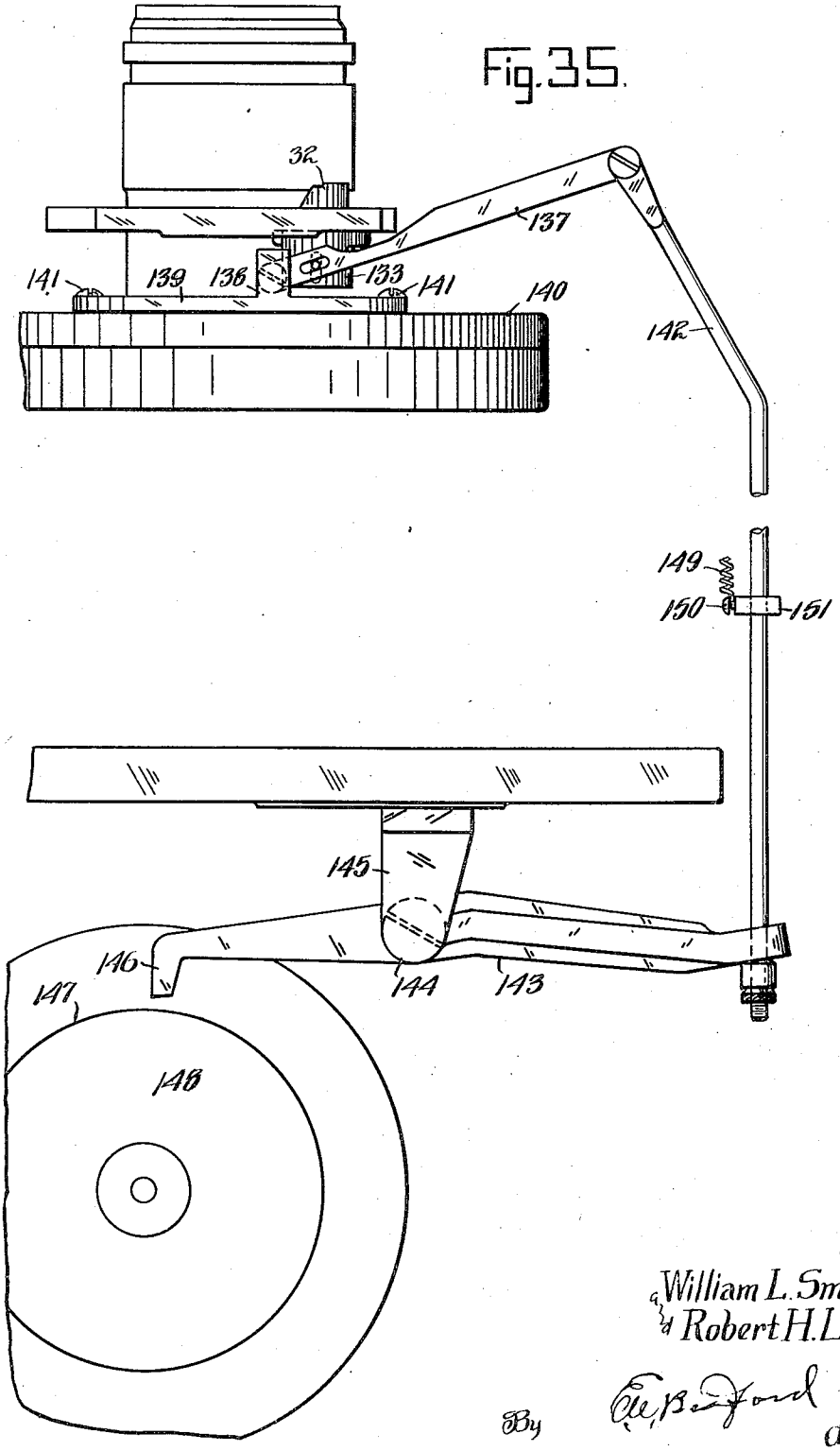
Inventors
William L. Smith, Jr.
Robert H. Lawson
By
Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 35.



Inventors
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Robert H. Lawson

By Ellsworth Bedford
Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

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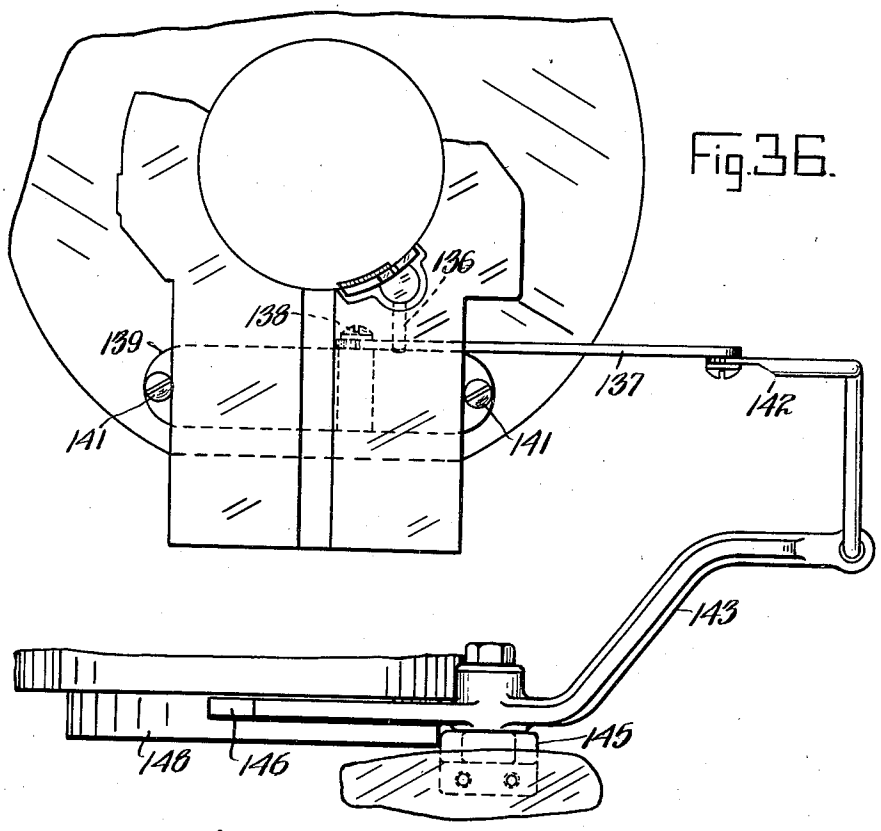


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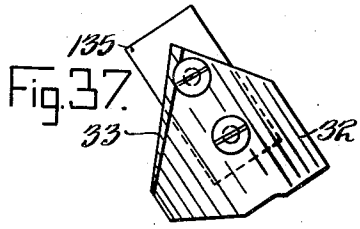


Fig. 37.

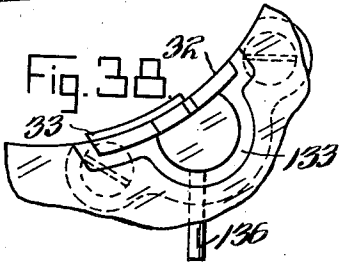


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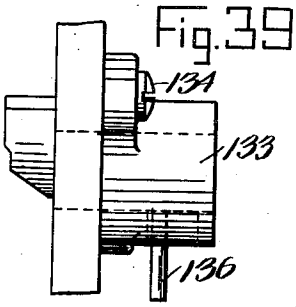


Fig. 39.

Inventors
William L. Smith, Jr.
Robert H. Lawson

By E. W. B. Ford
Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

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Fig. 40.

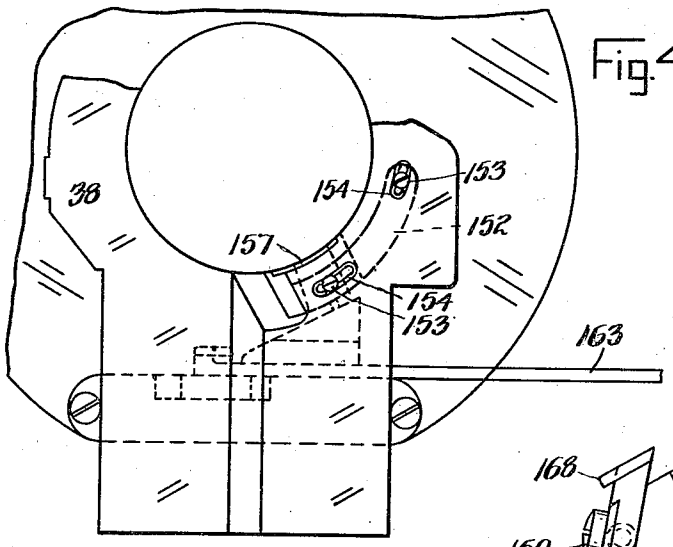


Fig. 43.

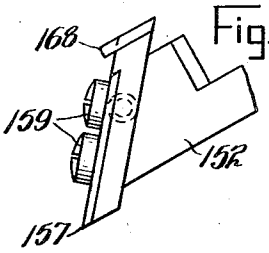


Fig. 41.

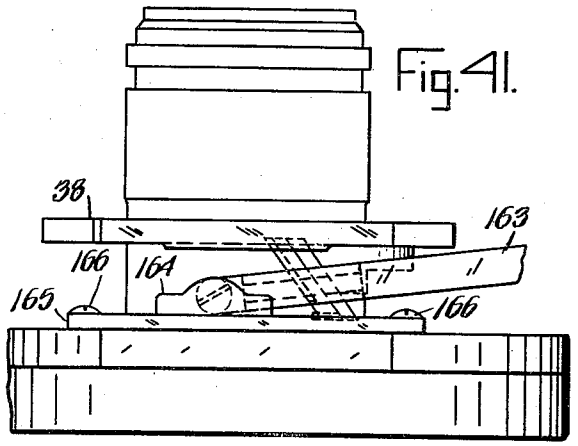


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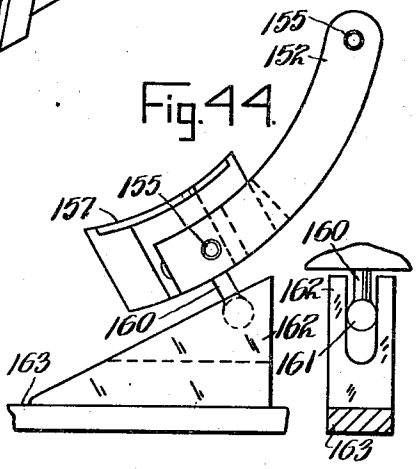
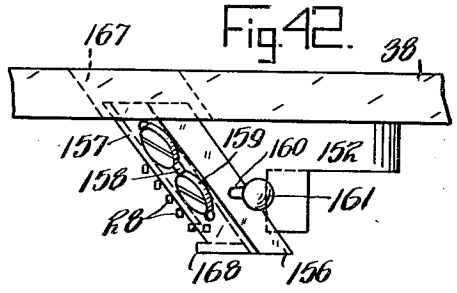


Fig. 45.

Fig. 42.



Inventors
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Robert H. Lawson

By

Attorney

March 23, 1937. W. L. SMITH, JR., ET AL 2,074,973

KNITTING MACHINE

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Fig. 48.

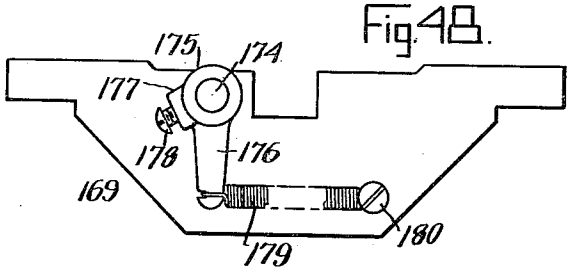


Fig. 46.

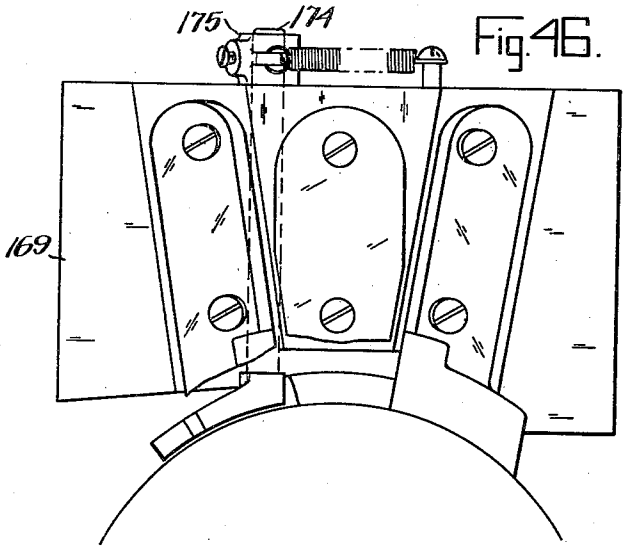


Fig. 49.

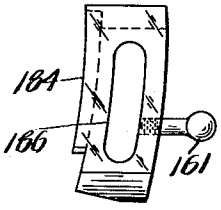


Fig. 50.

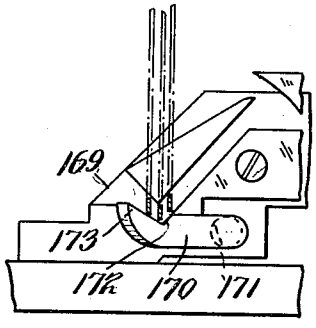
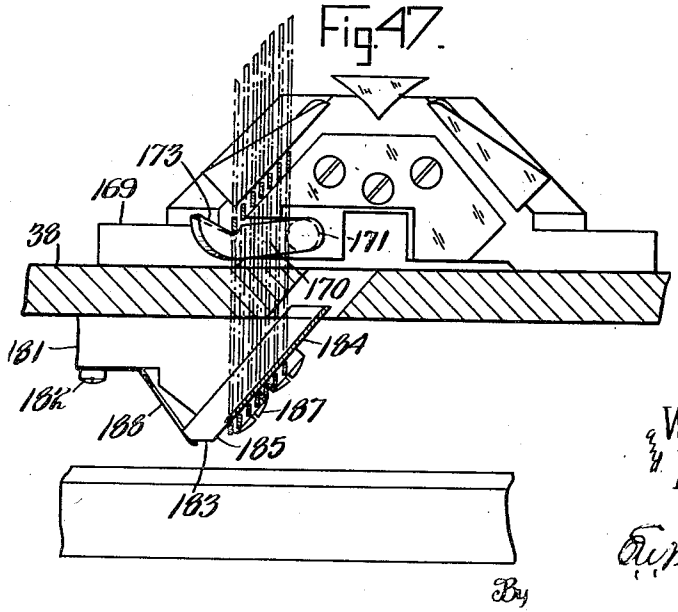


Fig. 47.



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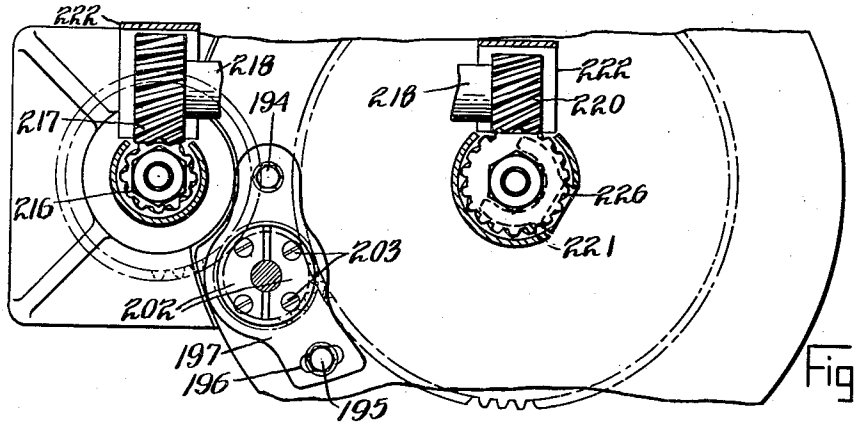


Fig. 52.

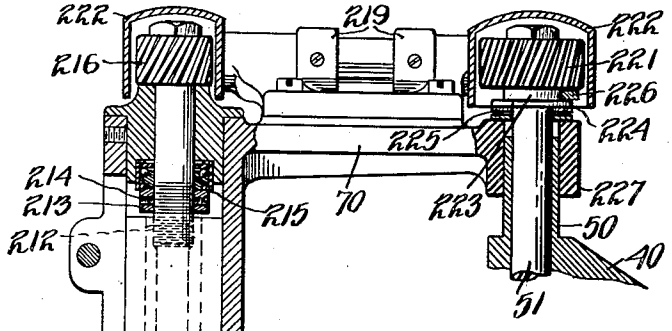


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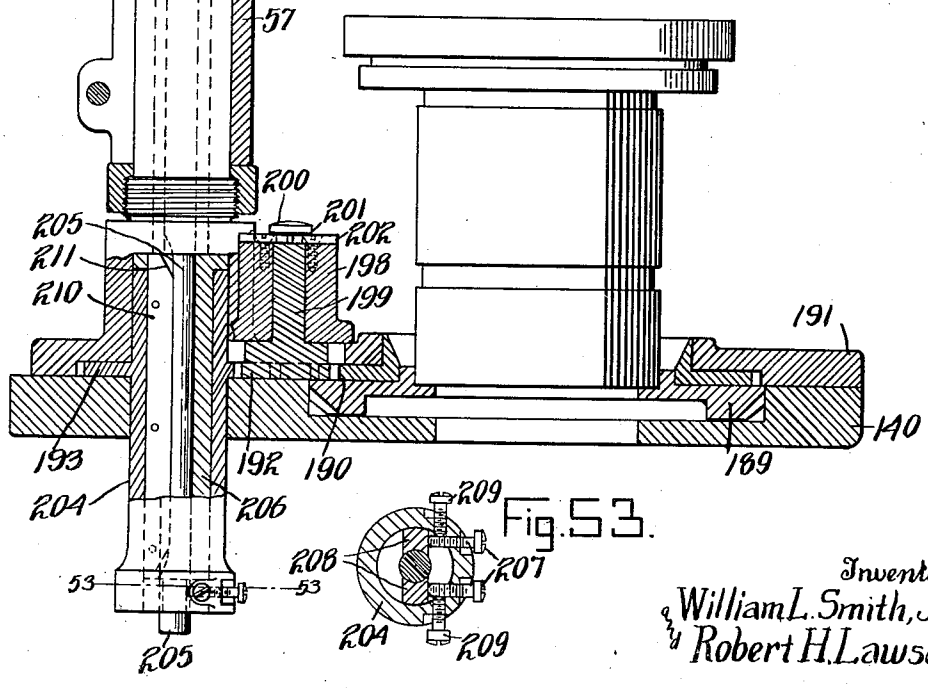


Fig. 53.

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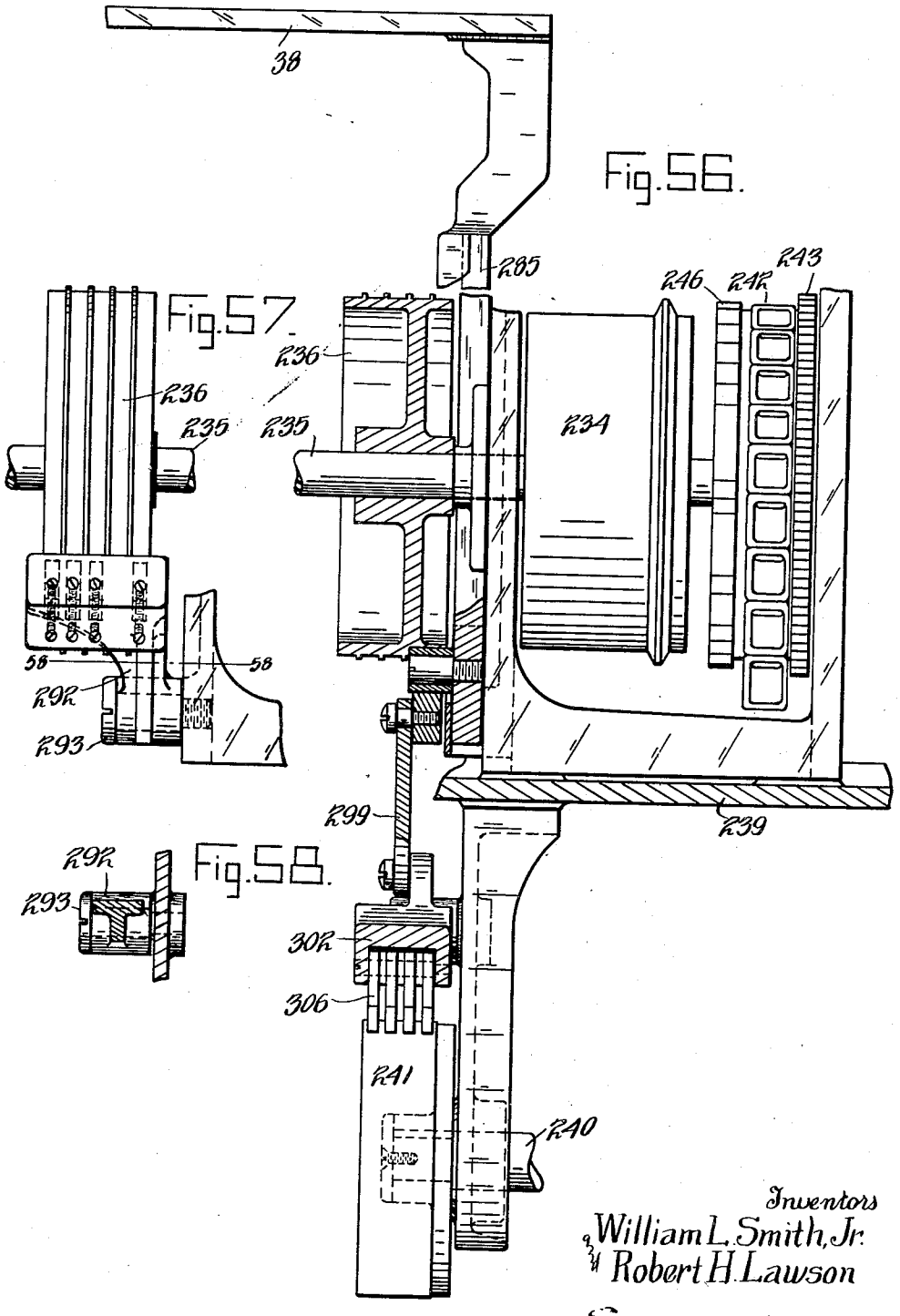


Fig. 56.

Fig. 57.

Fig. 58.

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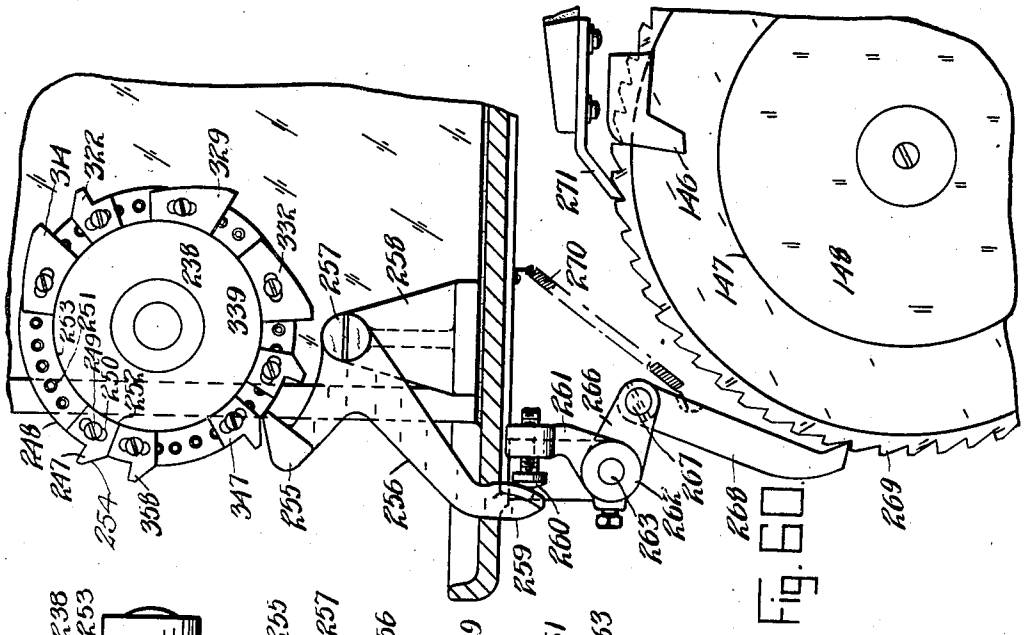


Fig. 60

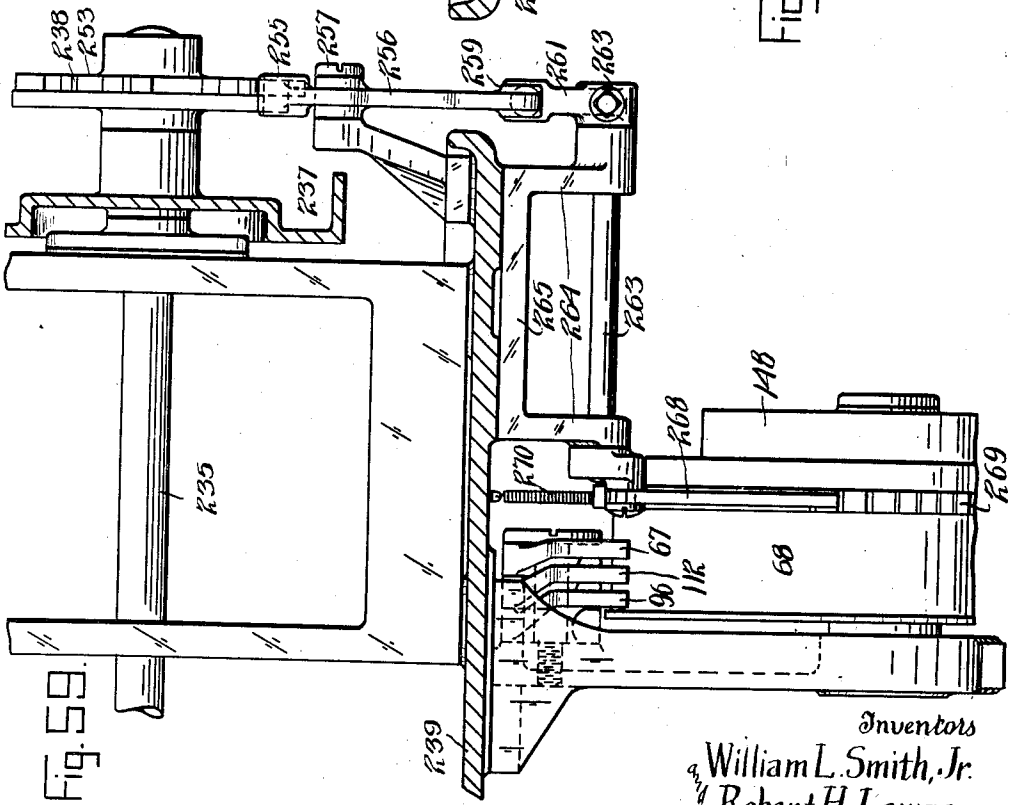


Fig. 59

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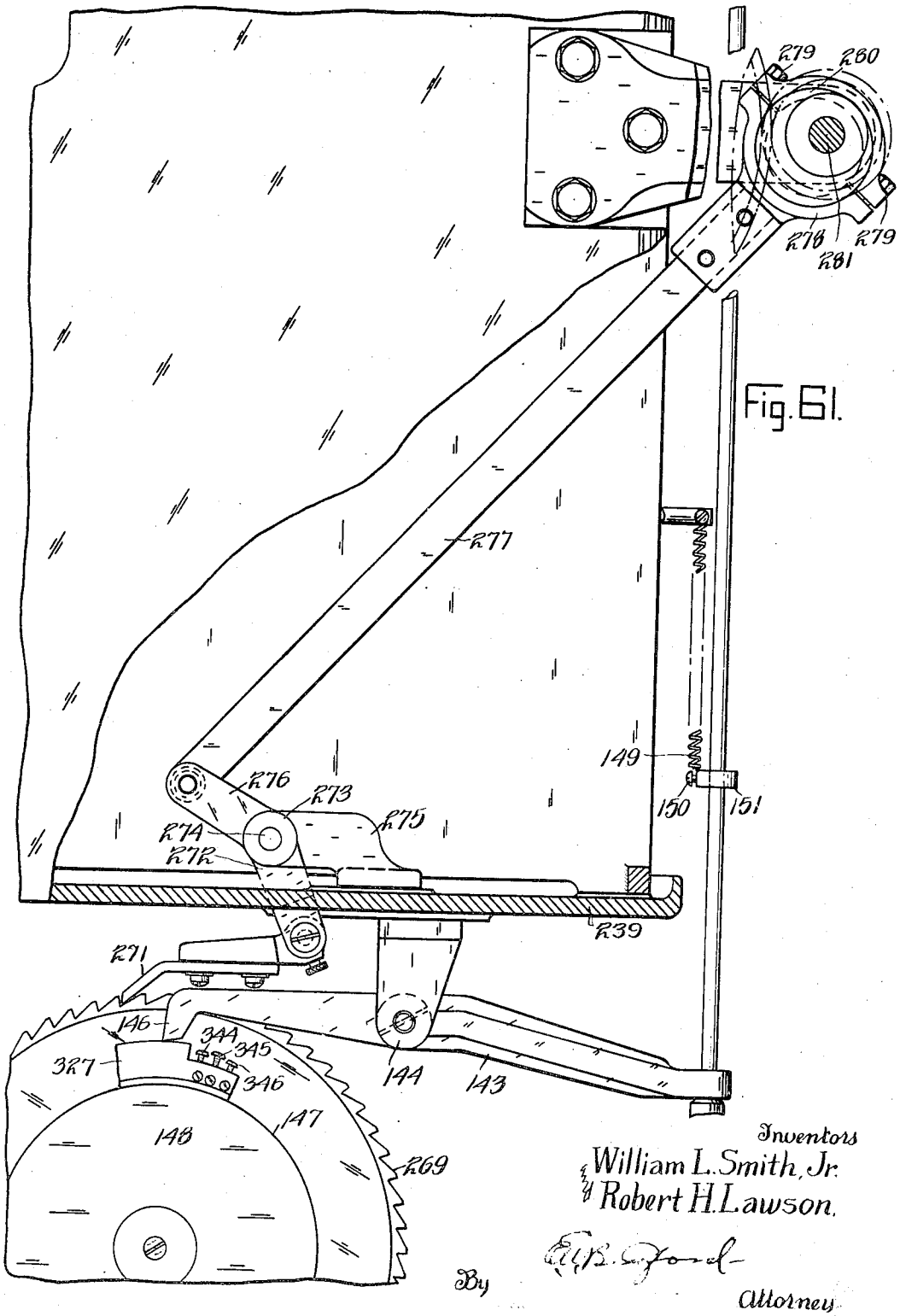


Fig. 61.

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Fig. 62.

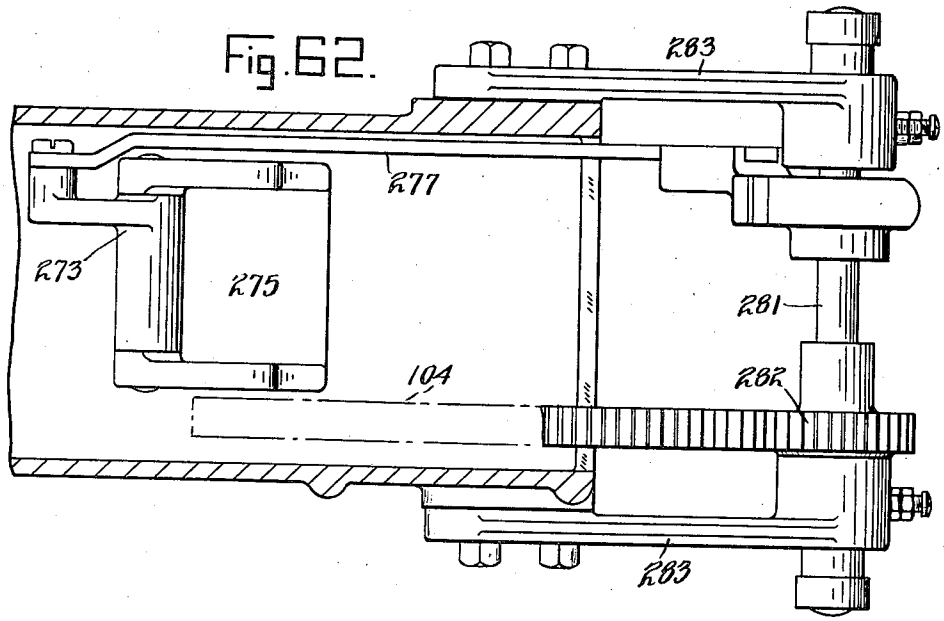


Fig. 63.

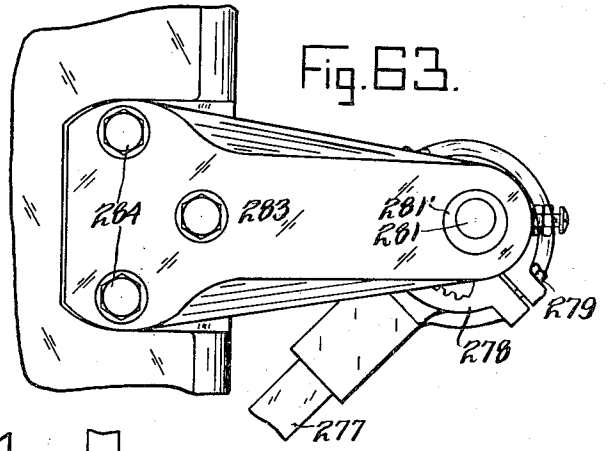
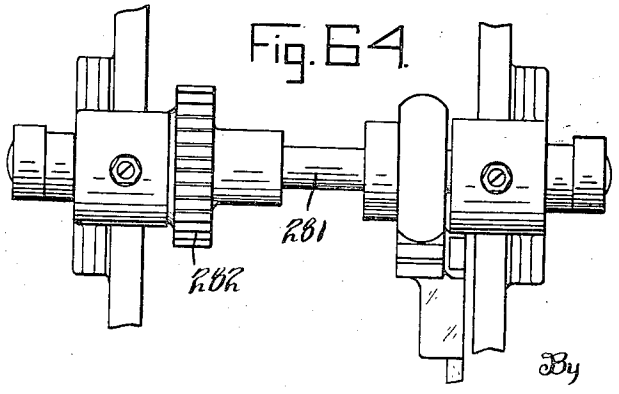


Fig. 64.



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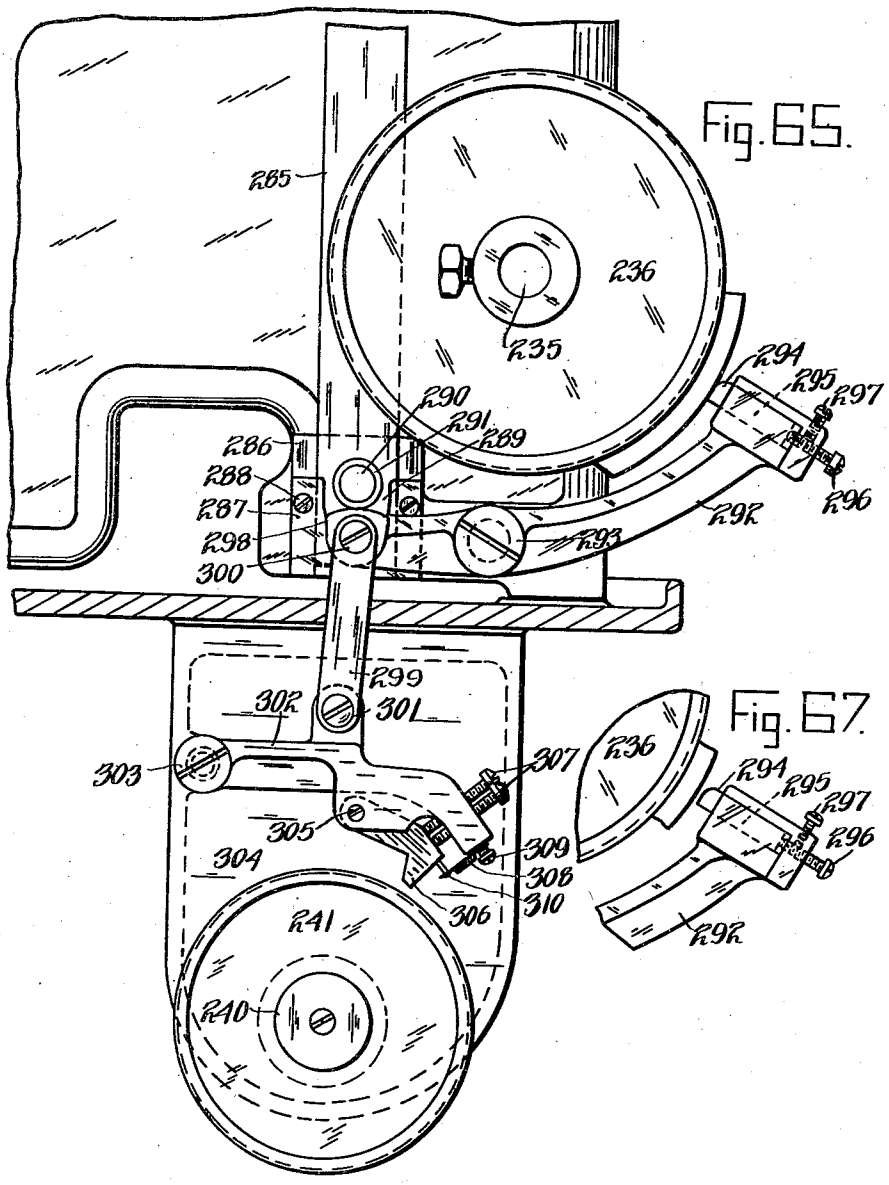


Fig. 65.

Fig. 67.

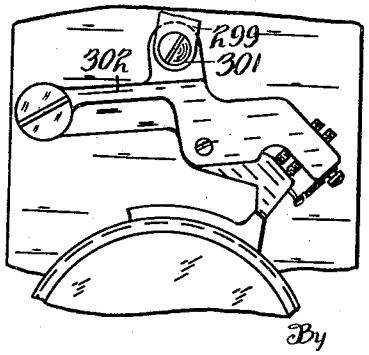


Fig. 66.

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Fig. 68.

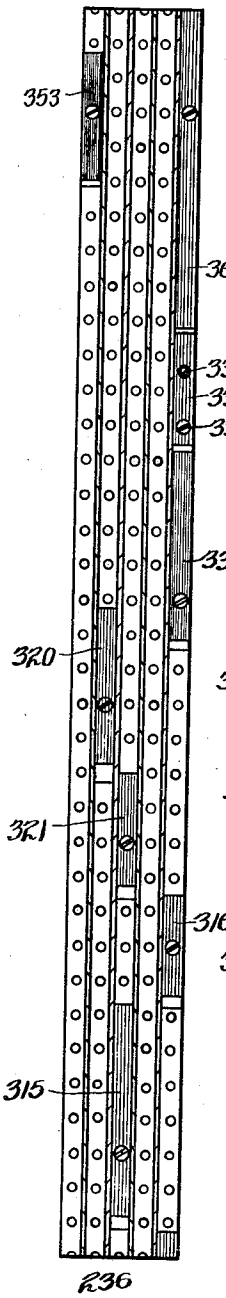


Fig. 69.

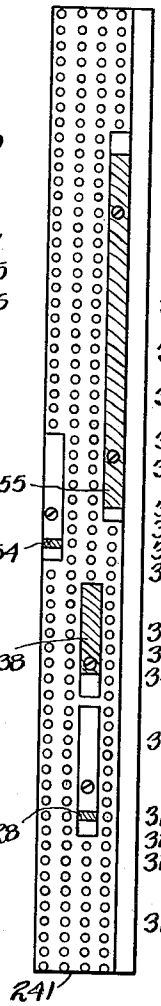


Fig. 70.

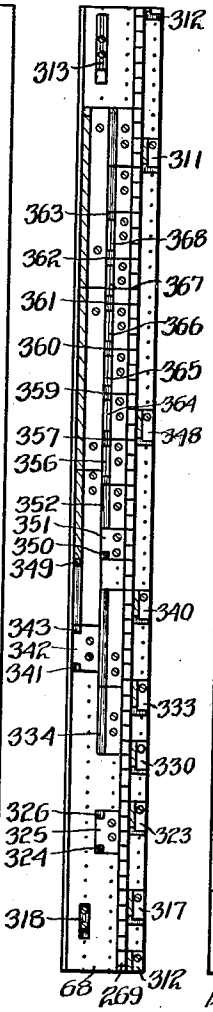


Fig. 71.

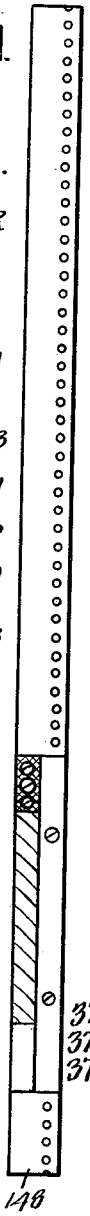


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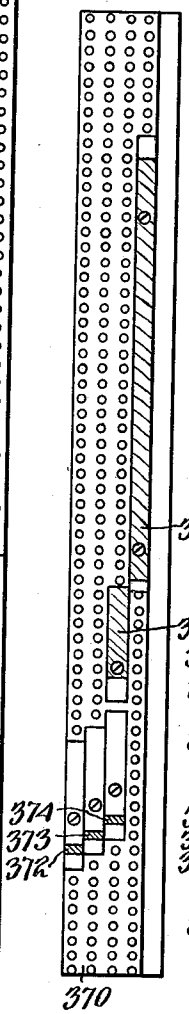


Fig. 73.

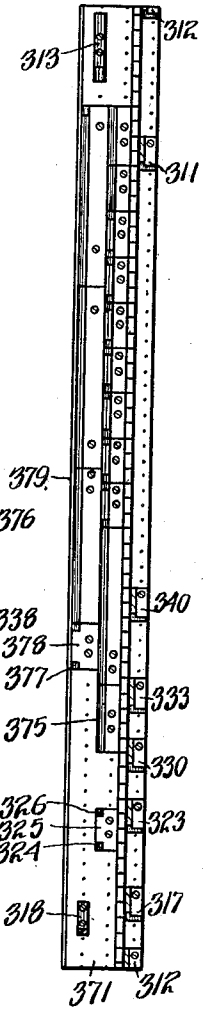
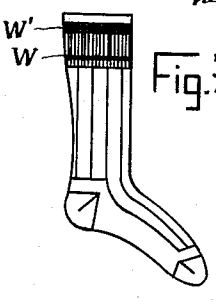


Fig. 74.



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Fig. 79.

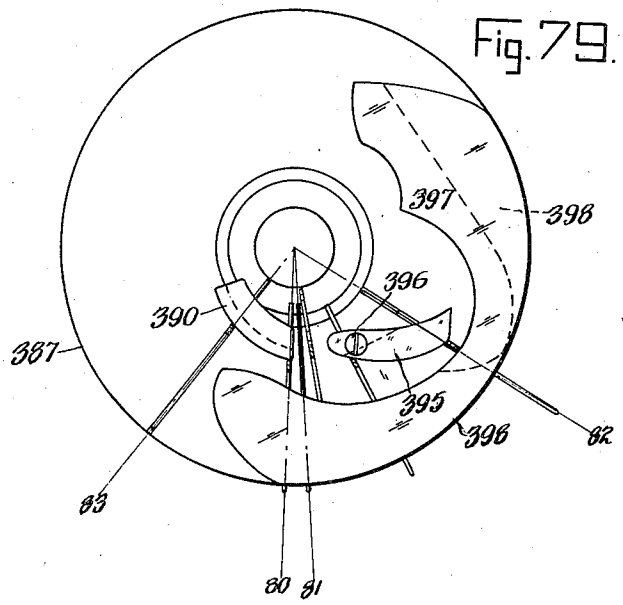


Fig. 83.

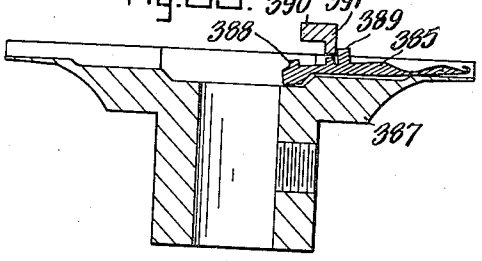


Fig. 80.

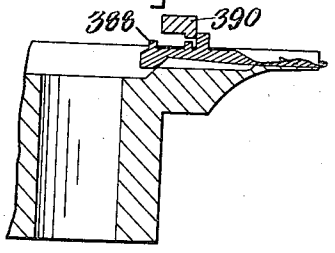


Fig. 82.

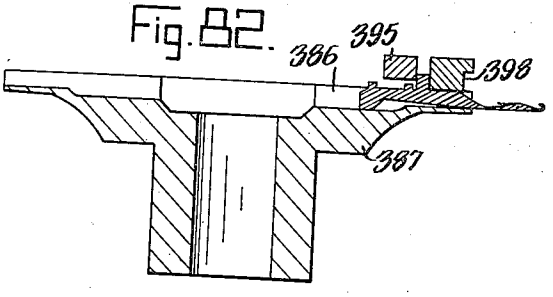
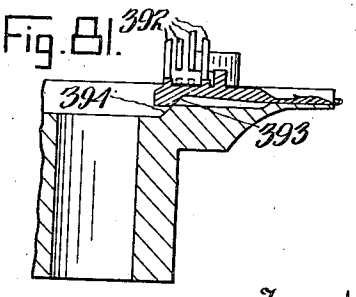


Fig. 81.



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Fig. 87.

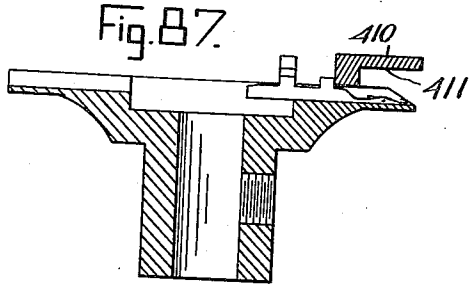


Fig. 85.

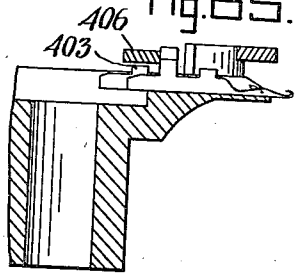


Fig. 86.

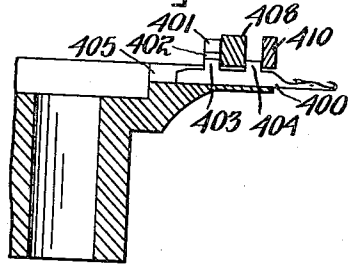
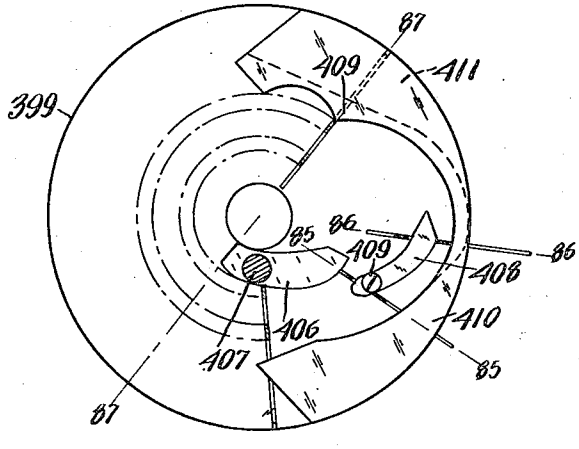


Fig. 84



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Fig. 89.

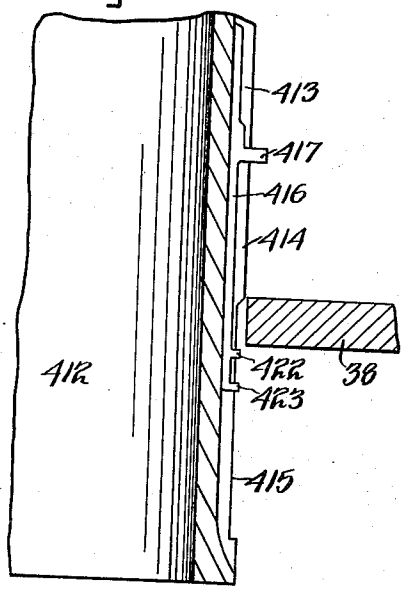


Fig. 88.

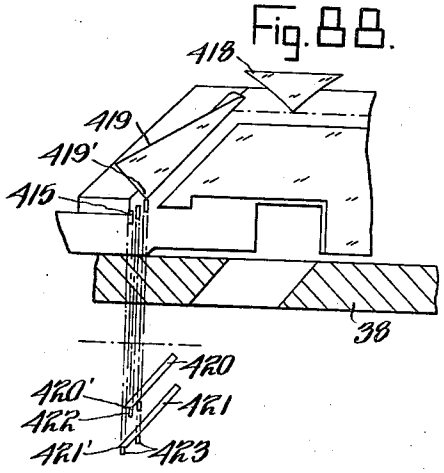


Fig. 92.

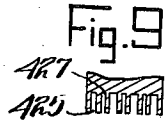


Fig. 93.

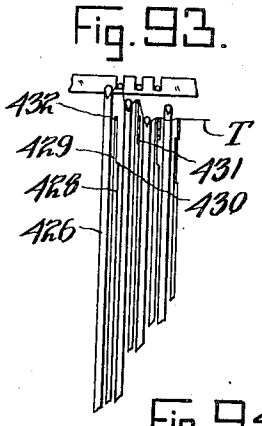


Fig. 90.

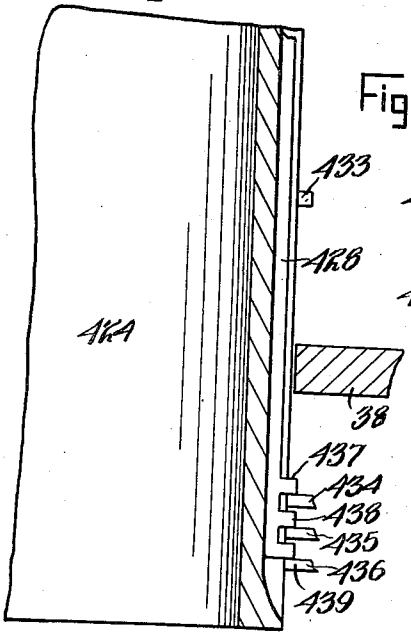


Fig. 91.

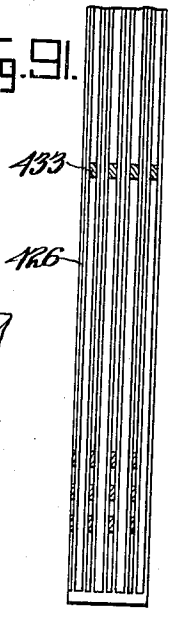
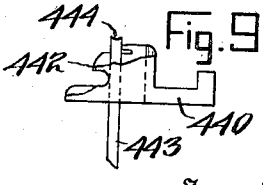


Fig. 94



Fig. 95.



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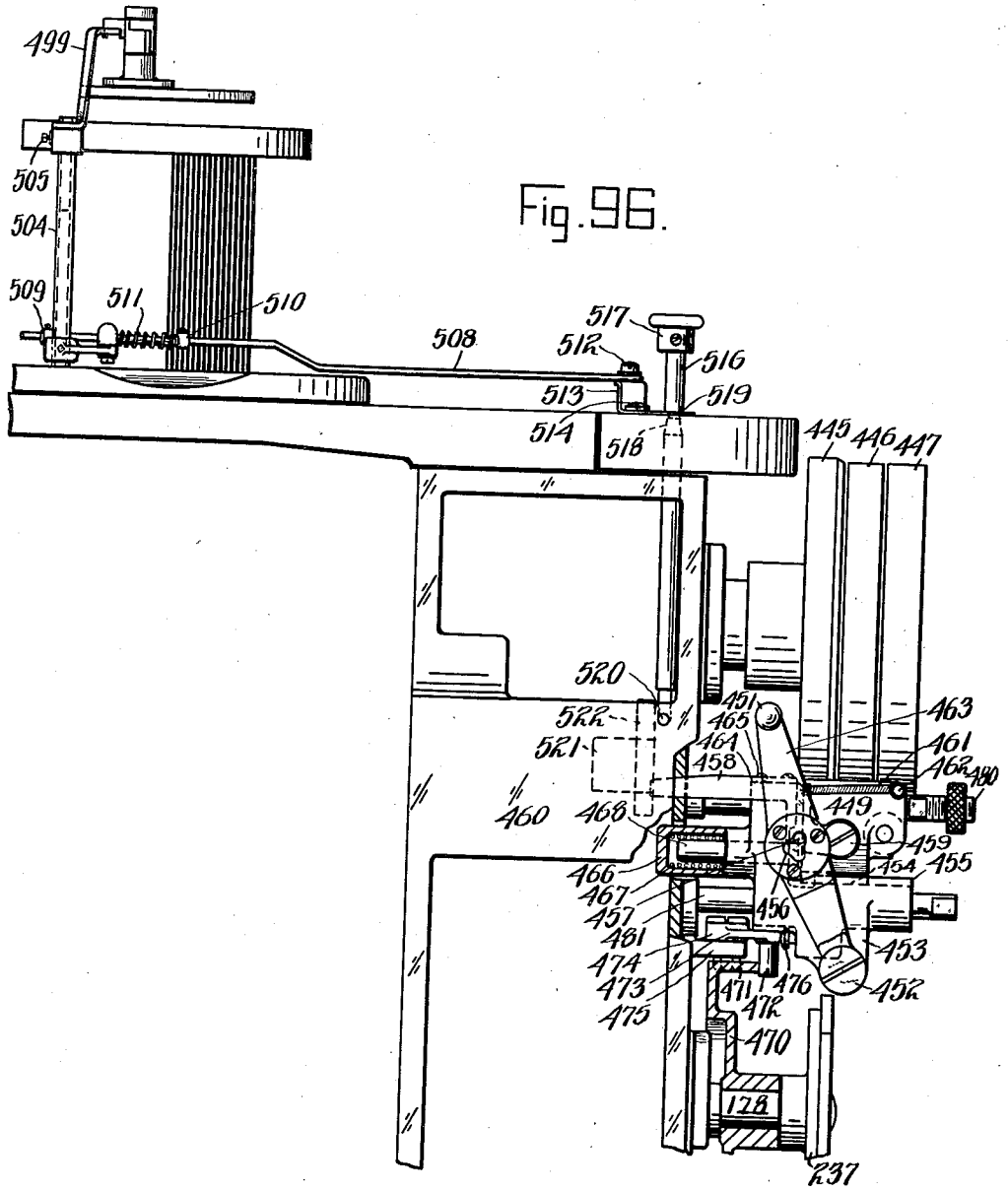
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Fig. 96.



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Fig. 97.

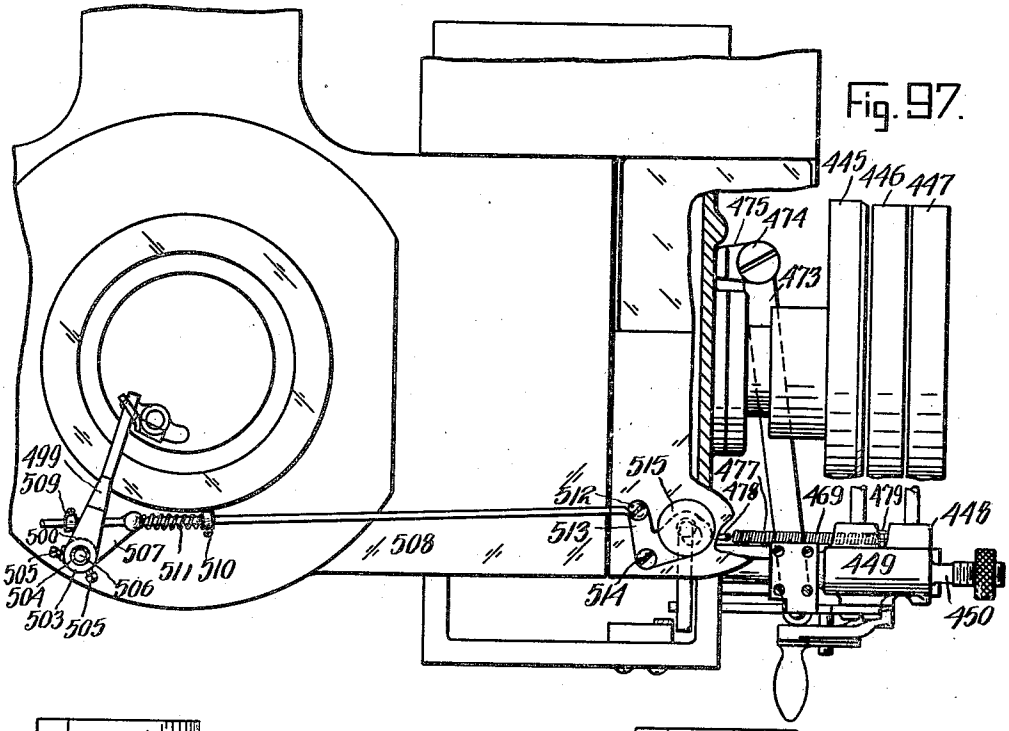


Fig. 99.

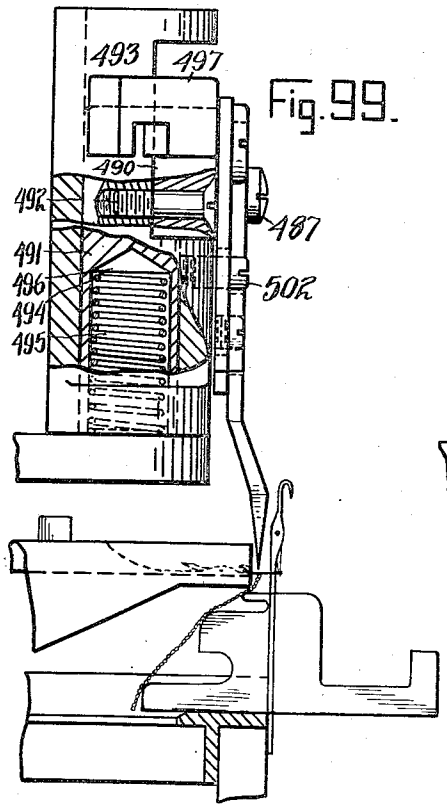
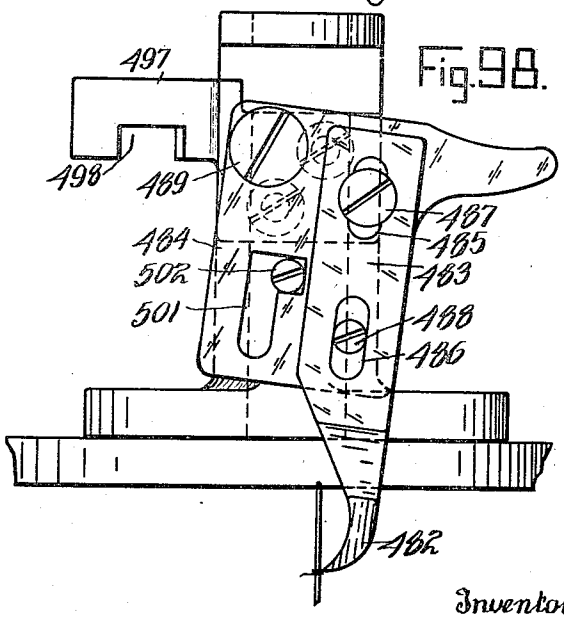


Fig. 98.



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Patented Mar. 23, 1937 2,074,973

UNITED STATES PATENT OFFICE

2,074,973

KNITTING MACHINE

William L. Smith, Jr., and Robert H. Lawson, Pawtucket, R. I.; said Smith assignor to May Hosiery Mills, Nashville, Tenn., a corporation of Tennessee

Application February 21, 1930, Serial No. 430,436
Renewed January 24, 1936,

25 Claims. (Cl. 66—24)

This invention relates to the knitting of a complete stocking on one machine, i. e., a stocking having a ribbed top, a ribbed leg and a plain or partly ribbed foot. However, the invention is not in all respects limited to the knitting of a ribbed stocking and although shown as applied to a circular machine of the type disclosed in the patent to Hemphill 933,443, September 7, 1909, it is applicable to other types of circular knitting machines and furthermore is not in all respects limited to circular knitting machines.

In the accompanying drawings:

Fig. 1 is a view in front elevation of a knitting machine equipped with the mechanism with which the present invention is concerned;

Fig. 2 is a skeleton view showing certain levers and connections for operating dial cams;

Fig. 3 is a plan view of a dial showing needles mounted therein in retracted position and adapted, when advanced, to knit two and one ribbed fabric in conjunction with cylinder needles;

Fig. 4 is a view partly in section and corresponding to Fig. 3;

Fig. 5 is a plan view similar to Fig. 3, but showing the dial knitting cam forward and advancing the long butted dial needles to knit a two and one ribbed instep in conjunction with the cylinder needles;

Fig. 6 is a view partly in section and corresponding to Fig. 5;

Fig. 7 is a view corresponding to Fig. 5, but showing the dial cam advancing medium butted as well as long butted dial needles to knit, in conjunction with cylinder needles, a two and one ribbed leg;

Fig. 8 is a view partly in section and corresponding to Fig. 7;

Fig. 9 is a view corresponding to Fig. 7, but showing the dial cam advancing the short as well as the medium and long butted dial needles to knit a one and one ribbed top in conjunction with the cylinder needles;

Fig. 10 is a view partly in section and corresponding to Fig. 9;

Fig. 11 is a view corresponding to Fig. 7, but showing the medium and long butted dial needles interspersed among the cylinder needles to knit a four and one ribbed leg;

Fig. 12 is a view partly in section and corresponding to Fig. 11;

Fig. 13 is a view corresponding to Fig. 11, but showing the dial cam advancing the long and short butted needles to knit, in conjunction with cylinder needles, one and one ribbed fabric;

Fig. 14 is a view partly in section and corresponding to Fig. 13;

Fig. 15 is a plan view showing the dial casting off cam advancing all the needles to clear their latches;

Fig. 16 is a view partly in section and corresponding to Fig. 15;

Fig. 17 shows the cam ring for determining the knitting level of the instep, cylinder needles, relatively raised, and the special cam for determining the knitting level of the sole, cylinder needles, relatively lowered and with the sole, cylinder needles knitting over sinkers, the arrow indicating the direction of movement of the needles with relation to the cams;

Fig. 18 is a view similar to Fig. 17, but taken at a later period in the cycle and showing the instep needles drawing their stitches over dial needles to knit a one and one ribbed instep;

Fig. 19 shows the needles moving in a reverse direction, as indicated by the arrow, during the knitting of the heel or toe;

Fig. 20 shows the cam ring in a relatively lowered position with the needles all drawing their stitches over sinkers and knitting plain, circular fabric, the dotted lines indicating the positions of the cam ring and needles when relatively raised for rib knitting;

Fig. 21 is a view partly in section showing the cam for acting upon the special butts of the sole needles;

Fig. 22 is a view partly in section taken along the line 22—22, Fig. 20, and showing the needle cylinder;

Fig. 23 is a view of a modified arrangement of needles;

Fig. 24 is a view partly in section of the dial and cylinder and cams for controlling the dial needles;

Fig. 25 is a plan view, partly in section, showing levers for controlling the dial knitting and casting off cams;

Fig. 26 is a view in plan and partly in section showing the levers and connections for controlling the dial knitting and casting off cams;

Fig. 27 is a view in elevation and corresponding to Fig. 26;

Figs. 28–31 inclusive, are detail views;

Fig. 32 is a view in rear elevation of certain levers and connections for controlling the dial knitting and casting off cams;

Fig. 33 is a view in side elevation of the levers and connections shown in Fig. 32 together with means for controlling the same;

Fig. 34 is an enlarged view of certain of the parts shown in Fig. 32;

Fig. 35 is a view in elevation of means for controlling the sole cylinder needles during the knitting of the ribbed instep;

Fig. 36 is a view in plan and corresponding to Fig. 35;

Fig. 37 is a detail view of the cam which acts directly upon the sole needles during the knitting of the ribbed instep;

Fig. 38 is a fragmentary view of a portion of the disclosure in Fig. 36, but upon an enlarged scale;

Fig. 39 is a side view corresponding to Fig. 38;

Fig. 40 is a plan view similar to Fig. 36, but showing a modified construction;

Fig. 41 is a view in elevation of the modification shown in Fig. 40;

Fig. 42 is an enlarged view of the needle actuating cam mounted in the cam ring;

Fig. 43 is a view of the cam, Fig. 42, but showing the reverse side thereof;

Fig. 44 is a detail view of the connection between the cam and operating lever;

Fig. 45 is an end view of the connection shown in Fig. 44;

Fig. 46 is a plan view of a further modification;

Fig. 47 is a view in elevation of the modified construction shown in Fig. 46;

Fig. 48 is an end view of the cam block showing the means employed for yieldably mounting an overthrow guard cam;

Fig. 49 is a detail view of a cam shown in Fig. 47;

Fig. 50 is a view in elevation similar to Fig. 47, but showing the overthrow guard cam as applied to ordinary cylinder needles;

Fig. 51 is a view partly in section of the driving connection between the needle cylinder and dial;

Fig. 52 is a plan view of the mechanism shown in Fig. 51;

Fig. 53 is a detail sectional view taken along the line **53—53**, Fig. 51;

Fig. 54 is an enlarged detail view;

Fig. 55 is a fragmentary sectional view of the needle dial;

Fig. 56 is a view, partly in section, of the main and auxiliary cam shafts and drums mounted thereon;

Fig. 57 is a detail view of the upper fashioning drum;

Fig. 58 is a view in section taken on the line **58—58**, Fig. 57;

Fig. 59 is a view in front elevation showing the means carried by the main cam shaft for initiating movements of the auxiliary cam shaft;

Fig. 60 is a view similar to Fig. 59 but in side elevation;

Fig. 61 is an elevational view, partly in section, showing the means employed for racking the lower cam shaft after movements thereof have been initiated by the means disclosed in Figs 59 and 60;

Fig. 62 is a plan view partly in section of the mechanism shown in Fig. 61;

Fig. 63 is a detail view of a part shown in Fig. 62, but in side elevation;

Fig. 64 is a view in rear elevation of the driving connection between the "**104**" gear and the pawl for racking the lower cam shaft;

Fig. 65 is an elevational view partly in section of the upper and lower fashioning drums and showing the upper fashioning drum controlling the length of stitch knit by the cylinder needles by determining the elevation of the cam ring;

Fig. 66 is a view showing the lower fashioning drum determining the elevation of the cam ring and consequently the length of stitch knit by the cylinder needles;

Fig. 67 indicates the relative positions of the main or upper fashioning drum and lever controlled thereby when the auxiliary or lower fashioning drum determines the length of stitch knit by the cylinder needles as shown in Fig. 66;

Fig. 68 is a development of the cams and as positioned upon the main fashioning drum for knitting a ribbed instep and all ribbed leg;

Fig. 69 is a similar view of the cams upon the auxiliary fashioning drum as positioned for knitting a four and one or other ribbed instep, a four and one or other ribbed leg and a one and one or other ribbed top;

Fig. 70 is a similar view of the cams as arranged upon a cam drum carried by the auxiliary cam shaft and for controlling the dial cams to knit a four and one or other ribbed instep, a four and one or other ribbed leg and a one and one or other ribbed top having tuck welts;

Fig. 71 is a similar view of a cam drum carried by the auxiliary cam shaft and for controlling the sole cylinder needles during the knitting of a ribbed instep;

Fig. 72 is a view similar to Fig. 69, but with cams arranged upon the cam drum to knit a one and one or other ribbed instep and ribbed leg throughout;

Fig. 73 is a view similar to Fig. 70, but with cams arranged thereon to cooperate with the cams upon the drum, Fig. 72;

Fig. 74 is a view of a stocking having a ribbed instep, ribbed leg and a fine ribbed top in which are knit tuck welt courses;

Fig. 75 is a view of a modification showing the dial casting off cam in a semi-retracted position and projecting the dial needles to such a position that they will act to prevent the web from moving up with the ascending cylinder needles;

Fig. 76 is a view corresponding to Fig. 75 and showing the cylinder needles moving up between partially projected dial needles;

Fig. 77 is a detail view of the means employed for holding the dial casting off cam in a semi-retracted position;

Fig. 78 is a view partly in section taken along the line **78—78**, Fig. 77 looking in the direction of the arrow;

Fig. 79 is a plan view showing a modified control of dial needles;

Fig. 80 is a sectional view taken along the line **80—80**, Fig. 79;

Fig. 81 is a sectional view taken along the line **81—81**, Fig. 79;

Fig. 82 is a sectional view taken along the line **82—82**, Fig. 79;

Fig. 83 is a sectional view taken along the line **83—83**, Fig. 79;

Fig. 84 is a plan view similar to Fig. 79 but showing still another modification;

Fig. 85 is a sectional view taken along the line **85—85**, Fig. 84;

Fig. 86 is a sectional view taken along the line **86—86**, Fig. 84;

Fig. 87 is a sectional view taken along the line **87—87**, Fig. 84;

Fig. 88 shows a modified means for controlling certain of the cylinder needles;

Fig. 89 is a similar view but showing the needle cylinder and in section;

Fig. 90 is a sectional view through the needle cylinder showing jacks mounted in additional grooves cut in the needle cylinder and adapted to be selectively controlled for two, three, or four level knitting;

Fig. 91 is a similar view in elevation of a portion of the needle cylinder showing needles and jacks mounted in parallel grooves;

Fig. 92 is a fragmentary sectional view showing the slots in the needle cylinder;

Fig. 93 is a view showing the jacks, Fig. 90, in cooperative relation with the needles as the latter draw their stitches;

Fig. 94 is a plan view of a modification of the means shown in Figs. 90–93;

Fig. 95 is a view in elevation of the means shown in Fig. 94;

Fig. 96 is a view in front elevation of a belt shifter and stop motion;

Fig. 97 is a plan view of the stop motion;

Fig. 98 is an enlarged detail view in front elevation showing the position of the detector; and

Fig. 99 is a view similar to Fig. 98, but in side elevation and partly in section.

The machine as a whole is indicated by the reference numeral 1 and includes a needle dial 2 and a needle cylinder 3. Connected to the latter to move therewith is a sinker head 4 surmounting which is the usual sinker cap 5 fixed so as not to turn with the sinker head. Radially slidable within tricks or grooves cut in the sinker head are sinkers 6 having butts 7 thereon to be actuated by cams in the sinker cap 5 in the usual manner. The sinkers are slidably supported for radial movements in the grooves of the sinker head and additionally by the stitch ring 8 which constitutes the upper portion of the needle cylinder, and has slots or grooves in alignment with the corresponding grooves cut in the sinker head 4.

Referring specifically to Figs. 3–16 inclusive and Fig. 24, the dial 2 is shown as provided with tricks or grooves 9 within which are slidably received dial needles 10 having reduced tails 11 converging toward the axis of the dial. The dial needles consist of long butted needles 12, medium butted needles 13, and short butted needles 14 though any desired number of different lengths of butts may be used depending upon the character of fabric to be knit. With the arrangement of dial needles as specifically disclosed in Figs. 3–10 inclusive, the long butted needles 12 are first projected by a cam 15 pivoted at 16, as shown in Figs. 5 and 6, to cooperate with cylinder needles 17 and knit a two and one ribbed instep, i. e., two cylinder needles to one dial needle. Thereafter the medium butted dial needles 13 are engaged and projected by the dial cam 15, as shown in Figs. 7 and 8, to knit two and one all around ribbed fabric for the leg portion of the stocking in conjunction with the long butted dial needles and cylinder needles. The descent of the cam 15 to its lowermost position, Figs. 9 and 10, projects the short butted dial needles 14 as well as the long and medium butted needles, the dial needles then all knitting and alternating with cylinder needles to knit a one and one ribbed top.

In Figs. 11 and 12 a somewhat different arrangement of the dial needles is disclosed, every fifth needle being either long butted or medium butted, the long butted needles, knitting the ribbed instep, in conjunction with the cylinder needles, the long and medium butted dial needles knitting an all around four and one ribbed fabric in conjunction with the cylinder needles, the long, medium and short butted needles knitting a one and one all around ribbed top in conjunction with the cylinder needles.

In Figs. 13 and 14 long and short butted needles only are utilized, the long butted dial needles 18 when projected by cam 15′ knitting one and one ribbed fabric throughout the instep portion of the stocking in conjunction with the cylinder needles. Thereafter with the cam 15′ in a lowered position, the long and short butted dial needles 18 and 19 are advanced to cooperate with the cylinder needles to knit one and one ribbed fabric with as many dial needles as cylinder needles.

Regardless of the different arrangements of the dial needles, Figs. 3–14 inclusive, at the completion of rib knitting the dial needles are in all cases retracted by the dial cam 20 to draw their last course of yarn through the previously knit course and cast off the latter. The dial needles are thereafter engaged by a casting off cam 21, Figs. 15 and 16, pivoted at 22 to the dial cap, the cam 21 projecting the dial needles until their latches are cleared of the last drawn loops after which the cam 23 fully retracts the dial needles causing the loops to close the latches and be cast off completely from the said dial needles. The dial needles free of their loops continue to traverse a substantially circular, retracted path, as the dial cam 15 after projecting the dial needles for the last course swings upon its pivot 16 to the fully retracted position of Fig. 3, and the casting off cam 21 also swings to a correspondingly retracted position upon its pivot 22, the cams 15 and 21 controlled in their movements by means to be hereinafter more specifically described.

Referring specifically to Figs. 17–23 inclusive, the cylinder needles 17 are divided into two groups, one group 24 having single butts 25 and adapted to knit the ribbed portions of the fabric in conjunction with the dial needles or certain ones of them and the other group 26 of cylinder needles having upper butts 27 at or adjacent to the level of the butts 25 and lower butts 28 carried by extensions 29 of the shanks of the needles projecting below the upper butts 27. During the knitting of the loopers rounds, ring toe and all around plain portions of the stocking the lower butts are inactive but during the knitting of the ribbed instep and in some cases during the knitting of an all around ribbed leg of a stocking the lower butts 28 are specially controlled as will be hereinafter more fully described. During all around plain knitting both groups of needles 24 and 26 knit in the manner usual in plain knitting by drawing their stitches over the upper edges of the sinkers 6 but during the knitting of the ribbed instep and in some cases during the knitting of the all around ribbed leg portion, certain of the cylinder needles i. e., those having butts 28 knit by drawing their stitches over adjacent sinkers, while the cylinder needles 24 knit the ribbed instep by drawing their stitches in whole or in part over the shanks of adjacent dial needles.

The cylinder needles 24 which draw their stitches over the shanks of certain of the dial needles in reality knit at a level above the level of knitting of the plain sole needles 26 as the latter needles, during the knitting of the plain sole, draw their stitches over the upper edges of the sinkers 6. Consequently if the cylinder needles 24 draw the proper length of stitch over the shanks of the dial needles as they are suc-

cessively depressed by the upper guard cam 30 and draw cam 31, the plain sole needles 26, if depressed to the same extent by the said cam 31 as are the other needles 24, will not draw the length of stitch desired but the stitch will be too tight throughout the plain sole. Accordingly a supplemental cam 32 movable with relation to the cam 31, and in a vertical direction, engages and depresses the needles 26 a distance sufficient to compensate for the difference in the knitting level resulting from the relative vertical positions of the dial needles and sinker edges over which the needles 24 and 26 respectively draw their stitches. A cam incline or flange 33 carried by the cam 32 acts to engage the lower butts 28 and depress the needles the additional extent required especially when knitting the plain sole and ribbed instep simultaneously.

In addition to cams 30, 31, and 33, cams 34 and 35 adapted again to raise the cylinder needles each course after they have drawn their stitches, a supplemental draw cam 36 and a lower guard cam 37, are all mounted upon the cam ring or carrier 38; the cams 34, 36 operative only during the reverse strokes of heel and toe or other reciprocating knitting as shown in Fig. 19.

Referring to Fig. 24, the dial cam 15 is shown as carried by a shaft 39 vertically slidable in a bracket 40 attached to and forming part of the dial cap 41. Surrounding the shaft 39 at the upper end thereof is a coiled spring 42 seated within a counterbore or recess 43 provided in the bracket 40. The spring 42 at one end thereof engages a shoulder 44 formed by the recess 43 and at the other end thereof the spring engages an arm 45 one end of which is fastened to the upper end of the shaft 39 and the other end carries an upstanding pin 46. Spring 42 tends to maintain the cam 15 in normal engagement with the lower face of the dial cap 41, the cam then being in a position to engage the longest butted dial needles 12 only. The pin 46 projects through an elongated slot 47 provided in one arm 48 of a lever 49 pivoted upon a sleeve 50 surrounding a shaft 51 which supports dial 2. The other arm 52 of the said lever 49 is upturned and pivotally connected at 53 to a link 54 the latter in turn pivoted at 54' to one arm of a second lever 55 pivoted intermediate its ends upon a pin 56 connected to and carried by a dial supporting post 57. The other arm of the lever 55 is engaged by a bell crank lever 58 the two arms 59, 60 of which are connected to a shaft 61 carried by bracket arms depending from a bracket 62 attached to the machine frame as by screws 63. Pivotally connected to the lever arm 60 and extending therebelow is a link 64 adjustably connected at its other end to one end of a lever 65 pivoted intermediate its ends and as at 66 to the machine frame, the other end of the lever 65 having a toe or lug 67 held in engagement with the surface of a drum 68 or cams carried thereby. In order normally to retain the dial cam 15 in a retracted position a pin or screw 69 is attached to the dial supporting bracket arm 70 the latter carried by the post 57. Attached to or hooked over the pin 69 is a coil spring 71 the other end of which is hooked over a pin 72 connected to the link 54 and tending to maintain the link in a forward position and consequently the dial cam 15 retracted. As hereinafter will be more fully described cams upon the drum 68 periodically actuate the lever 65 and through connections 64, 58, 55, and 54 rock the lever 49, the latter engaging pin 46 and turning the shaft 39 thereby moving the cam 15 to a position to project the dial needles or certain ones of them.

The in and out movements of the cam 15 for the purpose of retracting and projecting the dial needles or certain ones of them are supplemented by up and down vertical movements of the said cam 15 and for that purpose a second cam 73 is utilized. The cam 73 has two inclines or cam surfaces 74 and 75 with a horizontal portion 76 therebetween and a second horizontal portion 77. The cam 73 is carried by and is part of a lever 78 which surrounds and is supported by the sleeve 50 for pivotal movements. The end of one arm or wing 79 of the lever carrying the arm 73 is upturned and pivotally connected at 80 to a link 81, the end of the said link 81 in turn pivotally connected at 82 to one arm of a lever 83. The lever 83 is mounted upon the pin 56 and its other arm remote from the link 81, is engaged and actuated by one arm 84 of a bell crank lever 85 loosely mounted upon the shaft 61. A second arm 86 of the bell crank lever is turned at a right angle and to the end of the said other arm is pivotally connected a rod or link 87, which link 87 depends from the bell crank lever and at its lower end is pivotally connected to an arm 88 of another lever, the two arms 88, 89 of which are connected by a horizontally disposed pin 90 pivotally supported by ears or lugs 91 carried by a bracket 92 fastened to the machine frame as by screws 93. To the other arm 89 of the last mentioned lever is secured a link 94 depending from the lever and at its lower end adjustably received within a hole in the outer end of another lever 95 pivoted at 66 intermediate its ends, the other arm of the lever 95 provided with a toe 96 held in engagement with the drum 68 or cams thereon. Engagement of the lug or toe 96 by cams on the cam drum 68 is transmitted, through the connections 94, 90, 87, 83, and 81, to the cam 73 whereby the said cam 73 is moved to such a position that the first cam surface 74 moves into contact with the upper surface of the shaft 39 and depresses the same against the tension of the coil spring 42, lowering the cam 15 to an intermediate position where it projects the medium butted needles 13 as well as the long butted needles 12, and thereafter to a fully lowered position where the said cam 15 projects the short butted needles 14 as well as the said medium and long butted dial needles. A coiled spring 97 attached at one end to the pin 69 and at its other end to a pin 98 connected to link 81 constantly urges the same in a forward direction and consequently tends to maintain the cam 73 out of contact with the arm 45 and so that the coiled spring 42 may maintain the dial cam 15 in its upper position. While the cam 15 is at the intermediate position of Figs. 7, 8, 11 and 12 the horizontal portion 76 of the cam plate 73 is in engagement with the upper face of the arm 45. Thereafter to depress the cam 15 to engage the shortest butts, Figs. 9 and 10, lever 78 is rocked around still further by a second cam on drum 68 and through the connections described, the cam incline 75 of the cam 73 then still further depressing the arm 45 and cam 15 carried thereby until the horizontal face 77 of the cam 73 rests upon the upper flat surface of the arm 45, the cam 15 then being fully depressed as shown in Figs. 9 and 10 at which time all of the dial needles, long, medium, and short butted, are knitting in conjunction with the cylinder needles.

At the completion of the rib knitting when it

is desired to cast the stitches off from all the dial needles the casting off cam 21 is projected to the position shown in Fig. 15. The means employed to time and control the movements of casting off cam 21 includes a shaft 99 upstanding from the casting off cam 21 and made fast to an arm 99' to the outer end of which is secured a pin 100 upstanding therefrom and received within a slot 101 in a lever 102. To the outer end of the said lever 102 is pivotally connected a link 103, the latter in turn pivotally connected at 104 to a lever 105 pivoted intermediate its ends upon the pin or shaft 56, the other arm of which lever 105 is in engagement with one arm 106 of a bell crank lever 107. The arm 106 is fast to a sleeve 108 the latter surrounding the rod 61 and passing through two arms depending from the bracket 62, the said arms acting as bearings for the sleeve 108. To the outer end of the sleeve 108 is fixedly secured the other arm 109 of the bell crank lever 107 and to the free end of said arm is adjustably and pivotally secured a rod or link 110 the lower end of the latter adjustably fastened to a lever 111 pivoted intermediate its ends at 66 and having at the free end of its other arm a depending lug or toe 112 normally in engagement with the cam drum 68 and adapted to be engaged by cams thereon. A coiled spring 113 attached to pin 69 at one end engages over a pin or screw 114 at its other end, the second mentioned pin carried by the link 103. The tension of the spring 113 tends to maintain the link in a forward position and consequently the casting off cam 21 retracted. At the completion of rib knitting the casting off cam 21 is swung to the casting off position shown in Fig. 15, the in and out movements of the said casting off cam 21 being controlled from the pattern drum 68 through connections 111, 110, 109, 108, 106, 105, 103, and 102.

Projecting laterally from the machine frame is a bar 115 carrying pins or screws 116 and 117. To the pin 116 is attached a coiled spring 118 depending therefrom and at its lower end engaged over a pin or screw 119 carried by a collar 120 adjustably fastened to the link 64 and adapted to maintain the lever 65 in engagement with the drum 68 and cams mounted thereon and at the same time holding the arm 58 of the bell crank lever 59 in a retracted position and permitting the spring 71 to maintain the lever 49 and consequently the dial cam 15 in a normally retracted position. To the pin or screw 117 is likewise fastened a coiled spring 121 the lower end of which is connected to a pin or screw 122 carried by a collar 123 adjustably connected to the link 110 and normally maintaining the lever 111 in engagement with the drum 68 or cams thereon and at the same time maintaining the arm 106 of the bell crank lever 107 retracted so as to permit the spring 113 normally to maintain the casting off cam 21 in a retracted position. A third coiled spring 124 is attached at its upper end to a pin or screw 125 fastened to the circular base and at its lower end the coiled spring is connected to a pin or screw 126 carried by a collar 127 adjustably connected to the link 87 and adapted to maintain the lever 95 in contact with the drum 68 or cams thereon and at the same time to maintain the arm 84 of the bell crank lever 85 in a retracted position so that the spring 97 may maintain the cam 53 in a position to permit the dial cam 15 to remain in its uppermost position where it engages the long butted dial needles only.

Referring specifically to Figs. 17–20 and Figs. 35–39 inclusive, the lower guard cam 37 is shown pivoted at 128 to the cam carrier 38 and limited in its pivoting or rocking movements by a pin 129 carried by the cam carrier and received within an elongated slot 130 provided in cam 37. The cam 37 is undercut as at 131 where it seats upon the upper edge or surface of the cam 32 at 132. The cam 32 is periodically raised and lowered by means hereinafter to be described and when raised, Fig. 20, tilts or rocks the cam 37 upon its pivot 128 and when lowered the cam 37 moves back to the position shown in Fig. 17. The supplemental cam 32, adapted to engage the butts 28 of the special cylinder needles, is mounted for vertical, sliding movements in a bracket 133 fastened to the underside of the cam ring 38 as by screws 134. Attached to the cam 32 is a half-round extension 135 carrying a pin 136. Vertical movements imparted to the pin 136 are communicated to the cam 32, the bracket 133 acting as a bearing to support the extension 135 for vertical sliding movements.

In order periodically to raise and lower the cam 32, the following described means is provided. A lever 137, adjacent one end thereof, is pivoted to an upstanding lug 138 carried by a bracket 139 fastened to the circular base 140 as by screws 141. To the other end of the said lever is attached a connecting link 142 the lower end of which is adjustably connected to another lever 143 pivoted intermediate its ends at 144 to a bracket 145 attached to and depending from the machine frame. Lever 143 at or adjacent its other end is provided with a toe 146 adapted normally to be spaced some distance above the surface 147 of cam drum 148 and be actuated, from time to time, by cams fast to the said surface 147 of the cam drum but not shown in Fig. 35. A coiled spring 149 is attached, at one end, to the machine frame and at its other to a pin or screw 150 carried by a collar 151 and adjustably connecting the said collar to the link 142. A cam on the drum 148 when moved under the toe 146 depresses the other arm of the lever 143, against the tension of the spring 149, and lowers the cam 32 through the connections hereinbefore described. The raising and lowering of the cam 32 by the connections above described leading to the drum 148 causes the special or extra butted cylinder needles 26 to knit at two levels; at the upper level the cylinder needles draw their stitches over the shanks of the dial needles while at the lower level the cylinder needles draw their stitches over the edges of the sinkers.

Referring to the modified arrangement of the cylinder needles shown in Fig. 23 the needles 24 which are adjacent dial needles when knitting four and one are provided with single upper butts 25 while the needles 26 are provided with upper butts 27 and additional butts 28. When knitting a plain sole on cylinder needles alone and at the same time a ribbed instep by cylinder and dial needles, the cylinder needles knitting the sole draw their stitches over the edges of the sinkers while the cylinder needles knitting the instep in cooperation with the rib needles draw their stitches wholly or partly over the adjacent dial needles. In other words, when the cylinder needles for knitting the plain wales at the instep portion of the stocking are adjusted to draw their stitches over the dial needles, the plain heel cylinder needles must be specially controlled so as to draw their loops over the upper edges of the sinkers located at a lower level than the shanks of the dial needles. It is for the purpose of pro-

viding for the necessary two-level knitting that extra butts are provided upon the heel cylinder needles so that, during the knitting of the plain sole, they may be lowered to a greater extent than are the cylinder needles knitting the rib instep in cooperation with adjacent dial needles. Otherwise the stitches drawn by the plain heel cylinder needles would or might be too short as compared with the loops or stitches drawn by the instep cylinder needles and after knitting a certain number of courses, the plain sole would be shorter than the ribbed instep and as a consequence thereof the take up, constantly pulling upon the fabric, while properly tensioning the plain sole portion of the foot, would not sufficiently tension the said ribbed wales to insure a proper casting off of the stitches from the dial needles.

When knitting one and one ribbed fabric, i. e., the dial and cylinder needles alternating, each cylinder needle is flanked by a dial needle and consequently the cylinder needles draw their stitches or loops over the shanks of the dial needles, the sinkers not in any degree determining the length of the loops or stitches drawn by the cylinder needles as they descend or are lowered by the cylinder cams.

When knitting two and one ribbed fabric with two cylinder needles between adjacent, active dial needles, the cylinder needles draw their stitches in part over the adjacent dial needles, and in part over adjacent sinkers and with all of the plain stitches of substantially the same length. However, when knitting four and one ribbed fabric, i. e., every dial needle flanked by four cylinder needles, the intermediate cylinder needles draw their stitches over adjacent sinker edges as in plain knitting and though the take-up will cast off the stitches from the dial needles, it will function in a more satisfactory manner if the intermediate cylinder needles are each provided with an additional butt and the desirability for the specially butted cylinder needles increases with the number of adjacent dial needles. Thus when knitting four and one, four cylinder needles to one dial needle, the stitches knit by the single dial needle are tensioned by the take-up acting through adjacent, flanking plain or cylinder stitches; but when knitting, say, four and four ribbed fabric, four cylinder needles to four dial needles, all of the rib stitches, especially those not flanked by plain stitches, are not properly tensioned by the web take-up and consequently the dial needles may not properly cast off their stitches unless the cylinder needles not adjacent to dial needles are provided with additional butts **28**.

If it be desired to knit a four and one ribbed instep in conjunction with a plain sole, the cam **32**, in addition to up and down movements, may have in and out movements, i. e., movements toward and from the cylinder needles. During the knitting of the last course of the ring toe and prior to knitting the ribbed instep and plain sole, the cam **32** may be projected to its innermost position to depress and cause all the cylinder needles knitting the plain sole, as well as the specially butted cylinder needles, i. e., the ones not flanked by the dial needles and included in the ribbed instep half or portion of the cylinder needles, to draw their stitches over the sinkers and at a lower level.

At the beginning of the knitting of the heel the dial cam **15** is retracted, as described heretofore, and thereafter at the conclusion of the heel knitting the said cam is again moved out to active position, the cam **32** remaining fully projected. After knitting a few partly plain and partly rib courses above the heel, the dial cam **15** projects the medium butt dial needles to knit an all around ribbed leg and the cam **32** is retracted to miss the lower butts of the cylinder needles that are adjacent to dial needles, which lower butts are shorter than the butts of cylinder needles not adjacent to dial needles. As a consequence of the retraction of the cam **32** to miss the short lower butts of certain of the cylinder needles, the said needles knit at a higher level than do other cylinder needles and draw their stitches in part, at least, over the shanks of adjacent dial needles, whereas the needles having the long butts knit at a lower level and draw their stitches over the upper edges of adjacent sinkers as is usual in plain knitting. To close the eyelet holes which would otherwise be formed the dial cam **15** is raised prior to the second course of knitting so that the medium butted dial needles may hold their loops without knitting for that course while the heel cylinder needles knit a plain course, the cam **32** remaining partially retracted and actuating the long butted cylinder needles only. Prior to the third course of knitting the dial cam **15** is again lowered, and during the passage of the long butted needles, to an intermediate level to project the medium butted dial needles located upon the other half or portion of the dial.

Prior to knitting the first course of a one and one all ribbed top and for the purpose of closing eyelet holes the cam **15** is retracted then depressed to a position to engage the short butt as well as the medium and long dial needles and thereafter projected so that all of the dial needles will take one course of thread. For the following course the dial cam is retracted and then for the succeeding courses advanced. Also prior to the said first course the cam **32** is fully retracted so as not to actuate any of the special butted cylinder needles.

Should it be desired to knit a six and one ribbed leg and finish the same with a three and one ribbed top, three lengths of special butts would be provided upon the cylinder needles, the longest butts on the cylinder needles not adjacent to dial needles when knitting the mentioned three and one ribbed top.

In Figs. 40–45 inclusive is shown a modified means for controlling the special butted needles **26**. A cam bracket **152** is attached to and adjustably carried by the cam carrier **38** by means such as screws **153** passing through elongated slots **154** in the said cam carrier and into threaded engagement with holes **155** in the cam bracket **152**. Slidably carried by the cam bracket **152** is a member **156** having a flange **157** constituting a cam adapted to be engaged by the lower needle butts **28** of the specially butted needles **26** as indicated in Fig. 42. The member **156** is provided with an elongated slot **158** receiving therethrough two screws **159** which act slidably to connect the member **156** with the cam bracket **152** by passing through the said slot **158** and into threaded engagement with the bracket **152**. The cam carrying member **156** has attached thereto in any suitable manner a post or stud **160** the outer end **161** of which is spherical and received between two arms or wings **162** of an actuating member **163**. The actuating member **163** cor-

responds to the lever 137 shown in Figs. 35, 36 and is actuated by the link 142 and lever 143 controlled directly from the drum 148. The lever 163 is pivotally mounted at one end upon an upstanding lug 164 carried by and forming part of a bracket or plate 165 attached to the circular base as by screws 166. The aforesaid wings or arms 162 are connected to the lever 163 adjacent to the pivot and when the said lever is rocked by the pattern drum 148 through the connections 143 and 142, the spherical end 161 of pin 160 is engaged and actuated by the wings 162 and thereby raised or lowered, the upper portion of the cam carrying member 156 when raised projecting into a recess 167 provided in the cam carrier 38. To prevent overthrow of the specially butted needles 26 and unevenness in the stitches, the butts 28 of the said specially butted needles as they move down the cam 157 strike a ledge or horizontal flange 168 which acts to limit their downward movement.

In Figs. 46–50 inclusive is shown another means for preventing overthrow of needles, Figs. 46–49 inclusive disclosing overthrow control of the specially butted needles 26 while Fig. 50 shows the invention as applied to plain cylinder needles. In the said figures the cam block 169, mounted upon the cam carrier 38, is shown as provided with the usual draw and guard cams and in addition thereto with a yieldably mounted cam or stop 170 pivoted to the cam block at 171 and shaped adjacent its other end to provide an inclined surface 172 normally or when in raised position, Fig. 50, forming a continuation of the lower guard cam and therebeyond inclined upwardly as at 173 to raise the needles immediately after they have drawn their stitches.

As stated the stop 170 is yieldably mounted and for this purpose the pivot thereof consists of a pin 174 extending through the cam block 169 as shown in Fig. 46, and at its projecting end passing through a hub or sleeve 175 carried by an arm 176. The sleeve or hub 175 carries a boss 177 which is internally threaded receiving therein a screw 178 the latter in locking engagement with the shaft or pin 174 so that movements of the stop 170 will be transmitted to the arm 176. Adjacent its free end the arm 176 is notched to receive one end of a coiled spring 179, the other end of which is connected to the cam block 169 by a pin or screw 180. The spring 179 normally draws the arm 176 in the direction of the pin or screw 180 and thereby normally maintains the stop 170 in a horizontal position as shown in Fig. 50.

The stop 170 may be duplicated at the other side of the cam block 169 if desired.

In addition to the overthrow guard 170 and means for controlling the same, Figs. 47, 49 further disclose a construction of cam and mounting for the same whereby unevenness in the stitch will be avoided. To accomplish such a purpose a bracket 181 is attached to the underside of the cam carrier 38 by means such as a screw 182 and the said bracket has slidably mounted thereon a cam 183 similar to but not identical with the cam 156, Figs. 40–45. Cam 183 consists of a needle butt engaging flange 184 inclined at an angle of about 45 degrees with the horizontal, and cut away at 185. The cam 183 is provided with an elongated slot 186 and two screws 187 are received therein and into threaded engagement with the bracket 181 to slidably connect the cam 183 to the bracket. The curvature of slot 186 causes the curved, butt engaging flange 184 to hug the needle cylinder and properly engage the needle butts 28 for the full depth of their throw. If the slot 186 were straight or not of the proper curvature, the needle butts 28 would, as the needle cylinder revolves, move away from and out of contact with the flange 184. A leaf spring 188 attached to the bracket 181 by the screw 182 and at its free end seated within a notch provided in the lower end of the cam 183, maintains the said cam 183 in either its raised or lowered positions when the said cam is moved by the lever 163 through the connections hereinbefore described. It is impossible to provide for and maintain an exact fit between the spaced arms or wings 162 and the ball 161 constituting the outer end of stud 160 and if there is a looseness or play in the said connection, the cam 183 may not, at all times, be maintained in the exact raised or lowered positions desired and even a slight variation in the positions of the cam 183 will result in an unevenness of stitch very noticeable and objectionable in the fabric.

When knitting a plain sole and a ribbed instep the sinkers themselves may be so controlled or rather selectively elevated, as to permit the cylinder needles knitting the plain sole to draw their stitches over the upper edges of the sinkers which are positioned at a level above that which they occupy during plain circular knitting. To accomplish this purpose a half-ring or other means may be positioned under the sinkers which constitute the plain sole half or portion of the sinker head, and means provided to raise the half-ring or other means during the last circular course constituting the ring toe. In order to close the eyelets otherwise formed at the second transfer i. e., where the dial needles on the heel side of the dial are projected to knit all around ribbed fabric in conjunction with the cylinder needles, the sinkers on the heel half or portion of the sinker head, which are held in raised position throughout the knitting of the plain sole, remain in such position as the dial needles on the heel half or portion of the dial are projected to take the first course of ribbed knitting, thereafter for the second course the dial needles are retracted without taking yarn and for such second course the mentioned sinkers may be lowered a short distance or may be fully lowered, and thereafter for the third and succeeding courses the sinkers may be fully lowered if not fully lowered for the second course. If lowered a short distance only, for the second course, the needles cooperating therewith will knit relatively loose stitches and cast off their old stitches, whereas if the sinkers are fully lowered for the second course the sole cylinder needles will knit a relatively tight stitch and may not properly cast off their previous course stitches from their latches.

Figs. 24, 51, 52, 53, 54, and 55 disclose the driving connections between the needle cylinder and dial whereby the dial is driven by the cylinder and the said dial and cylinder maintained in a relatively fixed circumferential relation. A ring gear 189 is seated in and supported by the circular base 140 which is stationary and provides a bearing support for the said ring gear. Fastened to and part of the ring gear 189 is a spur gear 190 and connected to the circular base 140 is a plate 191 overhanging the spur gear 190 and serving to hold the latter and ring gear 189 in place. The teeth of an intermediate gear or pinion 192 mesh with the teeth of spur gear 190 and also with the teeth of a second spur gear 193. The intermediate gear 192 is removably connected to the circular base 140 as by screws 194,

195 the latter passing through a slot 196 formed in one arm of the bracket 197 to permit adjustments of the intermediate gear 192 with respect to the spur gears 190 and 193. The bracket 197 has an upstanding sleeve or bearing 198 receiving therewithin a stub shaft 199 formed as an extension of the intermediate gear 192 and attached to the upper end of the shaft 199 is a headed pin 200 provided with a reduced shank portion 201. Semicircular plates 202 are fastened to the sleeve or journal 198 as by screws 203 and engage under the head of the pin 200 so that upon removal of the screws 194, 195 the entire bracket and spur gear 192 may be raised bodily from the ring gear and removed from the machine. As before stated the intermediate gear 192 meshes with a third spur gear 193 the latter integral with or connected to a sleeve 204 and rotary movements imparted to the gear 193 through the intermediate gear 192 are transmitted to a shaft 205 through an inner collar or sleeve 206. As shown in Figs. 51 and 53 the outer sleeve 204 carrying the gear 193, is made fast to the inner sleeve 206 by means of set screws 207 engaging two arms 208 of sleeve 206, the arms formed by cutting away or removing portions of the sleeve at opposite sides thereof, the set screws 207 retained in place by locking screws 209. Thus rotary movements imparted to the gear 193 are transmitted through the outer sleeve 204 to the arms 208 and to the inner sleeve 206. Fastened to the inner sleeve 206 is a spline or key 210 seated in a keyway 211 cut in the shaft or rod 205 to thereby connect the inner sleeve 206 with the rod 205 and cause the rod to rotate with the inner sleeve and with the gear 193. The shaft 205 extends above the spline, keyway, and sleeve 206 and is provided adjacent its upper end with threads 212 to which is secured a collar 213 as by screws 214, the collar resting against a thrust bearing 215 seated in the upper end of dial supporting post 57. At its upper end shaft 205 has fixed thereto a spiral gear 216 meshing with a second spiral gear 217 carried by one end of a shaft 218 journalled in bearings 219, Fig. 51, and at its other end having a spiral gear 220 meshing with a spiral gear 221 carried by the upper end of shaft 51. Casings or guards 222 cover the several gears 216, 217, 220, 221 as well as the connecting shaft 218. Fixed to the shaft 51 immediately beneath the gear 221 is a collar 223 having a flange 224 and immediately beneath the flange is a thrust bearing 225 to take care of downward thrust due to the rotation of the dial. A bifurcated plate 226 seats upon the upper surface of the flange 224, the two arms of the plate partly encircling the collar 223 and acting to take the upward thrust of the shaft 51. The plate 226 is rigidly attached to a collar 227, the latter forming the outer end of the bracket arm 70 connected to the dial supporting post 57. The collar 227 is fastened as by screws (not shown) to the sleeve 50 forming part of the bracket 40 to which is rigidly connected the dial cap 41. The bracket 40 also serves to provide a bearing for the shafts 99 and 39 respectively actuating the casting off cam 21 and knitting cam 15, and in conjunction with sleeve 50 provides a bearing for the dial supporting shaft 51.

The dial 2 is supported upon the shaft 51 to rotate therewith by means of a hub or sleeve 228 integral with the dial and depending therefrom, the hub 228 fastened to the shaft 51 by means of a set screw as at 229. Surrounding the hub 228 is a sleeve 230 recessed as at 231 and 232 and made fast to the hub 228 by a screw 233. The recess 231 permits ready connection and disconnection of the dial 2 from the shaft 51 and also provides as an indication to properly aline the dial and cylinder so that the long, medium and short butted dial needles may be positioned in the right tricks or grooves in the needle dial. The recess 232 provides a means whereby the auxiliary take-up hooks (not shown) may engage the fabric during the knitting of the heel and toe pockets and maintain a tension upon the stitches so that the dial needles, when introduced, will cast off their stitches.

Figs. 56–73 inclusive disclose the pattern or control mechanism for timing the various operations necessary during the knitting of a complete stocking. In the said figures the main drum 234 which rotates one complete revolution for each stocking knit is carried by the main cam shaft 235 the latter also carrying the upper fashioning drum 236 adjacent one end thereof and adjacent the other end thereof a stop motion wheel or disc 237 as well as a cam disc or wheel 238, all of the parts mentioned fast to and turning with the main cam shaft 235. Situated below the oil pan 239 and forming part of the machine frame is an auxiliary cam shaft 240 having fixed thereon adjacent one end thereof a lower fashioning drum 241, as well as the drum 68 for controlling the movements of the dial knitting and casting off cams and the cam drum 148 adapted to time and control the movements of the cam 32. The movements of the main cam shaft 235 are governed and controlled by pattern chain 242, Figs. 1 and 56, as is usual in Banner machines, a pawl (not shown) controlled from the "104" gear advancing the ratchet 243 and chain 242 the distance between adjacent ratchet teeth once for each four courses of knitting, each link of the chain 242 representing three rackings or twelve courses. The chain 242 and ratchet 243 are freely mounted upon the cam shaft 235 and while the aforesaid pawl does not directly move or rotate the main cam shaft 235 it controls the movements thereof through appropriately positioned lugs or cams 244 on the chain 242 which control a lever 245 the latter normally maintaining a second pawl (not shown) idle but adapted when actuated by a lug 244 on the chain 242, to permit the said second pawl to drop into engagement with a ratchet 246, fast to the cam shaft 235, and thereby impart a movement to the main cam shaft and drums.

The movements of the auxiliary cam shaft are indirectly controlled by the pattern chain 242 and directly by the cam wheel or disc 238 fast to the said main cam shaft 235.

A cam 247 is fastened to the pattern wheel 238 adjacent to the periphery 248 thereof by means of a screw 249 passing through an elongated slot 250 provided in the cam and into threaded engagement with a hole 251. The cam 247 is curved as at 252 to seat upon a step 253 on the pattern wheel and is provided with a beveled or inclined edge 254 adapted to actuate a lever as hereinafter set forth. Other cams hereinafter referred to are similarly constructed and mounted upon the pattern wheel 238. When one of these cams is racked around to the position shown, Fig. 60, the next racking of the main cam shaft 235 causes the said cam to engage a toe 255 carried by one arm of a bell crank lever 256 pivoted at 257 on a bracket 258 fastened to the oil pan 239. The other arm of the bell crank lever 256 has a toe 259 in engagement with a

screw 260 adjustably connected to one arm 261 of a lever 262 the two arms of which are connected by a longitudinally extending shaft 263 carried and pivotally supported by depending arms 264 of a bracket 265 fastened to the underside of the oil pan 239. To the other end of the shaft 263 is fixedly secured the other arm 266 of the lever 262 and pivotally carried by the said arm 266 at 267 is a pawl 268 maintained in normal engagement with teeth 269 upstanding from the face of the drum 68 by a spring 270 attached at one end thereof to pawl 268 and at the other end to the oil pan 239. The aforesaid engagement of the toe 255 by a cam upon the cam wheel 238 rocks the lever 256 and consequently also the lever 262, the rocking of the last named lever moving pawl 268 and thereby racking the drum 68 by engaging teeth 269 carried thereby. The movement of the drum 68 carries an idler mounted thereon from under a constantly reciprocating pawl 271 pivotally carried by one arm 272 of a lever 273 pivoted at 274 to a bracket 275 itself carried by and mounted upon the oil pan 239. The second arm 276 of lever 273 is pivotally connected to a link 277 to the other end of which is connected a yoke 278 consisting of two semicircular sections connected together as by bolts or screws 279 and encircling an eccentric 280 fast to a shaft 281. The shaft 281 is mounted in eccentric bushings 281' which are circumferentially adjustable and held in adjusted positions by means of screws and lock nuts as shown. The shaft 281 has fixed thereto a gear or pinion 282 in mesh with the "104" gear and the shaft 281 and bushings 281' are supported by brackets 283 fastened to the machine frame as by screws or bolts 284. The pinion 282 is provided with twenty-six teeth and consequently for each revolution of the "104" gear, there are four revolutions of shaft 281, thus reciprocating the link 277 through the eccentric once for each course of knitting. The reciprocations of the link 277 are transmitted to the pawl 271 through the lever arms 272, 276, the pawl 271 through the connections described, reciprocating idly once for each course of knitting when held out of engagement with the ratchet teeth 269 by an idler on drum 68, but acting to rack the drum 68 once for each course of knitting when released from the idler by the mechanism hereinbefore described and including the starting pawl 268.

The racking of the drum 68 positions cams under the several levers 111, 95, 65, respectively controlling or timing the movements of the casting off cam 21, the up and down movements of the cam 15, the in and out movements of the cam 15, all for the purpose of timing and controlling the changes in the character of rib knitting as from four and one to one and one or the change from plain knitting to rib knitting and from rib to plain.

The cam drum 148 racked around with the drum 68 times the vertical or other movements imparted to the cam 32 to control the stitch drawing movements of the cylinder needles when knitting partly ribbed and partly plain fabric as the ribbed instep and plain sole. The auxiliary or lower fashioning drum 241 also moves circumferentially with the drum 68 and its movements govern the changes in the length of stitch knit by the cylinder needles when the knitting changes from plain to rib and from one kind of rib knitting to another as from four or three to one, to one and one; while the main or upper fashioning drum 236 carried by the main cam shaft 235 governs the changes in the length of stitch drawn by the cylinder needles when the knitting changes from rib to plain. Thus the auxiliary cam shaft is concerned with the control and timing of the cams during ribbed knitting, whereas the main cam shaft alone determines the character and length of stitch for plain knitting, although the auxiliary cam shaft may, at times, determine or assist in determining the length of stitch during plain knitting and the main cam shaft may, at times, determine or assist in determining the length of stitch during ribbed knitting.

Referring to Figs. 56, 57, 58, 65, 66, 67 the fashioning drums 236 and 241 are provided with cams thereon adapted to determine the positions of the cam block 169, cam carrier 38 and cams 30, 31, 36 and 37 thereon by means of a rod 285 connected to the said carrier 38. The rod 285 is slidable vertically and guided in such sliding movements by two bosses or flanges 286 cast with the frame, and duplicated at the upper portion of the said frame but not shown. A cap plate 287 fastened to the bosses 286 as by screws 288 is cut away at 289 to receive a pin or screw 290 fast to the rod 285 adjacent the lower end thereof, which pin 290 projects beyond the cap plate 287 and carries a sleeve or bushing 291. A lever 292 is pivoted at 293 to the machine frame and carries upon the end of one arm thereof cam engaging lugs 294 adjustably seated within recesses 295 and held in adjusted position by screws 296 the latter locked by other screws 297. The end 298 of the other arm of the lever 292 is normally maintained in engagement with the bushing 291 of the pin 290 by the weight of the cam block 169 and cam carrier 38 carried by the rod 285. A link 299 pivoted at 300 to the lever 292 is pivoted at its other end at 301 to a second lever 302 intermediate the ends of the latter, which lever 302 is pivoted at one end at 303 to a bracket 304 depending from the oil pan 239. The bracket constitutes part of the frame and supports the auxiliary cam shaft 240 and cam drums carried thereby. The lever 302 has pivoted thereto at 305 cam engaging lugs 306 adjustably held in set positions with respect to the cams upon the auxiliary fashioning drum 241 by adjusting screws 307 passing through and in threaded engagement with holes provided in one arm of said lever 302. Springs 308 at one end connected to pins 309 carried by lever 302, and at the other to corresponding pins 310 carried by the lugs 306, maintain the lugs 306 and screws 307 in adjustable contact.

Pattern mechanism control of cam drums

As hereinbefore described the upper fashioning drum 236 controls the length of stitch during plain knitting; the lower fashioning drum 241 controls the length of stitch during ribbed knitting; the drum 68 controls the in and out and up and down movements of the dial cam 15 as well as the in and out movements of casting off cam 21; the drum 148 controls the cylinder needles during two-level rib knitting i. e., when certain of the cylinder needles are drawing their stitches over the shanks of dial needles and others of the cylinder needles are drawing their stitches over the upper edges of the sinkers as in plain knitting. Hereinbefore the operating connections between the needles and the pattern drums have been described and now the various cams and lugs carried by the cam drums or discs mounted upon the upper and lower cam shafts 235 and 240 will

be described as well as the functions and how they time and control the desired movement of the cylinder and dial needles.

In Fig. 74 is shown a stocking the leg and instep portion of which are knit four and one rib while the sole is knit plain and the top of the stocking knit one and one rib with tuck welt courses incorporated therein. Figs. 68–71 of the drawings show the cam drums developed and the various cams and lugs positioned to knit the stocking shown in Fig. 74. Although Fig. 74 discloses a stocking with a four and one leg and ribbed instep and with a one and one ribbed top, the cams as arranged on their respective drums, Figs. 68–71, are adapted without change to knit other forms of ribbed stockings as for instance a two and one or three and one leg and ribbed instep followed by a one and one or other ribbed top, the relative arrangement of plain and ribbed stitches depending upon the arrangements of long, medium, and/or short butted dial needles as well as the relative number of dial and cylinder needles. The cams as shown, Figs. 68–71, permit the knitting of a ribbed instep and leg of one kind of rib and the knitting of a ribbed top of another kind of rib.

Developed views of cam drums with cams arranged thereon to knit a one and one instep and leg throughout, are shown in Figs. 72 and 73, which figures correspond to Figs. 69 and 70 but with different arrangements of cams. In combination with the cams positioned on the drums as shown in Figs. 72 and 73, the cams on the drums, Figs. 68 and 71, are not necessarily changed for the knitting of a one and one fabric throughout the ribbed instep and leg.

Although the foregoing description refers to a one and one ribbed instep and ribbed leg throughout, the dial and cylinder needles may be arranged to knit, throughout the instep and leg, two and one or three and one, or any other proportion of rib and plain wales so long as the ribbed fabric is uniform throughout the instep and leg, and without disturbing the arrangements of cams as shown in Figs. 72 and 73.

The stocking shown in Fig. 74 is, preferably, knit from the toe to the top although knitting may begin at the top. The various operations of the machine including the movements of the dial and cylinder needles are primarily controlled and timed by means of lugs **244** carried by a pattern chain **242** as hereinbefore described, the chain **242**, from time to time, advancing the upper cam shaft **235** and cams mounted thereon including the pattern wheel **238**, which latter initiates and times the movements of the lower or auxiliary cam shaft **240** and cams mounted thereon.

The cam or lug **247** carried by the pattern wheel **238** having caused the starting pawl **268**, acting through the bell crank lever **256**, to advance the drum **68** and move the idler **311** out from under the pawl **271**, the latter engages the ratchet teeth **269** and advances the drum during the knitting of a few courses and until a second idler **312** raises the pawl **271** above the teeth **269**. While the drum **68** is being racked the distance between the two idlers **311** and **312** a few so-called waste courses constituting the last few courses of a stocking are knit by the dial and cylinder needles and thereafter, while the pawl **271** is advancing the drum **68**, a cam **313** carried by the drum **68** and acting through connections heretofore described causes the casting off dial cam **21** to be projected to the position shown in Figs. 15 and 16 to thereby cause the dial needles to cast off their stitches.

After the casting off cam **21** has been projected by the cam **313**, the pawl **271** while constantly reciprocating rests upon the idler **312** and therefore does not engage the teeth **269** and advance the drum **68** until the cam **314** carried by the wheel **238** causes the starting pawl **268** to advance the pattern drum **68** again and move the idler **312** from under the pawl **271**. After the casting off cam **21** has caused the dial needles to cast off their loops, the cylinder needles alone knit a few waste courses at the top of the stocking and as a continuation thereof a few other plain courses or so-called loopers-rounds constituting the beginning of the next stocking.

Waste courses, loopers-rounds and toes

With the idler **312** holding the pawl **271** elevated so that the latter while constantly reciprocating rides idly upon the upper surface of the idler, the drum **68** remains stationary during the time pawl **271** is inactive. Throughout the knitting of the waste courses and the loopers-rounds as well as during the knitting of the toe, Fig. 74, the cylinder needles alone are knitting and at such time the pattern wheel **238** is at rest with the toe **255** of the bell crank lever **256** upon the periphery of the pattern wheel between the cams **247** and **314**.

During the knitting of the waste courses constituting the last few courses of a stocking and the loopers-round constituting the first few courses of another stocking, the cam **315** carried by the drum **236** is in engagement with a lug or toe **294**, and the length of stitch knit by the cylinder needles is thus determined by the cam **315** on the upper fashioning drum **236**. During the knitting of the toe a lug **294** rests against a cam **316** carried by drum **236** and thereby determines the length of stitch for the toe.

Ring toe

During the last reciprocating stroke of the knitting of the toe the pattern wheel **238** is advanced by means of the pattern chain **242**. The movement of the pattern wheel **238** brings the lug or cam **314** directly opposite the toe **255** of the bell crank lever **256** rocking the latter and causing the starting pawl **268** again to advance the drum **68** and move the idler **312** from under the constantly reciprocating pawl **271** the latter then engaging the teeth **269** and racking the drum **68** once for each course of knitting and until an idler **317** moves under the pawl **271** and elevates the latter above and out of contact with the teeth **269**.

Before the idler **317** elevates the pawl **271** a cam **318** carried by the drum **68** and acting through the connections **112—99** heretofore described causes the casting off cam **21** to be projected to the casting off position of Figs. 15 and 16, the cam **21** when projected moving all the dial needles to such a position that their latches may be opened by means of a latch opening brush **319**, Fig. 1. The toe **112** of the lever **111** rests upon the cam **318** throughout the knitting of the ring toe, Fig. 74, and pawl **271** reciprocates upon the idler **317**.

If it be desired to use a different and lighter yarn for the foot than for the toe a lighter yarn may be substituted for the toe yarn two or three courses prior to the first transfer, i. e., where the long butted ribbed needles are projected to

knit the first course of the ribbed instep, and in order to do this a cam **320** carried by the upper fashioning drum **236** engages a toe **294** thereby determining the length of stitch knit by the cylinder needles, the dial needles inactive throughout the knitting of the toe. Ordinarily the cylinder needles draw the same length of stitch during the knitting of the ring toe as they do during the knitting of the heel and toe, but a cam **321** may be provided upon the upper fashioning drum if a different length of stitch be desired for the ring toe.

Although any desired length of stitch may be used, preferably the stitch drawn by the cylinder needles when under control of the cam **320** is relatively short or tight while the stitch drawn by the cylinder needles as determined by the cam **316** during the knitting of the heel and toe is the longest or loosest and the stitch drawn by the cylinder needles for the ring toe as determined by cam **321** may be of an intermediate length or the same length as the stitch used during the knitting of the heel and toe.

Ribbed instep

A few courses prior to the beginning of ribbed instep knitting a lug or cam **322** carried by the pattern wheel **238** and acting through the bell crank lever **256** causes the starting pawl **268** to advance the drum **68** to such a position as to move the idler **317** carried by the drum **68** from under the pawl **271**, the latter thereafter engaging the teeth **269** and racking the drum **68** until an idler **323** carried by the drum **68** again elevates the pawl **271** to an inactive position, the drum **68** then remaining stationary until again moved by the starting pawl **268**. Just prior to the idler **323** moving to a position under the pawl **271**, a cam or lug **324** carried by the drum **68** engages lever **65** which lever acting through the connections heretofore described, causes the long butted dial needles, i. e., the ones in the instep half or portion of the needle dial, to be projected to take yarn for one course. Immediately thereafter and for a second course the lever **65** drops off of the cam **324** as at **325**, and the long butted dial needles are thereby retracted and do not take yarn for the second course, but hold their first course loops while the cylinder needles alone knit the said second course. For the third course and thereafter a second lug or cam **326** engages the lever **65** and through the connections described again projects the dial cam **15** and the long butted dial needles thereafter take yarn and knit throughout the ribbed instep. The third movement of the drum **68**, i. e., the one that causes the cam **326** to engage the lever **65**, brings the idler **323** under the pawl **271**, and the said idler remains in such position throughout the knitting of the instep.

It is desirable that the plain sole cylinder needles and the instep cylinder needles be controlled so as to knit at different levels during the knitting of ribbed fabric by the instep dial and cylinder needles, and plain fabric by the sole cylinder needles. For that purpose cams are provided upon the lower fashioning drum **241** to control the length of stitch knit by the instep cylinder needles while at the same time cams on drum **148** depress the cam **32** and cause the sole cylinder needles to knit at a lower level and over the sinkers. As the dial needles are projected by means of cam **324**, as above described, to take the first course of ribbed knitting and as the dial needles are retracted for the second course it is not necessary that the plain sole needles knit otherwise than as in plain knitting but when the dial cam **15** is projected by means of the cam or lug **326**, as described, for the third and succeeding courses of ribbed instep knitting it is necessary that the plain sole cylinder needles, and if desired certain of the cylinder needles which knit the ribbed instep in conjunction with the long butted dial needles, be specially controlled to draw their stitches over adjacent sinkers. Otherwise, during the knitting of the ribbed instep, and plain sole, if the cam block which controls the movements of the cylinder needles were set to permit the instep cylinder needles to draw the desired length of stitch and over adjacent dial needles, the plain sole cylinder needles would not be depressed to an extent to draw the desired length of stitch over the upper edges of the sinkers. Therefore the plain sole cylinder needles, i. e., the ones having additional butts, must be depressed an additional amount to compensate for the difference in the knitting levels, i. e., the level defined by the shanks of the dial needles and the level defined by the upper edges of the sinkers, and for that purpose the cam **32** is lowered by a cam **327** and connections therefrom, Figs. 35, 61, as the instep needles are knitting the first ribbed course in conjunction with the long butted dial needles. However, the lowering of the cam **32** prior to the long butted dial needles taking thread for the first rib course, does not affect the length of stitch in the plain sole as the cam block **169** is not raised by a cam **328**, Fig. 69, and connections leading therefrom until just prior to the third course.

Heel

The idler **325** remains positioned under the pawl **271** throughout the knitting of the ribbed instep, but while the instep needles are knitting their last course prior to the knitting of the heel, the lug **329** carried by the pattern wheel **238** actuates starting pawl **268** in the manner hereinbefore described which advances the drum **68** and moves the idler **323** thus releasing the pawl **271** and permitting the latter to rack the drum **68** until an idler **330** again raises the pawl **271** and stops the racking of the drum **68**. The first racking by the pawl **268** moves cam **326** from under lever **65**, the spring **71** then retracting the cam **15** and the dial needles which dial needles remain inactive during the knitting of the heel although they hold their stitches.

Th first racking by pawl **268** also causes the drum **241**, moving with the drum **68**, to advance a sufficient distance to move cam **328** and release a toe **306** which permits the cam block **169** to drop and the cylinder needles to knit plain fabric for the heel by drawing their stitches over the upper edges of the sinkers in the usual manner. Upon release of the cam block **169** by cam **328** as just stated, the upper fashioning drum **236**, by means of its cam **331**, resumes control of the length of stitch drawn by the cylinder needles. The cam **327** although still engaging the toe **146** of lever **143** and thereby holding the auxiliary cam **32** in its lowermost position, does not govern the length of stitch drawn by the cylinder needles as the cam block **169** is in its lowermost position and depresses the heel cylinder needles to as low a level as they would be depressed by the cam **32**, acting upon the auxiliary butts **28** of the heel needles.

Immediately prior to the knitting of heels and toes a counterbalance weight operating upon the take-up rolls (not shown) is moved to such a position as to relieve the fabric from the tension ordinarily exerted by the take-up rolls upon the forming fabric, and when circular knitting is resumed the counterbalance weight is moved back to its initial position, the take-up rolls thereafter tensioning the fabric so that the dial needles will properly cast off stitches.

Rib and plain above heel

Circular knitting is resumed immediately upon the completion of the heel and for several courses thereafter the long butted instep dial needles knit four and one ribbed fabric in conjunction with cylinder needles while the plain sole, cylinder needles alone knit plain fabric for the rear half or portion of the stocking.

After the last reverse stroke of the needle cylinder completing the knitting of the heel gore, the pattern chain **242** acts as hereinbefore stated to cause the main cam shaft **235** and pattern wheel **238** to advance, and the movement of the pattern wheel **238** carries the cam or lug **332** to a position opposite the toe **255** of the bell crank lever **256**, thereby rocking the said bell crank and causing the starting pawl **268** to advance the drum **68** again and move the idler **330** from under the pawl **271**. The pawl **271** thereafter engages the ratchet teeth **269** and further advances the drum **68** until the next idler **333** elevates the pawl **271** to an idle position above the ratchet teeth **269**. As the idler **330** moves from under the pawl **271** a cam **334** carried by the cam drum **68** moves under the toe **67** of the lever **65**, raises one arm thereof and, through the connections hereinbefore described, again projects the dial cam **15** and restores the long butted dial needles to active, knitting position.

As the long butted dial needles are projected by the cam **334** acting through the connections described, a cam **335** carried by the upper fashioning drum **236** rocks the lever **292** and raises the cam block **169** to its uppermost position, the instep cylinder needles at such time knitting at the upper level while the double or special butted sole needles knit at a lower level and over the sinkers, the cam **327** carried by the drum **148** acting to cause the special butted cylinder needles to knit at the mentioned lower level and over the upper edges of the sinkers. The cam **335** is attached to the drum **236** by means of two screws **336** and **337** the latter screw serving adjustably to position one end of the cam **335** at a level above the other cams carried by the drum **236** and at or substantially at the level of a cam **338** carried by the lower fashioning drum **241**, the cams **338** and **335** constituting in effect a single cam in that as the cam **335** releases the lever **292**, the cam **338** moves under a toe **306** of the lever **302** and thereby maintains the cam block **169** elevated as before.

All ribbed leg

After a certain number of partly plain and partly ribbed courses have been knit the medium butt dial needles **13** are projected to a position to be interspersed among the plain sole cylinder needles and to knit, in conjunction therewith and with the long butted dial needles and the instep cylinder needles, a four and one all around ribbed leg.

While the long butted dial needles are passing the cam **15** the pattern wheel **238** is again advanced by the pattern chain **242** and the movement of the pattern wheel **238** causes a lug or cam **339** carried thereby to rock the bell crank lever **256** and actuate the starting pawl **268** to initiate movement of the lower cam shaft **240** and drum **68**. The initial movement of the drum **68** causes the idler **333** to move from under the pawl **271**, the latter then engaging the ratchet teeth **269** and advancing the drum **68** until the pawl **271** is again raised by means of an idler **340**. The movement of the pattern drum **68** causes a cam **341** to engage the toe **96** of the lever **95** and, through the connections hereinbefore described, lowers the dial cam **15** to an intermediate position. Upon continued rotation of the needle dial the medium butted dial needles are engaged and projected with the dial cam **15** to take yarn for one course. Immediately thereafter and while the long butted dial needles are moving past the cam **15**, the toe **96** of the lever **95** drops off of the cam **341** and upon the surface of the cam plate at **342** thereby elevating the cam **15** to its upper position. During the said second course the medium butted dial needles remain in retracted position not taking yarn but holding their first course loops and as the long butted dial needles move past the cam **15** for the third course the said cam is again lowered to an intermediate position by means of a second cam **343** engaging the toe **96** of the lever **95** and as hereinbefore described causing the cam **15** to drop to an intermediate position where it projects the medium as well as the long butted dial needles, the dial cam **15** thereafter remaining in such position throughout the knitting of the four and one portion of the leg of the stocking

The described movements of the dial cam **15**, i. e., lowered to an intermediate position for the first course of all around ribbed knitting, raised during the second course, and finally relowered for the third and succeeding course of ribbed knitting, closes eyelet holes which would otherwise be formed by the additional wales knit in by the medium butted dial needles. The movements of the cam **15** are similar in effect to its movements prior to the first transfer, i. e., when the long butted dial needles are advanced to begin ribbed instep knitting, except that for controlling the movements of the long butted dial needles during the first three courses of instep ribbed knitting, the dial cam **15** is projected for the first course, retracted for the second course, and again projected for the third and succeeding courses of ribbed instep knitting; whereas for the first three courses of all around rib knitting the dial cam **15** is lowered to an intermediate position for the first course, raised for the second course, and relowered for the third and succeeding courses of all around, four and one, ribbed knitting.

As the dial needles **13** are projected for the first course of all around ribbed knitting, cam **338** carried by the lower fashioning drum **241**, engages with a toe **306** of a lever **302**, Fig. 65, and thereby, through the link **299**, maintains the cam block **169** elevated so that all of the cylinder needles will thereafter knit at the upper level, unless it be desired to specially control intermediate cylinder needles, i. e., the ones not flanked by dial needles. The cam **327** theretofore under the toe **146** of the lever **143** and maintaining the cam **32** at a low level for the purpose of causing the special or double butted cylinder needles to knit at a lower level than the other cylinder needles, simultaneously with the projection of the medium

butted dial needles 13 as the cam 341 depresses the cam 15, moves out from under the toe 146 of the lever 143, the spring 149 causing the said toe 146 to come to rest upon a screw 344 adjustably affixed to cam drum 148. For the second course of knitting and as the toe 96 of the lever 95 drops off of the cam 341, the toe 146 of the lever 143 is again elevated by means of a screw 345 adjustably fastened to the drum 148 the upper surface of which screw is positioned at a level, preferably, intermediate the upper surface of the screw 344 and of the surface of the cam 327. Thereafter for the third and succeeding courses of knitting and as the toe 96 of the lever 95 rides up on a cam 343, the toe 146 of the lever 143, drops off of the screw 345 and on to the upper surface of a screw 346 the upper surface of which is at the level of the screw 344. The medium butted dial needles after having taken a first course of thread hold the same during the second course of knitting and although the screw 345 determines the length of stitch to be drawn by the cylinder needles, the aforesaid medium butted dial needles tend to lengthen the stitch knit by the cylinder needles for the second course and if the upper surface of the screw 345 were flush with the upper surface of the cam 327 the stitches drawn by the cylinder needles for the said second course would be too long.

One and one ribbed top

Throughout the knitting of the four and one all around ribbed leg the pawl 271 idly reciprocates upon the idler 340. If it be desired to finish the top of the stocking in one and one rib the short butted dial needles 14 are projected by the dial cam 15 so as to knit, in conjunction with the cylinder needles, one and one all around ribbed fabric. In order to permit the dial cam 15 to engage and project the shortest butted dial needles it is necessary to specially actuate the dial cam as will now be described.

As a cam 347 carried by the pattern wheel 238 actuates the starting pawl 268 in a manner hereinbefore described the latter advances the drum 68 and thereby causes the idler 340 to be moved out from under the pawl 271 which pawl thereafter racks the drum 68 for each course of knitting and until another idler 348 elevates the pawl 271 out of active relation with the ratchet teeth 269. As the drum 68 is advanced cam 334 moves from under the toe 67 of the lever 65 and permits the cam 15 to be retracted by the spring 71. For one or two courses the cylinder needles alone knit and the dial needles although in retracted position hold their loops. During the one- or two-course interval the dial cam 15 is depressed to its lowermost position by cam 349 which latter cam acts as a continuation of the cam 343 though at a higher level above the surface of the drum 68 than the said cam 343. The cam 349 engages the toe 96 of the lever 95, and thereby causes the retracted dial cam 15, through the connections hereinbefore described, to be depressed to a position to engage the short butted dial needles 14 as well as the medium and long butted dial needles. In order to close the eyelet holes otherwise formed by the addition of the short butted dial needle wales the short as well as the long and medium butted dial needles are advanced for one course and then retracted, and for this purpose a cam 350, acting through the connections described, projects the dial cam 15 for one course. Immediately thereafter the cam 350 moves out from under the toe 67 of lever 65 and permits the said toe to drop onto the surface of the cam plate at 351 and the spring 71 to retract the dial cam 15 and consequently the dial needles. The dial needles remain in retracted position for one or two courses while the cylinder needles alone knit, but immediately prior to the next course a cam 352 acting through the lever connections heretofore described again projects the dial cam 15 which advances all of the dial needles to take thread and knit all around one and one ribbed fabric in conjunction with the cylinder needles.

As the toe 67 of the lever 65 drops off of the cam 334 thereby retracting the dial cam 15 and consequently the dial needles, a toe 306 of the lever 302 drops off of the cam 338 carried by the lower fashioning drum and for one or two courses the length of stitch drawn by the cylinder needles is determined by a lug 294 carried by the lever 292 in engagement with cam 353 carried by the drum 236. As the dial needles are all projected for one course by means of the cam 350, a cam 354 carried by the lower fashioning drum 241 engages the toe 306 of the lever 302 and raises the cam block 169, the cylinder needles then knitting at the higher level and drawing their stitches over the shanks of adjacent dial needles. Immediately thereafter and for one or two courses the dial cam 15 is retracted as the toe 67 of the lever 65 drops off of the cam 350. As the dial needles retract, the cam 354 moves out from under the toe 306 of the lever 302, the cam block 169 drops to a lower knitting level and the aforesaid cam 353 carried by the cam drum 236 again determines the vertical position of the cam block 169 during the mentioned one or two courses. For the next course and thereafter the cam 352, acting through the connections heretofore described, projects all of the dial needles and a cam 355 upon the drum 241 engages a toe 306 carried by the lever 302 and thereby again raises the cam block 169 to its upper knitting level at which level the cam block remains throughout the knitting of the one and one ribbed top.

The cams 338 and 355 are not in alignment but the cam 338 is mounted in one circular series of holes by means of a set screw and the cam 355 is similarly mounted in another circular series of holes. By such an arrangement the toes 306 respectively opposite the cams 338 and 355 may be adjusted at different distances from their respective cams and thereby determine a slight difference in the length of stitch drawn by the cylinder needles when controlled by the respective cams 338, 355. Although any desired relative length of stitch may be employed the stitch knit by the cylinder needles when under control of the cam 355 is, preferably, somewhat longer or looser than the stitch knit by the cylinder needle when under control of the cam 338.

If it be desired to knit a so-called tuck or other welt, W, Fig. 74, the cam 352 is cut away somewhat as at 356 though not to an extent to permit the dial needles to be completely retracted. As a toe 67 of the lever 65 drops off of the cam 352 and onto the recessed portion 356 thereof the dial needles all retract to a so-called welt position, i. e., to a position where while they do not cast off their stitches from their latches nevertheless they take thread for each course. The thread is thereby accumulated in the dial needle hooks and is not cast off until two or more such tuck courses have been taken by the dial needles after which the toe 67 of the lever 65 is again elevated by a cam 357 which latter cam is at the same elevation as the cam 352. As the dial needles are again projected they cast the accumulated or

tucked loops off from their latches and draw a new course of thread through the same to complete the welt W. Thereafter the dial and cylinder needles knit one and one ribbed fabric as before and until other tuck welt courses W', Fig. 74, are to be knit in. A kick of the pawl 271 acting upon the teeth 269 moves the cam 357 under the toe 67 of the lever 65 and causes the dial needles to knit again and also moves an idler 348 under the pawl 271. The drum 68 thereafter remains stationary until a sufficient length of one and one ribbed fabric has been knit and additional welt courses W' are to be knit.

Additional welt courses

At the desired time in the knitting of the one and one ribbed top, a cam 358 carried by a pattern wheel 238 and acting through the bell crank lever 256 causes the starting pawl 268 again to initiate the movement of the drum 68 thereby advancing the same and withdrawing the idler 348 from under the pawl 271, the latter then engaging the teeth 269 and advancing the drum 68 for each course of knitting and until idler 311 moves under the pawl 271 and elevates the same above the teeth 269. During the knitting of the courses measured by the space between the idlers 348 and 311, additional cams 359, 360, 361, 362, and 363 are provided as well as welt cams 364—368. The cams 359—363 act in conjunction with their companion cams 364—368 respectively, and in the same manner to form tuck welt courses as do the cams 356 and 357 heretofore described. Any desired number of tuck welt courses may be provided at the top of the stocking, five such tuck welts knit in with the cams 359—368 arranged as shown.

While the drum 68 is being racked from idler 348 to idler 311, the cam 355 maintains the cam block 169 at its upper knitting level so that all of the cylinder needles measure their stitches over the shanks of adjacent dial needles.

After the toe 67 of the lever 65 rides up the cam 363, a few courses of one and one ribbed fabric are knit until and during the time the idler 311 is holding the pawl 271 out of action and for two courses thereafter.

Any desired number of one and one ribbed courses may be knit in the stocking above the last welt, and the cut edge of the stocking may be turned over to the inside thereof and sewed thereto if desired or the ribbed courses may be stitched adjacent to the last welt and the excess rib courses trimmed.

As heretofore described as the knitting of the desired number of courses continues after the knitting of the last welt, the cam 247 carried by the pattern wheel 238 causes the pawl 268 to initiate a forward movement of the drum 68 such forward movement withdrawing the idler 311 from under the pawl 271 and permitting the said pawl to engage the ratchet teeth 269 and advance the drum 68 until the idler 312 again raises the pawl 271 out of action. During the courses intervening between the idlers 311 and 312 two or three one and one ribbed courses are knit and then the cam 363 as well as the cam 349 release their respective levers and permit the dial cam 15 to retract and move to its upper position and the dial needles to become inactive after which the cylinder needles knit plain fabric. When the cylinder needles have knit a course or two of plain fabric the casting off cam 21 is moved to the casting off position of Figs. 15 and 16, by means of the cam 313 acting upon the lever 111 and the dial needles are then cleared of their stitches by cam 23.

As the idler 311 is moved from under the pawl 271 and the latter racks the drum 68 once for each course of knitting, the cam 355 moves out from under a toe 306 of a lever 302 and the cam block 169 slowly drops to the lower knitting level, and the length of stitch knit by the cylinder needles is then determined by cam 315 carried by the upper fashioning drum 236. The gradual movement of the cam block 169 to its lower knitting level results in the cylinder needles, although still drawing their stitches over the shanks of the dial needles which are still knitting, to draw an excessively long stitch for a few courses. If the cam block 169 were maintained at its upper knitting level until the dial needles were retracted, then the immediate dropping of the cam block 169 to its lower knitting level at the same time that the dial needles were retracted, would prevent the cylinder needles from properly casting off the last course drawn over the shanks of the dial needles.

The cam 369, Fig. 68, serves no useful function during the normal operation of the knitting machine but should the pattern drums and pattern chain 242 be out of time or the mechanism for controlling rib knitting be rendered inoperative, the cam 369 would prevent the cam block 169 from dropping beneath its lower knitting level.

The long butted dial needles for knitting the ribbed instep in conjunction with cylinder needles, may extend half way around the dial if desired; but, preferably, and as indicated in Fig. 74, the long butted dial needles are positioned in the dial grooves around less than one-half of the circumference of the said dial so as to space the rib wales from the heel gore. In Figs. 3 and 5 long butted needles are shown as extending less than halfway around the dial 2 and although as therein shown there are only about sixty needles in the dial, the present invention is not in any way limited to a course gauge machine and in fact, ordinarily, one hundred and fifty or more needles are mounted in a corresponding number of tricks or grooves cut in the dial 2 and the heel gore and adjacent rib wales of the instep separated by two or more rib wales, i. e., two or more plain wales separate the heel gore from the first rib wale at each side of the stocking.

Uniform rib throughout instep and leg

If it be desired to knit one and one or other ribbed fabric throughout the instep and leg, i. e., without a change as from a four and one leg to a one and one top, the cams carried by lower fashioning drum 370 and the drum 371 for controlling the dial knitting and casting off cams are somewhat differently arranged than are the cams upon the corresponding drums 241 and 68. The cams, arranged upon the drums 370, 371 for one and one or other rib, uniform throughout the foot and leg, are shown developed in Figs. 72 and 73 respectively.

When knitting one and one with all the instep cylinder needles drawing their stitches over dial needles, it is necessary to shorten the stitch drawn by the instep cylinder needles as the dial needles take yarn for the first course of the first transfer, i. e., going into the ribbed instep from the ring toe and in order to maintain the cam block 169 at the desired elevation during the transfer, three cams 372, 373, and 374 are attached to the drum 370. The cam 372 is adapted to engage a toe 306 of the lever 302 and elevate the cam block

169 as the long butted dial needles are projected to take thread for the first course. For the second course, as hereinbefore described in connection with Figs. 69 and 70, the long butted dial needles are retracted to a position so that they will not take yarn but will hold the first course loops. As a consequence of the retraction of the long butted dial needles the instep cylinder needles draw their stitches, for the second course, over the upper edges of sinkers as in plain knitting, and therefore the drum 370 is advanced to permit the aforesaid toe 306 to drop off of the cam 372 and an adjacent toe 306 of the lever 302 to rest upon cam 373. With the height of the cam block 169 determined by the cam 373, the toe 306 in engagement therewith is adjusted at a level to permit the cam block 169 to be at a relatively low level and control the instep cylinder needles to draw their stitches over the upper edges of adjacent sinkers. For the third course and thereafter the drum 370 is again advanced, withdrawing the cam 373 from under the second mentioned toe 306 and causing a third toe 306 to ride up and seat upon a cam 374, the latter cam then maintaining the cam block at or substantially at the level determined by the first cam 372. The positioning of the cam block for the first and third and following courses, at the upper knitting level, permits the drawing of a relatively tight stitch while for the second course the instep cylinder needles draw a relatively loose stitch at a lower level.

After the first transfer there is substantially no difference in the operation of the cam drums 370 and 371 as compared with the drums 241 and 68 until after the second transfer, i. e., where the ribbed needles on the heel half or portion of the dial are projected to take yarn and knit all around ribbed fabric in conjunction with the cylinder needles and other dial needles. When knitting four and one, and one and one, three lengths of dial butts are provided, whereas when knitting one and one throughout two lengths of dial butts only are used and the short butted dial needles are located around the heel half or portion of the dial. Furthermore when changing from four and one to a one and one ribbed top it is necessary to specially actuate or control the dial needles in order to effectuate the third transfer, i. e., the knitting in of additional rib wales by the short butted dial needles; but when knitting one and one or other ribbed fabric throughout without change, such third transfer is not necessary and consequently the cam 375 while corresponding to the cam 334, Fig. 70, is considerably longer and the entire all around ribbed leg portion of the stocking is knit with the pawl 271 resting upon the idler 340. Furthermore, whereas when changing from four and one to one and one it is necessary to specially control the length of stitch knit by the cylinder needles and by means of cams 338, 354, and 355; when knitting one and one throughout the cam 354 is dispensed with, and in its place a cam 376 corresponding to but longer than cam 355 acts as a continuation of the cam 338, the two cams 338 and 376, in conjunction with cam 327, controlling the length of stitch knit by the cylinder needles during the knitting of the leg. Just before the short butted dial needles 19 advance to take yarn for the first all around ribbed course a lighter yarn may be substituted for the yarn knit in by the needles during the knitting of the partly ribbed and partly plain portion of the stocking, and as the said lighter yarn is moved to feeding position the cam 376 engages a toe 306 and thereby determines the elevation of the cam block 169. The toe 306 is adjusted to knit a somewhat tighter stitch than is knit during the partly ribbed and partly plain portions of the fabric.

When knitting a four and one rib leg and a one and one rib top as hereinbefore described in connection with Figs. 69 and 70, dial needles with three lengths of butts are used and to actuate the same the cam 15 is depressed or lowered in two steps, first, to engage the medium butted dial needles located upon the heel half or portion of the dial, and second, to engage the short butted dial needles which are interspersed among the long and medium butted dial needles. For the purpose of moving the cam 15 to engage the medium butts and then to engage the short butts, cams 343 and 349, Fig. 70, are provided. However, when knitting one and one or other uniform ribbed fabric throughout the foot and leg portion of a stocking, the cam 377 depresses the dial cam 15', Figs. 13 and 14, to project the short butted needles 19, positioned around the heel half or portion of the dial. The said dial needles take thread for one course and for the second course the toe 96 of the lever 95 drops off of the cam 377 and on to the cam plate at 378, the cam 15' thereupon moving back to its upper position and permitting the short butted dial needles to retract and hold their first course thread during the knitting of the second course. Thereafter for the third course of knitting the cam 379 engages the toe 96 of the lever 95 and again depresses the cam 15' to a position to engage the short butted dial needles 19, the cam 15' remaining in such lowered position throughout the knitting of the leg.

Figs. 75, 76, 77 and 78 disclose a means for preventing complete retraction of the dial casting off cam 21 during rib knitting so that the dial needles 10 are partially projected thereby to a position such that their hooks are substantially in line with the shanks of the cylinder needles 17 prior to and as the latter ascend to cast off their old loops from their latches. Although the dial needles are shown as substantially in line with the cylinder needles, the dial needles may be projected to a position beyond the said cylinder needles if desired, but the object of the special control of the dial needles is accomplished if they are projected as shown.

The partial projection of the dial needles, Figs. 75 and 76, relieves the tension on the rib wales and permits the constantly acting take up which exerts a downward pull upon the web to hold the web and consequently the last knit loops L thereof and prevent the latter from moving up with the ascending cylinder needles as they move up between the dial needles. Furthermore when knitting ribbed fabric with more cylinder needles than dial needles certain of the wales between needle wales are sinker wales and, when the dial needles are partially projected by the casting off cam, the shanks of the said dial needles project over and engage the said sinker wales and thereby assist the take up to prevent the web from moving up with the cylinder needles as they rise between the partially projected dial needles. If the dial needles are not partially advanced the resultant strain upon the stitches by the take up exerting a pull or tension in one direction, the dial needles exerting a tension in another direction, and the ascending cylinder needles exerting a tension in still another direc-

tion, may break certain of the loops or stitches and produce holes in the knit fabric.

The means for preventing the complete retraction of the dial casting off cam **21** during rib knitting consists of an L-shaped stop **380** adjustably fastened to the link **54** as by screws **381** passing through elongated slots **382** provided in the stop **380** and into threaded engagement with the link **54**. An arm **383** of the stop is shown, Figs. 77 and 78, in engagement with a pin or screw **384** carried by the link **103** and consequently preventing the link **103** from being advanced to its fullest extent by the spring **113** and thereby fully retract the dial casting off cam **21**.

Referring specifically to Figs. 79–83 inclusive, needles **385** of a special construction are mounted to slide radially in tricks or grooves **386** cut in the dial **387**. The slots **386** are not cut to a uniform depth but the portions thereof adjacent to the axis of the dial are cut somewhat deeper than are the portions adjacent the periphery of the dial. The dial needles **385** are all of substantially the same construction, differing only in the disposition of special selective butts **388**. The needles may be initially provided with any desired number of such selective butts and, as indicated in Fig. 81, four such butts are provided upon the needles herein disclosed, two of which butts are shown in full, and the other two, intermediate the butts first mentioned are shown in dotted lines. The four or more butts **388** are breakable and as herein shown the two intermediate butts, indicated by dotted lines in Fig. 81, were broken off leaving only the two end butts **388**. However, all of the dial needles **385** do not have their butts positioned as are the butts shown in full lines in Figs. 80–83 but certain of the needles have others of the butts **388** removed, the number and arrangement of the butts **388** on the several dial needles **385** dictated by the pattern or design to be knit in by the said dial needles.

The butts **388** as heretofore stated are selective butts only and each needle has, in addition to the butts **388**, an actuating butt **389** positioned forward of the selective butts **388** and adapted to be engaged by a fixed cam **390** carried by the dial cap. The cam **390** is provided with a cam flange **391** which engages and projects to knitting position such of the needles **385** as have been selected to knit during a given course. Positioned immediately above each of the four selective butts **388** are four cams **392**, which cams are adapted to be independently controlled in any desired manner and so that any one or ones of the said cams may be raised and lowered at will to and from the active or lowered position of the end cams **392**, Fig. 81, and the inactive or elevated position of the intermediate cams, Fig. 81.

Fig. 80 represents the position of a needle which has been previously selected by the cam flange **391** engaging its butt **389** and moving the needle from the position shown in Fig. 83 to that shown in Fig. 80. As will be understood from an inspection of Fig. 83 the cam flange **391** engages the butts **389** of all of the dial needles and for each course of knitting. Thereafter in the knitting cycle, and as shown in Fig. 81, the cams **392** that have been moved to their lowermost positions engage butts **388** and consequently again push down or depress the needles **385** which, when their butts **389** were engaged by the cam flange **391**, were raised to the positions shown in Figs. 80 and 81 by beveled edges **393** provided upon the lower edge of each needle riding up correspondingly inclined or beveled surfaces **394** formed in the dial **387** adjacent the axis thereof. The first selecting movements are imparted to the needles, as before described, by the cam flange **391** engaging the butts **389** and advancing the needles from the position shown in Fig. 83 to that shown in Figs. 80 and 81. Thereafter such of the cams **392** as are in their lowermost positions engage their companion butts **388** and depress certain of the dial needles to the position shown in Fig. 83 while the other dial needles, not so depressed, remain in the elevated position shown in Fig. 81 in which position the dial needles are horizontally supported in the dial grooves so that when they are thereafter projected to take yarn and knit during the ensuing course, they will not be tilted or inclined to the horizontal. The elevated or selected dial needles are later in the knitting cycle, and as shown in Figs. 79 and 82, advanced by a cam **395** which cam though it remains in a fixed position with respect to the needles during the knitting of ribbed fabric, is pivoted at **396** to the dial cap so that it may be moved automatically, and at desired times, to and from the position shown in Fig. 79 to and from a partially retracted position whenever tuck or welt stitches are desired when the partially retracted cam **395** engages the butts **389** of the needles selected as heretofore described and advances the needles to take another course of yarn without clearing their latches until a following course. The butts **389** of the needles that have been depressed by cams **392** engaging butts **388**, pass beneath the cam **395** the forward part of which is cut away as indicated by dotted lines, Fig. 79, sufficiently to permit the idle butts **389**, although projecting a slight distance above the dial **387**, to pass beneath the said cam **395**.

Thereafter in the knitting cycle the butts **389** of all of the needles are engaged by the fixed retracting cam **397** carried by and forming part of the dial cap. The cam **397** is cut away, forward of the dotted lines, Fig. 79, as at **398** so that the latches of the dial needles may have sufficient room to swing to a closed position as they are retracted by the said cam. The dial needles after leaving the cam **397**, traverse a retracted path until they are again engaged by the flange **391** of the cam **390** which cam again advances all of the dial needles by engaging their butts **389** and thereby raising the said needles to the position shown in Figs. 80 and 81 after which the lowermost positioned cams **392** again engage the corresponding butts **388** on the needles and select certain of the needles as before.

This invention may be applied to hosiery machines and to so-called body machines of a much larger diameter and when applied to body machines the greater amount of room available for the manipulation and control of the dial needles permits the use of a greater number of selective butts than are herein shown.

Although the selection of certain dial needles is primarily intended to provide means whereby various changes of ribbed patterns may be knit in, i. e., as from a four and one ribbed instep to a four and one ribbed leg and then to a one and one ribbed top, nevertheless the invention lends itself to a selection of dial needles from course to course or as desired should it be desired to knit in designs or patterns in ribbed fabric whether produced on a hosiery machine or on a body machine.

Referring specifically to Figs. 84–87 inclusive,

wherein is shown still another modified means for controlling dial needles, **399** represents a dial in which are mounted, to slide to and from knitting position, needles **400** some of which are provided with long butts **401** others with intermediate butts **402** and still others with shorter or short butts **403** and in addition thereto all of the needles are provided, forward of the butts **401**, **402**, **403** with butts **404** by means of which the needles are finally moved or advanced to knit.

The slots **405** in the dial in which the dial needles slide to and fro are cut in the usual manner with the bottom walls thereof horizontally disposed and at an equal depth throughout.

In order to select the dial needles or to impart to them a preparatory movement, there is provided a cam **406** carried by a pin **407** by means of which the said cam **406** may be caused, by automatic means not herein specifically disclosed, to assume such positions as to engage and project or select the long butted needles, or the long and medium butted, or all of the needles. In Fig. 85 the cam **406** is shown in an intermediate position where it engages and selects the medium butted as well as the long butted needles. Such of the needles as are engaged by the cam **406** move radially forward a short distance to such a position that their butts **404** may be engaged, and the needles further advanced, by means of a second cam **408** which latter is mounted for pivotal or swinging movements in the dial cap by a pin **409**. Ordinarily the cam **408** is fixed in position but if it be desired to produce tuck welts or other tuck fabric the said cam **408** may be slightly retracted to such a position that the needles **400** controlled thereby will not clear their stitches. The needles **400** whose butts **404** are in the path of the cam **408** and advanced thereby, move forward to take yarn and knit during the ensuing course; whereas the needles **400** not so selected e. g., the short butted needles **403**, remain in their retracted position and pass beneath the cam **406** and as a consequence thereof the butts **404** on the said short butted needles are not engaged and advanced by the cam **408**. Thereafter in the knitting cycle the dial needles are fully retracted by the retracting cam **409** forming part of a dial cam plate **410** fixed to the dial cap after which the butts **401**, **402**, **403** and **404** transverse their respective circular pathways indicated in dotted lines, Fig. 84, until certain ones or all of the dial needles are again selected and partially advanced by the cam **406** as just described.

As the active needles are retracted by the cam **409** the needle latches pass beneath the cam plate **410** and within a recessed or cut out portion **411** thereof which permits the dial latches to be swung to a closed position by the loops or stitches back of the latches.

The modification shown in Figs. 84–87 although primarily intended to be used in hosiery machines of the smaller sizes may equally well be applied to hosiery machines of a larger diameter or to so-called body machines. While the selecting means disclosed in Figs. 79–83 permit greater selection than does the construction specifically disclosed in the Figs. 84–87 inclusive, still the two forms of the present invention have much in common in that, in both forms, a cam or cams select certain of the needles only so that, later in the knitting cycle, they will be engaged by another cam, fixed during normal knitting, and thereby fully advanced to knit in the usual manner.

Figs. 88 and 89 disclose a modification of the means for selectively controlling the stitch forming movements of certain of the cylinder needles hereinbefore specifically disclosed in Figs. 17–23 and Figs. 35–49 inclusive. The cylinder **412**, Fig. 89, has the usual needle slots **413** cut therein providing walls **414** which walls are cut away somewhat as shown in **415** adjacent to the lower portions of the cylinder and slidably mounted within the slots **413** are needles **416** corresponding to but not identical with the special needles **26**, Figs. 17–23 inclusive. The said needles **416** are provided with upper butts **417** by means of which they are depressed when engaged by the upper guard cam **418** and draw cam **419** during plain knitting. At other times it is desirable that the needles **416** be depressed an additional amount to knit at another level as when certain of the cylinder needles are knitting a ribbed instep in conjunction with dial needles while the cylinder needles **416** are knitting a plain sole. Prior to the beginning of rib knitting the cam block is elevated and it is desirable that the cylinder needles **416** be depressed an additional amount to compensate for the elevation of the cam block. To provide for such two or more level knitting other cams **420** and **421** are provided in addition to the stitch drawing cam **419**, and the said cams **420**, **421** are adapted to engage auxiliary butts **422**, **423** and depress their needles so that the latter will knit at another or other levels. The cams **420** and **421** may be mounted upon a cam plate or carrier such as **156**, Fig. 42, and the cam plate corresponding to cam plate **156** may be controlled in the same manner as hereinbefore described in connection with Figs. 40–45. The cams **420** and **421** while fixed to the said cam plate may be adjustable thereon so as to vary the length of stitch drawn by the cylinder needles **416** when their butts **422** and **423** are engaged by the respective cams **420** and **421**. The points **420'** and **421'** of the cams **420** and **421** extend beyond the point **419'** of the cam **419** and the auxiliary butts **422** and **423** are thus depressed an additional amount. The cams **420** and **421** are inclined at a somewhat steeper angle than is the cam **419** so that the butts **422** and **423** are not actually engaged by their respective cams **420** and **421** until the butts **417** reach the point **419'** of the cam **419**.

As heretofore described during the knitting of the ribbed instep and sole the cylinder needles that knit the plain sole are depressed an additional amount so as to knit over sinkers while the instep cylinder needles knit over dial needles and the length of stitch knit by the plain sole cylinder needles is determined by the cam **421** engaging butts **423**. An intermediate length of stitch determined by the cam **420** engaging the butts **422** may be availed of for one of several purposes. During the second course of a transfer the dial needles retract and with the cam block elevated it is desirable that the cylinder needles be depressed an additional amount so as to draw the desired length of stitch over the sinkers but it is not necessary that the said needles be depressed to the extent required of the sole needles during the knitting of the ribbed instep and plain sole and for that reason the intermediate cam **420** by engaging auxiliary butts **422** causes the cylinder needles to draw a sufficient length of stitch. When knitting a rib with three or more adjacent cylinder needles the intermediate cylinder needles which are not adjacent to dial needles may be provided with butts **422**,

and furthermore the first cylinder needle taking yarn for the plain sole during each course of knitting or the first needle of a series of three or more consecutive cylinder needles are, preferably, provided with additional butts such as 422 and depressed to an intermediate level so as to draw a length of stitch somewhat longer than they would otherwise draw if not provided with additional butts such as 422 and 423.

The dot and dash line, Fig. 88 indicates the path taken by the butts 423 of certain of the idle instep needles, which path is above the top of the intermediate cam 420.

In Figs. 90–93 inclusive, is shown a modified construction of needle cylinder 424 provided with needle slots 425 within which are slidably mounted needles 426, and additional slots 427, between the slots 425, within which are likewise slidably mounted jack-like instrumentalities 428. The jacks 428 are reduced adjacent their upper ends as at 429 providing shoulders 430 above which, and adjacent to the said jacks, sinkers 431 are adapted to slide transversely. The upper edges of the jacks 428 are slightly curved or concaved to provide seats 432 for the thread T and, as shown in Fig. 93, some of the needles 426 draw their stitches over the said upper edges or seats 432; the jacks functioning in much the same manner as do sinkers in plain knitting i. e., they provide edges over which the thread or yarn may be drawn by descending cylinder needles. However, the jacks 428 may be positioned at any height desired and, as shown in Fig. 93, are intermediate the level of the shanks of the dial needles and the level of the upper edges of the sinkers. The intermediate or third knitting level may be availed of as hereinbefore mentioned in connection with the description of Figs. 88 and 89 and with such jacks 428 ordinary cylinder needles controlled in the usual manner by cams engaging butts 433, may be used.

Cams 434, 435, 436 by engaging butts 437, 438, 439 control the elevation or position of the upper edges or seats 432 of the jacks 428 when the needles draw their stitches, Fig. 93. The cams 434, 435, 436 may be adjustably mounted upon a cam plate which is connected to move with the cam ring 38 as the latter is elevated or depressed by means such as disclosed in Figs. 35–45 inclusive. The cams 434, 435, 436 are each adjusted on the cam plate so that the jacks which they control will be raised and their edges or seats 432 positioned to cause the adjacent cylinder needles to draw a desired length of stitch.

Although Figs. 89 and 90 show the needles 416 and jacks 428 provided with a plurality of butts, some of the needles and jacks are provided with single butts only, certain of the needles or jacks provided with butts at one elevation and others of the needles or jacks provided with butts at another or other elevations. The cylinder needles that are adapted to knit plain fabric at times and ribbed fabric in conjunction with dial needles at other times as well as the jacks 428 that are adapted to cooperate with cylinder needles to knit plain fabric at times and rib fabric in conjunction with dial needles at other times, are provided with a plurality of auxiliary butts 422, 423, or 437, 438, and 439.

The cams 420, 421, Fig. 88 and the cams 434, 435, and 436, Fig. 90, are mounted to move radially to and from active relation with the butts on the needles 416 or jacks 428. Such radial movements of the cams 420, 421 and 434, 435, 436, are automatically controlled and at desired times so that certain only of the auxiliary butts carried by the needles 416 and jacks 428 may be acted upon by their respective cams as and when desired.

In Fig. 94 wherein is shown a modification of the construction shown in Figs. 90–93 inclusive, and wherein the two parts of a two-part sinker 440 are reduced and separated as at 441. Slidably received between such separated portions 442 of each sinker 440 are jacks 443 which jacks are similar to and selectively controlled in the same manner as are the jacks 428, Figs. 90–93. The upper edges of the jacks 443 are curved as shown at 444 to provide thread retaining seats for the threads drawn thereover by descending needles. The needles draw their stitches over the jacks 443 as they do over the corresponding jacks 428, Fig. 93, but are centrally positioned between the adjacent cylinder needles and for that reason the stitches are more uniform than when the form of jack shown in Fig. 93 is used.

Belt shipper and stop motion

In Figs. 96–99 inclusive there is shown means for stopping the machine either manually or automatically at desired times. A fast pulley 445, a medium speed or slow pulley 446 and a loose pulley 447 are fixedly mounted upon a shaft and when driven by means of a belt (not shown) drive the knitting machine through gearing (not shown). A belt shipper 448 is provided with two arms which serve to shift a belt (not shown) from any one of the mentioned pulleys to another. The said belt shipper 448 is carried by a bracket 449 slidably mounted upon a shaft or rod 450. The sliding movements are imparted to the bracket and belt shipper through the instrumentality of a manually or automatically operated lever 451 which is pivoted at 452 to another bracket 453 upon which latter bracket the first mentioned bracket 449 is mounted to slide, by means of a rib 454 depending from the upper bracket engaging in a groove 455 provided in the upper face of the lower bracket 453. The two brackets 449, 453 are also slidable together as a unit. Intermediate its ends the lever 451 is provided with a more or less triangular shaped opening 456 and received within the latter is a pin 457 carried by and laterally projecting from one side of a lever 458 which is pivoted to the bracket 449 at 459. The said lever 458 consists of a normally horizontally disposed portion extending from the pivot 459 to a point adjacent the aforesaid pin 457 and from there extending at a right angle and then terminating in a horizontally disposed arm with the end 460 thereof projecting through the machine frame for a purpose presently to be described. A spring 461 attached at one end to a pin 462 carried by the upper bracket 449, has its other end fastened to a pin 463 which is fixed to the lever 458. The spring tends to maintain the lever 458 in such a position that the pin 457 carried thereby is in the uppermost portion of the opening 456 and the spring 461 also serves to maintain the lever 458 in such a position that a shoulder 464, provided by a notch cut in the upper edge of the said lever, seats against an adjacent edge of a plate 465 carried by the forming part of the lower bracket 453, which seating of the shoulder 464 against the plate 465 acts as a latch to hold the bracket 449 in a

fixed relation with the bracket 453. When the parts are in the relative position just described, the belt shipper may be holding the belt upon the fast pulley 445 or the medium speed or the slow pulley 446 or in some cases upon the loose pulley 447, the pulley upon which the belt is positioned being determined by other means presently to be described. Carried by the lower bracket 453 is a hollow boss or tubular extension 466 and received within the same is a coiled expansion spring 467 which latter surrounds a pin 468 attached to and forming part of the upper bracket 449. The aforesaid spring 467 bears at one end against the extension 466 and at its other end upon a face 469 of the bracket 449 and when the shoulder 464 is released from engagement with the plate 465 by means presently to be described, the spring serves to move the said bracket 449, with respect to the lower bracket 453 and thereby shift the belt from the fast pulley 445 to the slow pulley 446 or to the loose pulley 447 and in some cases from the slow pulley 446 to the loose pulley 447.

Upon the upper cam shaft 178 is secured a cam drum or disc 470 having a cam 471 thereon which cam is maintained in constant engagement with a pin 472 depending from and carried by the free end of an arm 473 which is pivoted at 474 to a bracket 475 secured to the machine frame. The pin 472 is maintained in adjustable engagement with the cam 471 by means of an adjusting screw 476 carried by the bracket 453, the head of which adjusting screw is held in constant yielding engagement with the arm 473 by means of a spring 477. The spring 477, at one end, is connected to a pin 478 carried by the machine frame and at the other end is connected to a pin 479 attached to bracket 453, and the spring thus normally maintains the said bracket 453 in a position adjacent to the machine frame as shown in Fig. 96. The upper bracket 449 is slidably mounted on the lower bracket 453 by means of the rib 454 received within the groove 455 as hereinbefore described, and is also mounted to slide upon a pin or rod 480 carried by and projecting laterally from the machine frame, while the lower bracket 453 is likewise slidably mounted upon a pin 481 carried by and projecting laterally from the machine frame.

Positioned immediately above the dial needles as shown in Figs. 98 and 99 is a detector 482 adapted to be actuated as will be presently described by the accumulation of yarn upon the needles due to a broken needle latch or to some other cause. The detector 482 is carried by and forms part of a plate 483 adjustably fastened to a second plate 484 as by means of elongated slots 485, 486 in the plate 483 and screws 487 and 488 passing through the respective slots and into threaded engagement with the plate 484. The slots 484, 486 and screws 487, 488 permit the detector 482 to be adjusted to a desired vertical position with respect to the needles. The plate 484 is pivoted at 489 to a block 490 which is fastened to a sleeve or plunger 491 by means of screws such as shown at 492. The sleeve 491 is slidably received within a longitudinally extending opening provided in a bracket 493 which bracket is fastened to the dial cap. The sleeve or plunger 491 is provided with a longitudinally extending opening or recess 494 receiving therewithin a coiled spring 495 the upper end of which engages shoulders 496 provided by the said recess 494, and the lower end of which spring 495 seats upon the upper surface of the dial cap and tends to move the plunger 491 and parts carried thereby, including the detector 482, to an elevated position.

Projecting laterally from the block 490 is an overhanging extension 497 notched as at 498. One arm 499 of a lever 500 is adapted to be seated within the notch 498 and be retained in a set position until released from engagement therewithin by connections controlled from the detector 482. Plate 484 is provided with a bayonet slot 501 within which is received a pin 502 carried by the bracket 493. The aforesaid lever arm 499, having one end thereof normally received within the notch 498, is provided at its other end with a hub 503 attached to a sleeve 504 as by means of a set screw 505. Sleeve 504 is pivotally mounted upon a pin 506 upstanding from and carried by the circular base and has fixedly secured thereto adjacent its lower end, as by means of a second set screw 505, a second lever arm 507 of the lever 500, the free end of which lever arm 507 slidably receives therethrough a rod 508 to which is adjustably fixed, adjacent one end thereof, a collar 509. A second collar 510 is also adjustably fixed to the rod 508, and the lever arm 507 has a sliding connection with the rod 508 between the two collars 509 and 510. A coiled expansion spring 511 surrounds the rod 508 between the collar 510 and the lever arm 507 and tends to move the said arm to the left, Fig. 97, and into engagement with the collar 509. At its other end the rod 508 is pivoted as at 512 to one arm of a lever 513 pivoted at 514 to the machine frame, the other arm of which lever 513 is provided with a keyhole slot 515. A vertically movable rod or detent 516, provided with a head 517 at the upper end thereof, is received through the said keyhole slot 515 and is reduced adjacent its upper end as at 518 thereby providing a shoulder 519 which shoulder normally seats upon the parts of the lever 513 defining the narrow portion of the keyhole slot 515, and is normally supported thereby, in the elevated position of Fig. 96. At or adjacent to its lower end the rod 516 is turned at substantially a right angle as at 520 for a purpose presently to be described and attached to the machine frame adjacent the turned end of the rod is a block 521 to which is fastened a plate 522 positioned to guide the rod 516 in its vertical movements and prevent the right-angled end 520 thereof from turning upon a vertical axis.

Although the mechanism specifically disclosed in Figs. 96–99 inclusive is primarily intended to serve as a stop motion, in its broader aspect it serves as a belt shipping mechanism whereby the machine may be manually stopped at any time by moving the belt from the fast or slow pulley to the loose pulley. Furthermore the speed of the machine may be reduced by manually moving the belt from the fast to the slow pulley.

When the mechanism hereinbefore described functions as a stop motion the detector 482 is actuated, as hereinbefore stated, by an accumulation of thread or yarn due to any cause such as a defective needle. The accumulation of thread finally bunches the same until, due to the rotation of the dial and cylinder, the bunch of thread engages the point of the detector 482 and thereafter continued rotation of the cylinder and dial causes the accumulated thread or bunch to swing the detector from the position shown in Fig. 98 to the right which movement is transmitted to the plate 484 rocking the same upon its pivot 489 and moving the horizontal portion of the

bayonet slot 501 away from the pin 502 whereupon the spring 495, constantly pressing against the shoulder 496 of the plunger or sleeve 491, elevates the latter which carries up with it the block 490 until it strikes the upper portion of the bracket 493 overhanging the said block 490. The extension 497 of the block 490 moves up with it and thereby frees the lever arm 499 from engagement with the notch 498. When the arm 499 is free of the notch 498 the coil spring 511 expands and moves the lever arm 507 to the left, Fig. 97, until it forcibly engages the collar 509 and thereby moves the rod 508. The movement of the rod 508 swings the lever 513 upon its pivot 514 and such movement of the lever 513 withdraws the narrow portion of the keyhole slot 515 from under the shoulders 519 and permits the rod 516 to fall through the enlarged portion of the keyhole slot 515 which is of greater diameter than the rod 516. As the rod 516 descends the turned end 520 thereof strikes the end of the lever 458 projecting through the frame, rocks the said lever upon its pivot 459 and releases the shoulder 464 from engagement with the plate 465 which release permits the spring 467 to force the upper bracket 449 to move to the right, Fig. 96, and carry with it the belt shipper 448 by which the belt is moved to the loose pulley and the machine stopped.

The cam 471 carried by the drum or disc 470 is adapted to engage the pin 472 at desired times, and force the same to the right, Fig. 96, in to contact with the screw 476 and move the lower bracket 453 to the right, Fig. 96. The movement of the lower bracket 453 is transmitted to the upper bracket 449 and to the belt shipper 448, either to stop the machine or to change from high speed to medium or slow speed. The speed may be automatically changed as aforesaid at any time during the knitting of the stocking, e. g., prior to the knitting of heels and toes. Furthermore if it be desired to cast off each stocking another cam may be carried by the cam disc or drum 470 to move the lever 473 to such an extent as to ship the belt from the fast pulley to the loose pulley and stop the machine.

The construction of the knitting machine as hereinbefore described besides having the many advantages specifically recited to in the foregoing description has many other advantages some of which will be briefly referred to.

The sliding connection between the dial and cylinder provided by the spline 210 engaging in the keyway 211 permits the dial to be elevated above the cylinder and swung to one side without breaking the driving connection between the said dial and cylinder and so that, when the dial is restored to knitting relation with respect to the cylinder, the dial and cylinder will be still in phase and ribbed knitting resumed without the necessity of adjusting the dial and cylinder.

The latch ring and dial are independently mounted upon the machine frame so that the dial may be swung to one side or disconnected from the cylinder and a binder plate attached to the latch ring in the usual manner after which the cylinder needles alone may knit plain fabric. Furthermore instead of swinging the dial to one side and attaching a binder plate to the latch ring, the dial needles may be operatively disconnected from the cylinder needles and the dial retained in positon thereafter to function as a binder plate. In either case the auxiliary cam shaft 240 and cams carried thereby which control the knitting operations during ribbed knitting may be disconnected from the main cam shaft 235 by raising the pawl 268 against the tension of the spring 270 and then swinging the bell crank lever 256 upon its pivot until its toe 255 is moved out of the path of the cams carried by the pattern wheel 238.

The dial needles are advanced or projected between cylinder needles adjacent the knitting point only and consequently accurate positioning of the dial and cylinder grooves so that the dial needles will, with certainty, pass between raised cylinder needles, is necessary at one portion of the dial and cylinder only.

Drums 236 and 241 carried by the respective cam shafts 235 and 240 each have several rows of cams for controlling the stitch length and each said row of cams upon the main cam shaft is positioned opposite toes or lugs 294 independently adjustable to and from the surface of the cams carried by the drum 236 while the auxiliary cam drum 241 is likewise provided with several rows of cams each row positioned opposite and adapted to engage toes or lugs 306 which latter are also independently adjustable to and from the surface of the said cams. The independent adjustments of the toes or lugs 294 and 306 provide a convenient means whereby the length of stitch may be readily changed for any part of the stocking by adjusting the set screws 296 or 307 and thereby changing the positions of the lugs 294 and 306 and without the necessity of moving either the main or auxiliary cam shafts.

Although specific terms have been used in the foregoing description to designate the several parts, this invention is not otherwise limited than as defined by the terms of the claims appended.

We claim:

1. In a circular knitting machine of the independent needle type, a dial and a cylinder and needles mounted therein adapted to knit plain fabric, cams associated with the needles in the dial to position the same to knit, in conjunction with the cylinder needles, ribbed fabric or welt fabric, the needles in the dial having differentiated butt formations and one of the cams being movable to engage and project more or less of the dial needles to take thread, the said cam being movable in one direction to increase the number of needles taking thread and in another direction to project certain of the dial needles to thread taking position.

2. A circular knitting machine as claimed in claim 1 wherein a pattern drum and connections therefrom are adapted to move the dial cam to engage the needle butts and project the dial needles and to retract the cam to an inactive position, the pattern drum also adapted to depress the dial cam to engage a greater number of needle butts and thereby control the movements of a greater number of dial needles.

3. A circular knitting machine as claimed in claim 1 wherein the butts upon the dial needles are divided into long butts, medium butts, and short butts, the long butted needles being interspersed among the cylinder needles upon the instep half or portion of the cylinder, the medium butted needles interspersed among the cylinder needles being upon the heel portion of half of the cylinder, the short butted needles being interspersed among the aforesaid long and medium butted dial needles, pattern means adapted to control the movements of the dial cam whereby when in one position the long butted dial needles alone knit in conjunction with the cylinder needles, when in another position the long and me-

dium butted needles knit in conjunction with the cylinder needles, and when in a third position the long, medium, and short butted dial needles knit in conjunction with the cylinder needles.

4. In a knitting machine of the character described and including a dial and a cylinder having needles mounted therein for independent movements, butts on the dial needles differentiated with respect to each other, a movable needle projecting cam associated with the dial needles and adapted to engage their butts to radially project the said needles, the aforesaid cam being movable to cause the desired ones of the dial needles to be projected or to remain retracted, the said cam being also movable in a direction substantially at right angles to the direction of movement first mentioned and when moved from one position to another, in the direction second mentioned, adapted to engage and project a different number of needle butts, and a casting off cam adapted to project the needles at desired intervals.

5. A knitting machine of the independent needle type including a dial and a cylinder, needles mounted therein, some of the dial needles having long butts others medium butts and still others short butts, a unitary cam adapted to advance, first, the long butt needles, second, the medium butt needles, and third, the short butt needles, the cam movable in one plane to advance the long butted needles, movable at right angles to the dial needles to advance the medium butt needles, movable in one plane and then at right angles to the dial needles and finally again in one plane to advance the short butt needles.

6. A knitting machine of the independent needle type including a dial and a cylinder and needles mounted therein, a sinker head and sinkers mounted therein, the needles mounted in the dial having butts thereon of different lengths, a dial cam and means for positioning the same to actuate, first, the dial needles having the longest butts and thereafter to actuate the other dial needles, certain of the cylinder needles having upper butts only and others of the cylinder needles having upper butts and lower butts, cam means adapted to actuate the needles by engaging their upper butts, said cam means adapted to be positioned at one level relative to the needle cylinder to engage the upper butts and cause the needles to draw their stitches over sinkers and to be positioned at another level relative to the needle cylinder to engage said butts and cause the needles to knit at another level relative to the needle cylinder, other cam means adapted, at times, to engage the said lower butts and cause their needles to knit over sinkers while needles having upper butts draw their stitches at said other level.

7. In a knitting machine of the class described, two opposed needle beds and needles mounted therein, the said needles adapted to knit ribbed fabric, other instrumentalities, said instrumentalities being movable to and from two or more positions and adapted in each position to cooperate with the needles in one said needle bed in such a manner that the needles of said needle bed last mentioned will draw their stitches in whole or in part over the said instrumentalities, said instrumentalities being individually movable lengthwise and in the direction of movement of the needles mounted in the last mentioned needle bed.

8. In a knitting machine of the type described including a dial and cylinder and needles mounted therein adapted to knit plain fabric, the dial needles having differentiated butt formations, means adapted to control the dial and cylinder needles to knit ribbed fabric and as a continuation thereof other ribbed fabric with a greater proportion of rib wales, a unitary dial knitting cam in cooperative relation with the butts of one formation to knit the ribbed fabric first mentioned, means in cooperation therewith adapted to move the dial cam to engage the butts of others of the dial needles which are differentiated from the butts first mentioned and thereby to move the last mentioned dial needles to take thread for one or more courses, means adapted thereafter to move the dial cam to a position to miss the second mentioned butts for a course or courses, means adapted thereafter again to move the needles provided with the butts second mentioned to take thread and knit.

9. In a knitting machine of the independent needle type a needle bed and needles mounted therein adapted to move to and from thread taking position, means including jacks, mounted in the needle bed, individual to certain ones, at least, of the needles adapted to be positioned so that the needles as they draw their stitches, draw the same in part, at least, over adjacent portions of the jacks and thereby measure a desired length of stitch, means for selectively controlling the jacks so that needles may knit at a plurality of levels, said means consisting of differently positioned butts carried by certain of the jacks.

10. Instrumentalities for use in a knitting machine of the independent needle type including a sinker and a jack adapted to slide centrally through the sinker and between spaced portions thereof, the jacks adapted to cooperate with the needles and assist the said needles to determine the length of stitch.

11. A circular knitting machine of the independent needle type, dial and cylinder needles and sinkers mounted therein for independent movements, means adapted to control the dial and cylinder needles to knit plain fabric, part rib and part plain fabric, and all rib fabric, the cylinder needles when knitting plain fabric knitting at one level relative to the cylinder and when knitting rib fabric in conjunction with the dial needles knitting at another level relative to the cylinder, certain of the cylinder needles knitting over sinkers at one level relative to the cylinder and others of the cylinder needles knitting in conjunction with the dial needles and at another level relative to the cylinder when knitting part plain and part rib fabric, and having a cam block positioned at a relatively low level with respect to the cylinder to control the cylinder needles for plain knitting and positioned at a higher level for rib knitting and wherein the cylinder needles that knit plain fabric draw their stitches over sinkers and some of the cylinder needles that knit rib fabric in conjunction with the dial needles draw their stitches over the shanks of the dial needles and having supplemental means consisting of a cam and additional butts upon certain of the cylinder needles, which are adapted to knit plain fabric while others of the cylinder needles knit rib fabric in conjunction with the dial needles, and the cam being adapted to engage the additional butts and further depress certain of the cylinder needles during stitch formation.

12. In a knitting machine of the type described the combination of dial and cylinder needles, sinkers cooperating with certain cylinder needles and means for simultaneously causing some of the cylinder needles to draw stitches over cooper-

ating dial needles while other cylinder needles draw stitches over sinkers, means for regulating the level to which cylinder needles which cooperate with dial needles are drawn and means for drawing other cylinder needles which cooperate with sinkers to a different level, the two levels being so regulated that equal lengthened stitches will be formed in the portions of rib and plain fabric thus produced.

13. A circular knitting machine having in combination a dial and cylinder and series of needles mounted therein, means for controlling the said series of needles to knit rib fabric, a cam movable substantially diametrically opposite the dial needle controlling means for clearing loops and means functioning independently of the loop clearing to maintain said cam in intermediate position to project dial needles outwardly a sufficient distance for holding loops down on the shanks of cylinder needles.

14. A circular knitting machine of the independent, rotary needle cylinder type having therein a dial, a cylinder, and needles mounted in the dial and cylinder, cams associated with the needles in the dial to position them to knit rib and plain fabric in conjunction with the cylinder needles, said dial needles having differentiated butt formations and one of the cams in the dial being movable to engage the formations on needles, said cam being movable in one direction to increase the number of needles acted upon and in another direction to cause needles, the butts of which are contacted, to be actuated.

15. A needle dial and an actuating cam having a butt engaging surface for use in the said dial and means whereupon the butt engaging portion of said cam may be moved both to and from the center of the dial and vertically with respect to said dial, and means functioning upon said cam independently to move it in each of said directions.

16. In a knitting machine the combination of a needle carrier and knitting instrumentalities including a series of independently movable needles having different butt formations, cams for drawing needles having one butt formation to one stitch drawing level to draw stitches over one set of instrumentalities and other cams for drawing the remaining needles having a different butt formation to another level to draw their stitches over another set of instrumentalities, and an overthrow guard cam constructed and arranged to allow those needles drawn to the greater extent to pass without interference but effective to prevent any additional stitch drawing movement of the needles drawn to the shorter extent, the construction being such that the stitches drawn over one set of instrumentalities at one level and the stitches drawn over the other set of instrumentalities at a different level will be of substantially the same length.

17. In a knitting machine, the combination of a needle carrier and knitting instrumentalities including a series of independently operated needles, said needles having different butt formations, cams for moving needles having one butt formation to cause them to draw their stitches over instrumentalities at one level and another cam for moving needles having a second butt formation to cause them to draw their stitches over other instrumentalities at another level, and an over-throw guard cam resiliently mounted for preventing any over-travel of those needles moved to draw their stitches at one level, but allowing needles moved to draw their stitches at the other level to pass without interference, the construction being such that the stitches drawn over instrumentalities at one level and the stitches drawn over other instrumentalities at another level are of substantially the same length.

18. In a dial and cylinder knitting machine of the class described, a main cam shaft and an auxiliary cam shaft mounted for independent rotation, cam drums carried by the two cam shafts, a drum on the main cam shaft adapted to control the length of stitch knit by the cylinder needles when knitting plain fabric, a drum on the auxiliary cam shaft adapted to control the length of stitch knit by the cylinder needles when knitting in conjunction with dial needles, a second drum on the auxiliary cam shaft for controlling and timing the active and inactive positions of the dial needles.

19. In a knitting machine of the type described, the combination of means for knitting plain or rib fabric including a series of cylinder needles, a series of dial needles and sinkers, said sinkers being disposed at a different level from that of the dial needles, some of said cylinder needles having two butts thereon at spaced points, a cam for cooperating with one of the butts on the said needles to cause them to draw loops over the dial needles and another cam for cooperating with the other butts to cause their cylinder needles to draw proper lengthened loops over the sinkers.

20. In a knitting machine of the type described, the combination of dial and cylinder needles, sinkers cooperating with certain cylinder needles and means for simultaneously causing some of the cylinder needles to draw stitches over cooperating dial needles while other cylinder needles draw stitches over sinkers, means for regulating the level to which cylinder needles which cooperate with dial needles are drawn and means for drawing other cylinder needles which cooperate with sinkers to a different level, the two levels being capable of variation so that stitches of a predetermined length may be drawn by either group of needles.

21. A knitting machine of the circular independent, rotary needle cylinder type having in combination a dial, a cylinder, needles in said dial and cylinder for knitting fabric, stationary cams for acting upon the two groups of needles to effect the knitting of plain fabric, rib fabric or part plain or part rib fabric, dial needles having different heights of butts, and a cam for projecting said dial needles to yarn taking position, said cam being movable in one direction for purposes of selecting more or less of the butts having different heights and in a direction substantially at right angles to that first mentioned for causing said selected needles to be projected outwardly for the purpose described.

22. A needle dial and an actuating cam having a butt engaging surface for use in the dial of a dial and cylinder knitting machine having in combination means including a spindle about which the cam may be swung from the center of the dial outwardly and upon which the cam may be moved axially of the dial, means for swinging said cam inwardly and outwardly of the dial and other means for moving it axially, said last mentioned means functioning when the cam is in either of its positions.

23. In a dial and cylinder knitting machine of the class described, a main cam shaft and an auxiliary cam shaft mounted for independent rotation, cam drums carried by the two cam shafts,

a drum on the main cam shaft adapted to control the length of stitch knit by the cylinder needles when knitting plain fabric, a drum on the auxiliary cam shaft adapted to control the length of stitch knit by the cylinder needles when knitting in conjunction with dial needles, a second drum on the auxiliary cam shaft for controlling and timing the active and inactive positions of the dial needles, a third drum on the auxiliary cam shaft adapted to control the length of stitch knit by cylinder needles knitting plain fabric while other cylinder needles are knitting ribbed fabric in conjunction with dial needles.

24. A circular knitting machine of the type described, including a dial and cylinder and needles mounted therein, means for controlling the dial and cylinder needles to knit ribbed fabric, a cam substantially diametrically opposite the dial needle controlling means radially movable and adapted at times to clear the loops, means for maintaining the said cam in an intermediate position to project the dial needles a sufficient extent to prevent the web from moving up with ascending cylinder needles.

25. A knitting machine having therein knitting instrumentalities independently operated for knitting plain fabric or rib fabric, said instrumentalities including cylinder needles, dial needles over which cylinder needles draw loops in the knitting of rib fabric and sinkers over which said cylinder needles draw loops in the knitting of plain fabric, all of said cylinder needles that knit over dial needles having a butt thereon and a cam functioning on said butt for causing the cylinder needles to draw loops in conjunction with dial needles, cylinder needles that knit over sinkers having another butt thereon and a cam for cooperating with said butt to cause the needle to draw loops of proper length over the sinkers.

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