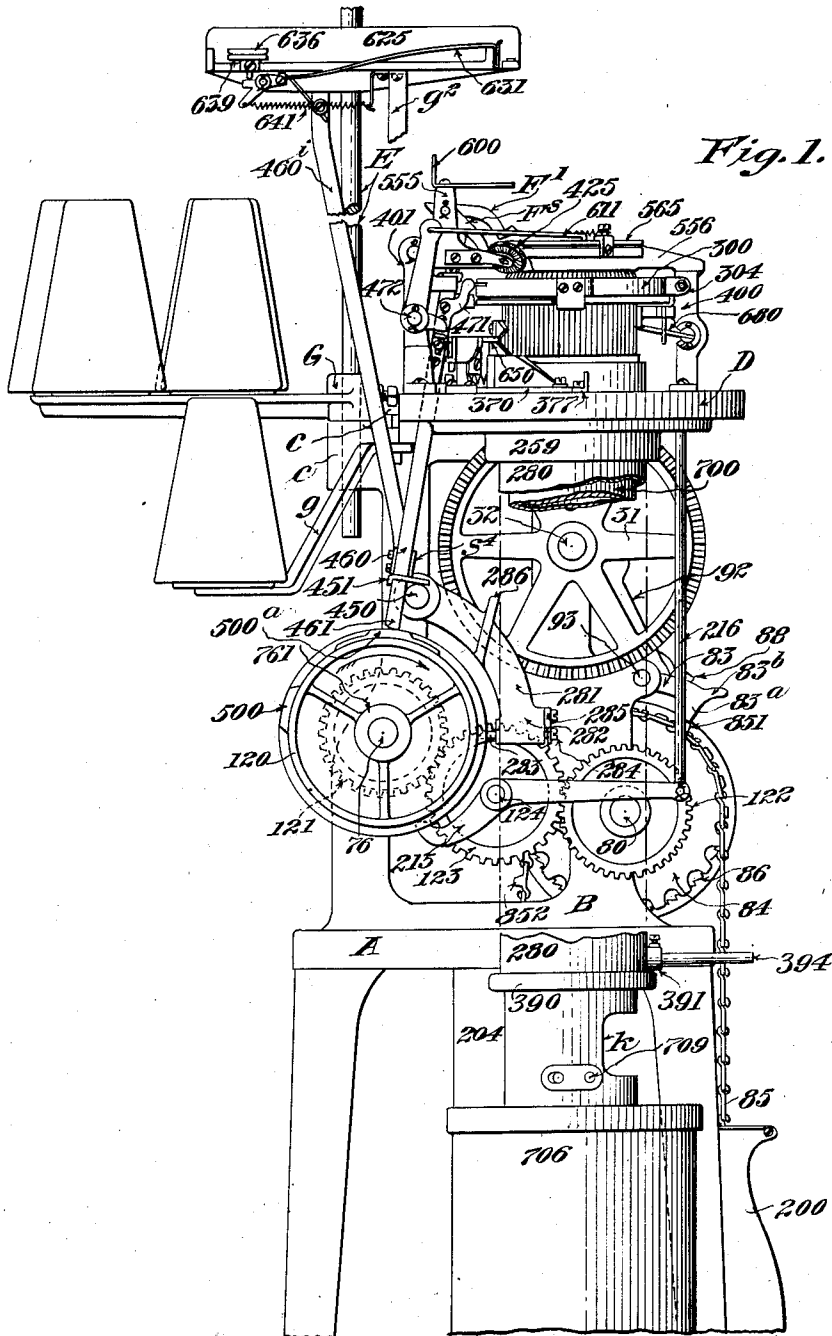


R. W. SCOTT.
CIRCULAR KNITTING MACHINE.
APPLICATION FILED FEB. 3, 1913.

1,152,850.

Patented Sept. 7, 1915.

12 SHEETS—SHEET 1.



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12 SHEETS—SHEET 2.

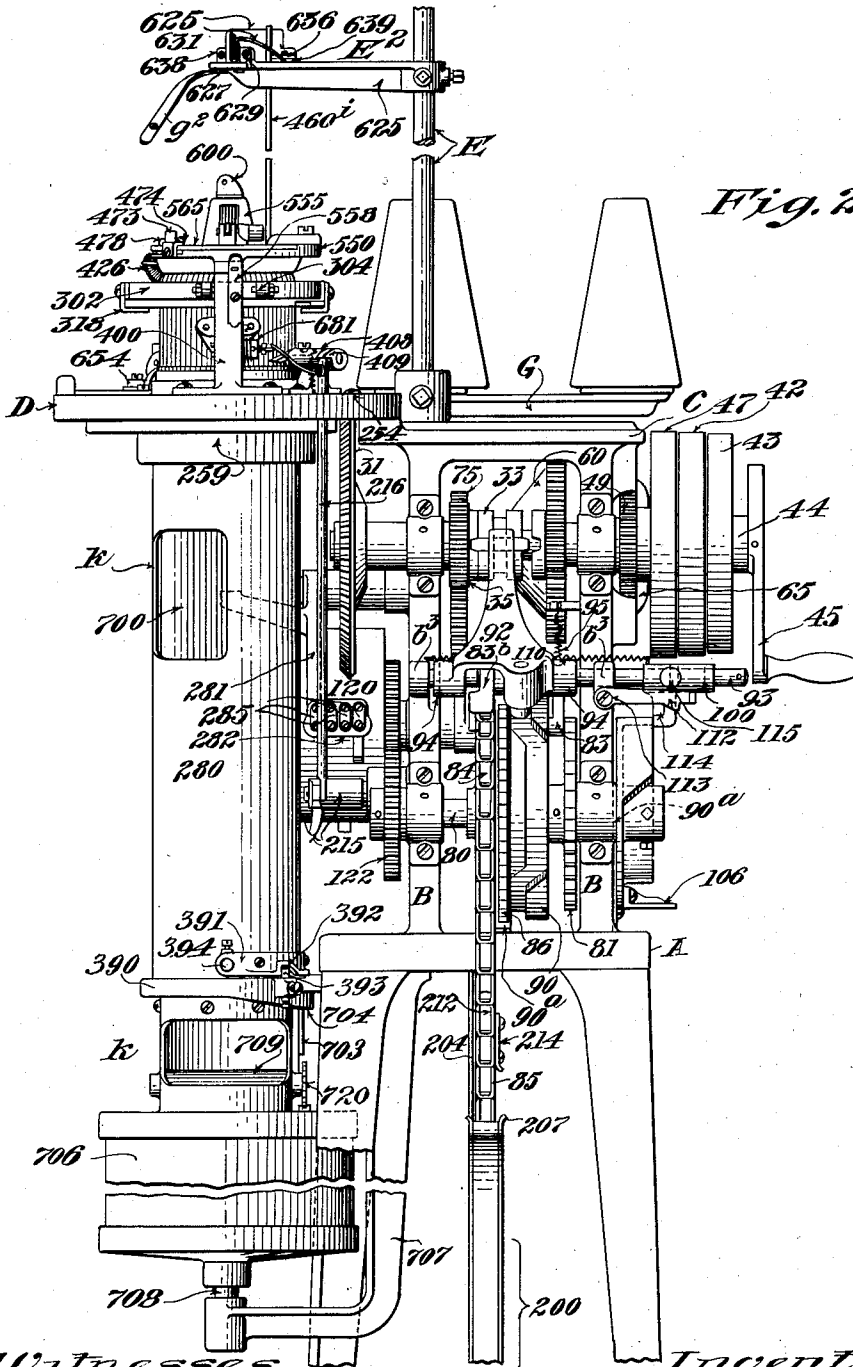


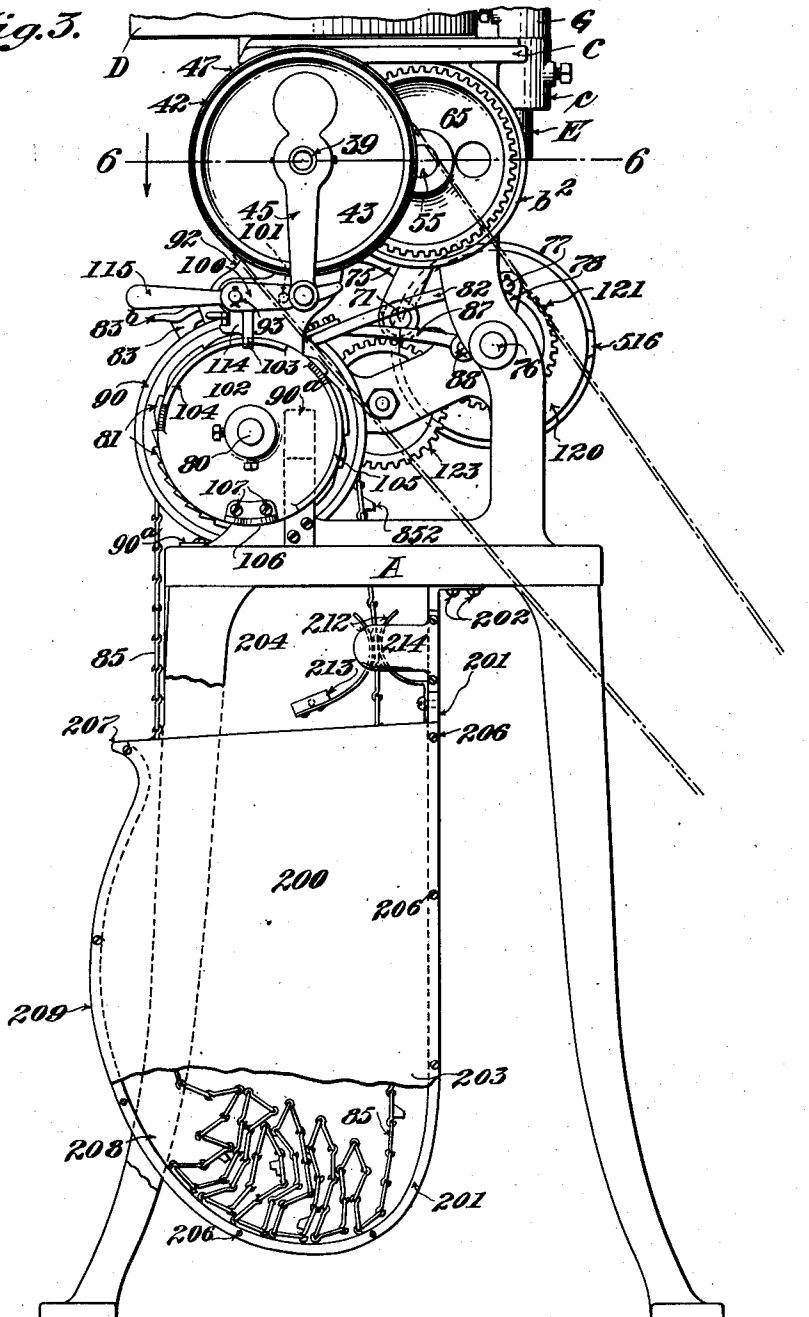
Fig. 2.

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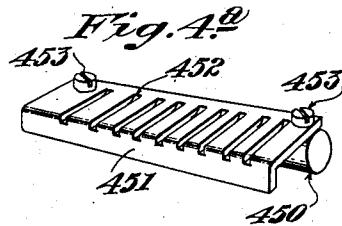
1,152,850.

Fig. 3.



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12 SHEETS—SHEET 4.



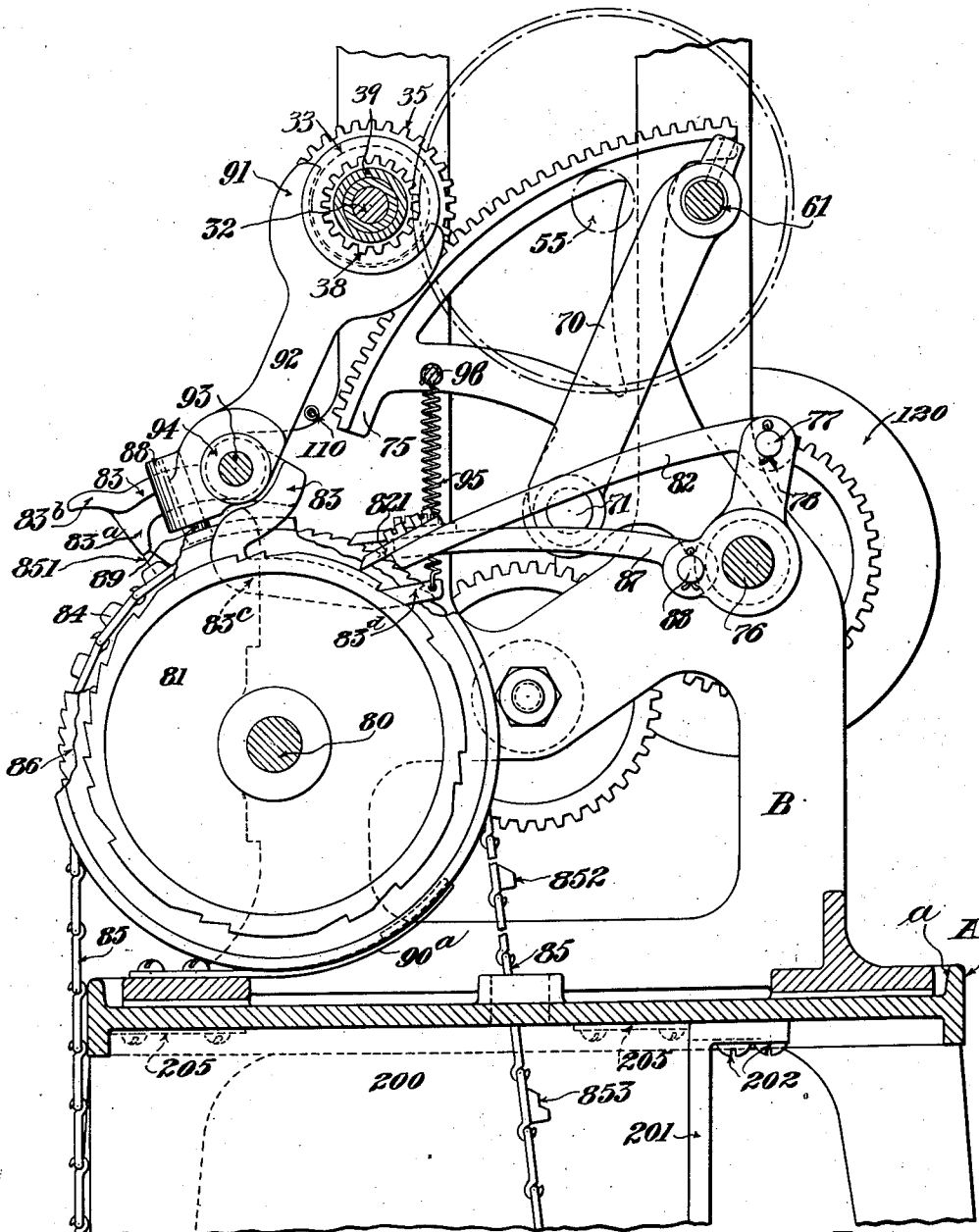
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Fig. 5.



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12 SHEETS—SHEET 6.

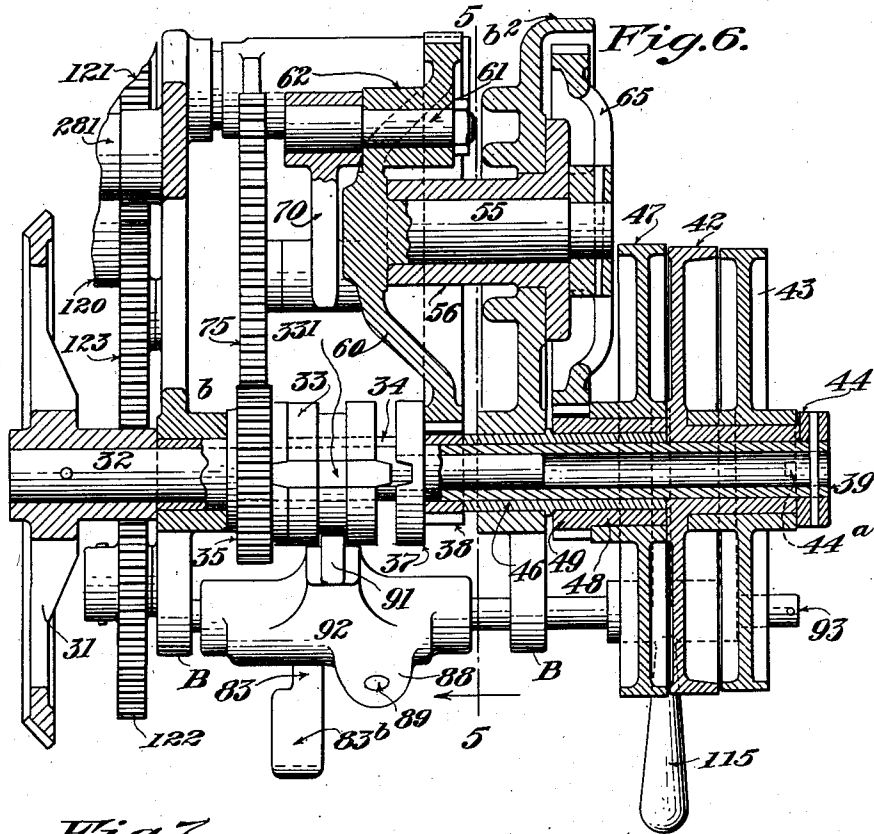


Fig. 7.

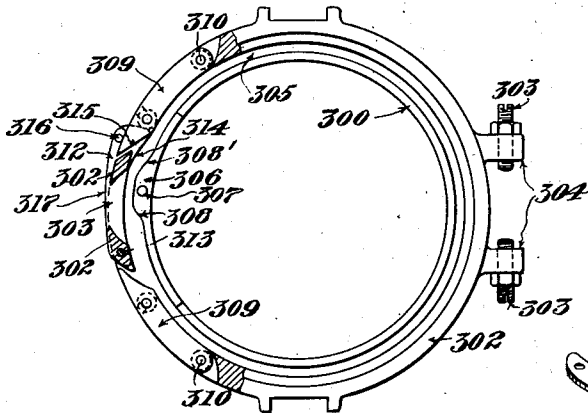


Fig. 8.

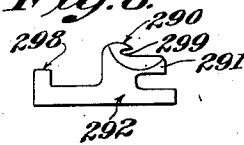


Fig. 8a.



Fig. 7.2

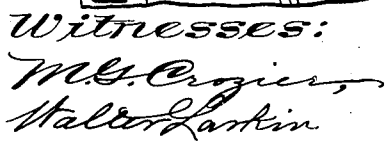


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1,152,850.

Patented Sept. 7, 1915.
12 SHEETS—SHEET 8.

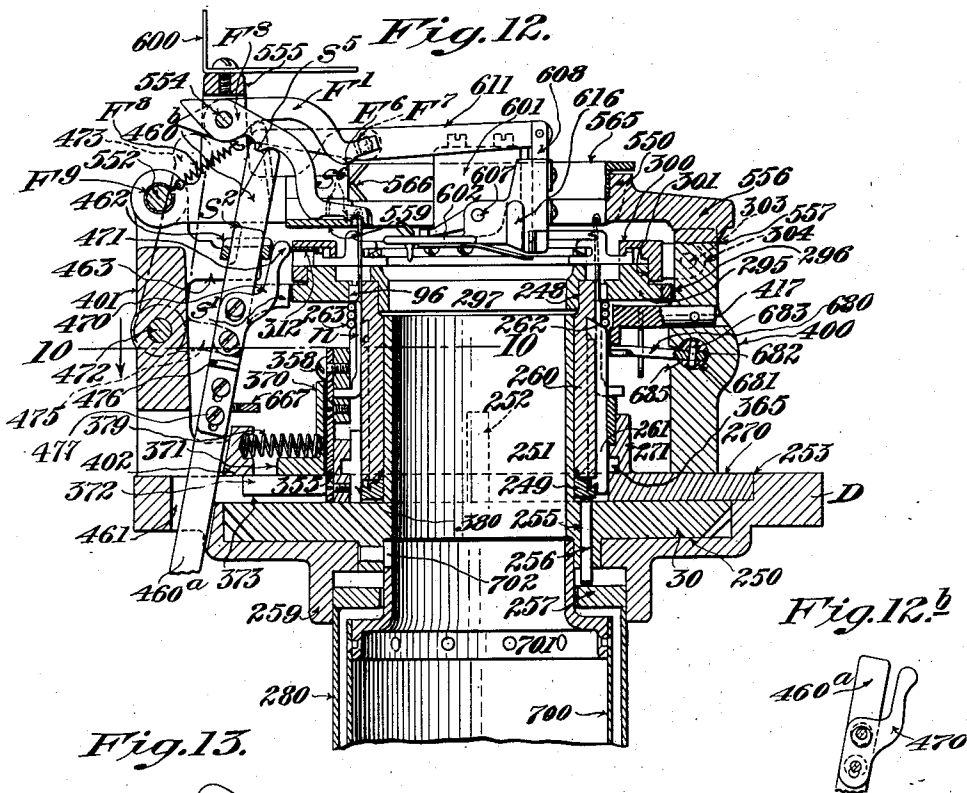


Fig. 13.

Fig. 12.^b

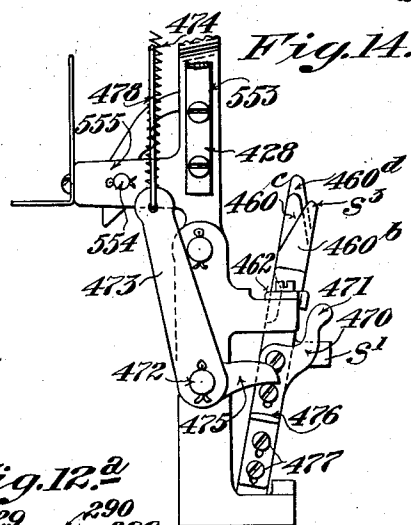
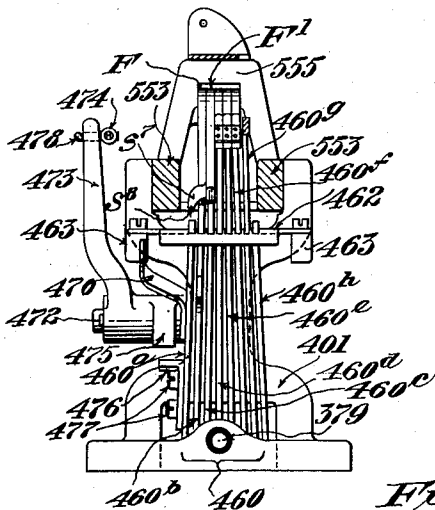


Fig. 14.

Fig. 12.^a

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1,152,850.

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12 SHEETS—SHEET 9.

Fig. 15.

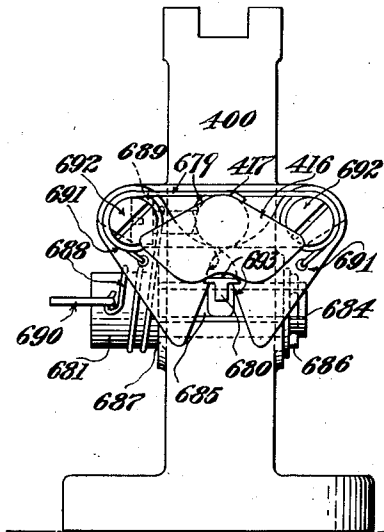


Fig. 16.

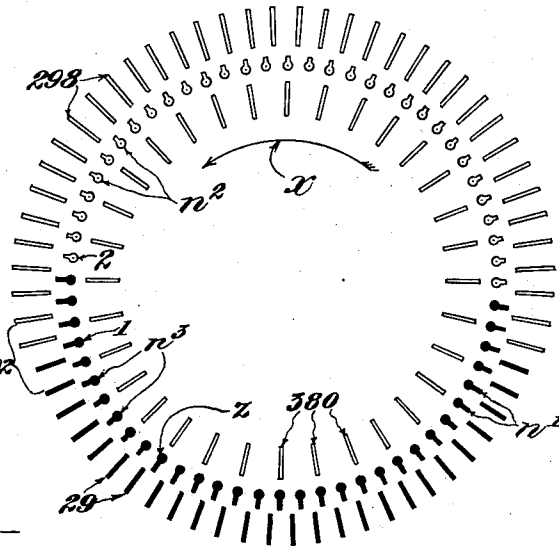
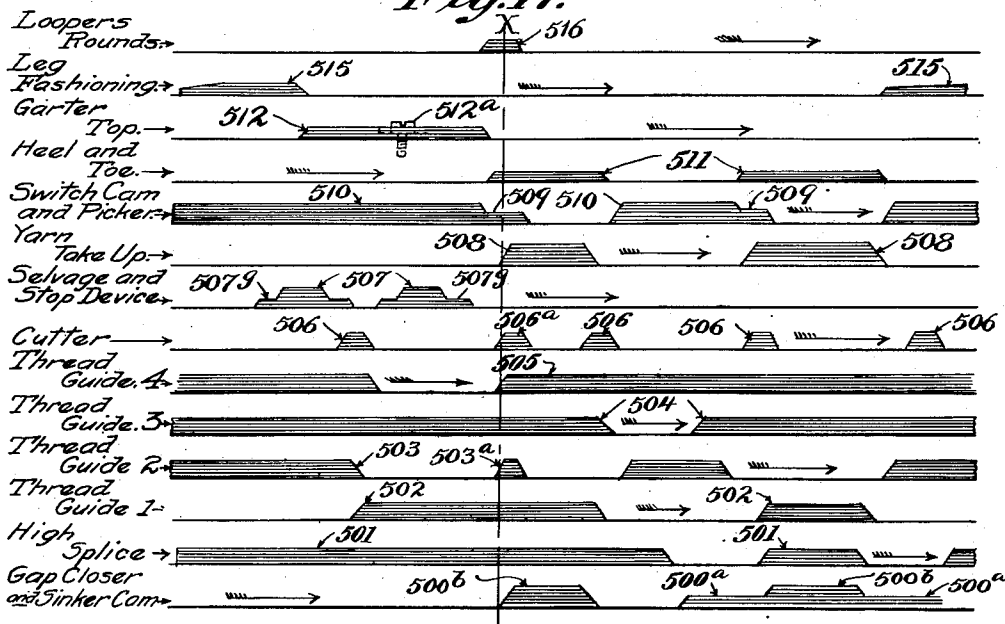


Fig. 17.



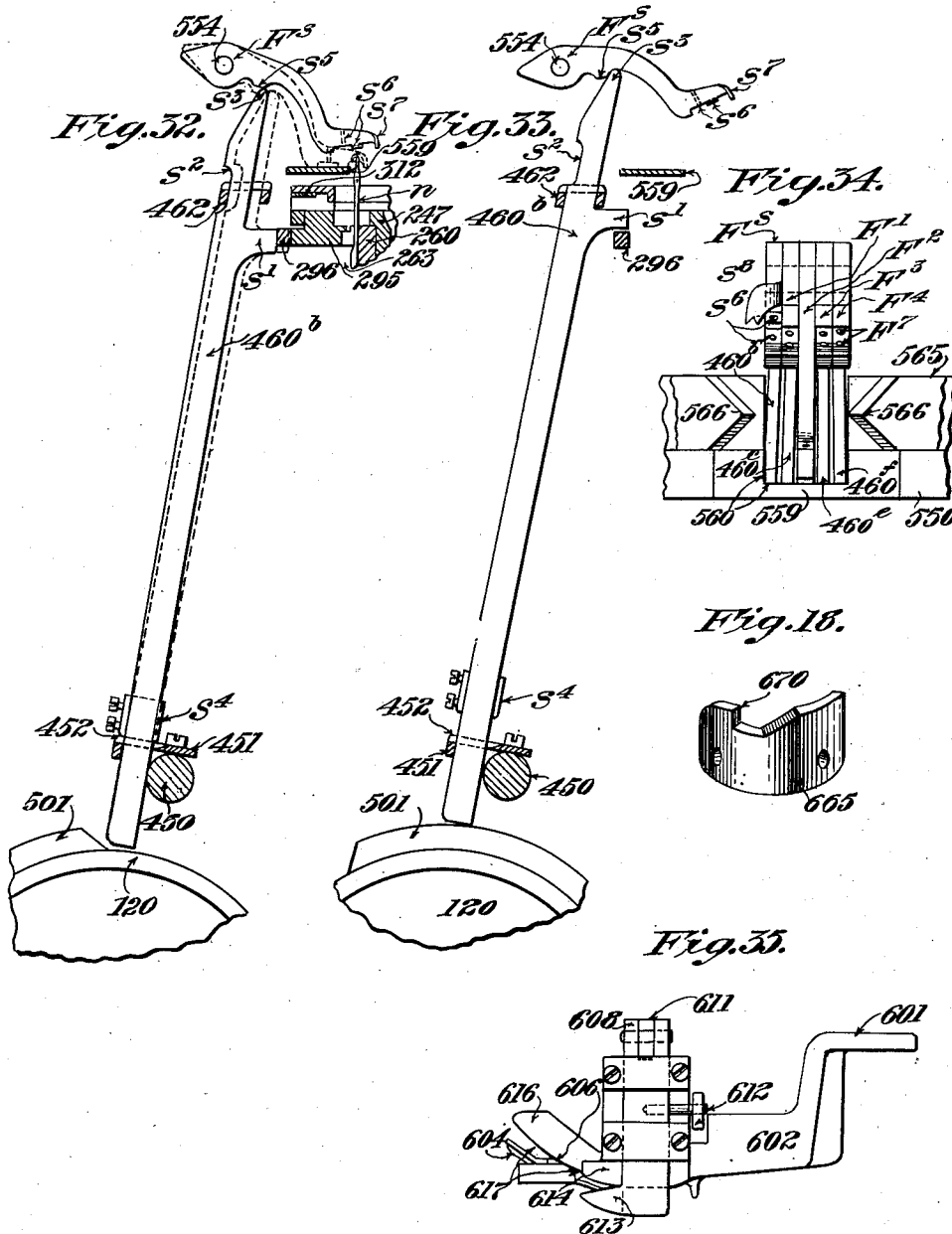
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CIRCULAR KNITTING MACHINE.
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1,152,850.

Patented Sept. 7, 1915.
12 SHEETS—SHEET 10.



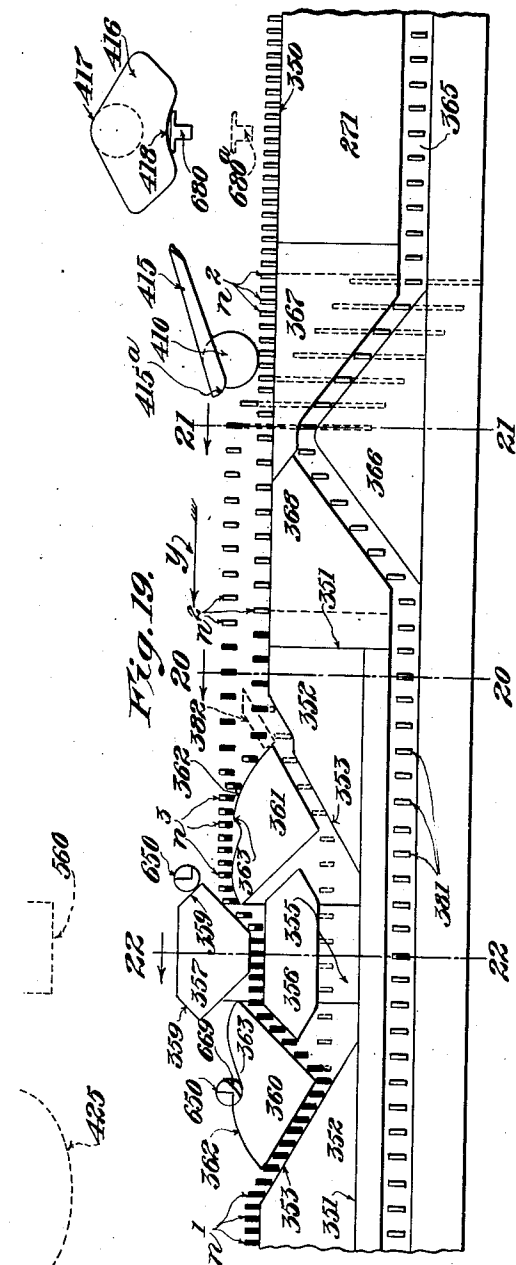
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APPLICATION FILED FEB. 3, 1913.

Patented Sept. 7, 1915.
12 SHEETS—SHEET 11.



Witnesses:
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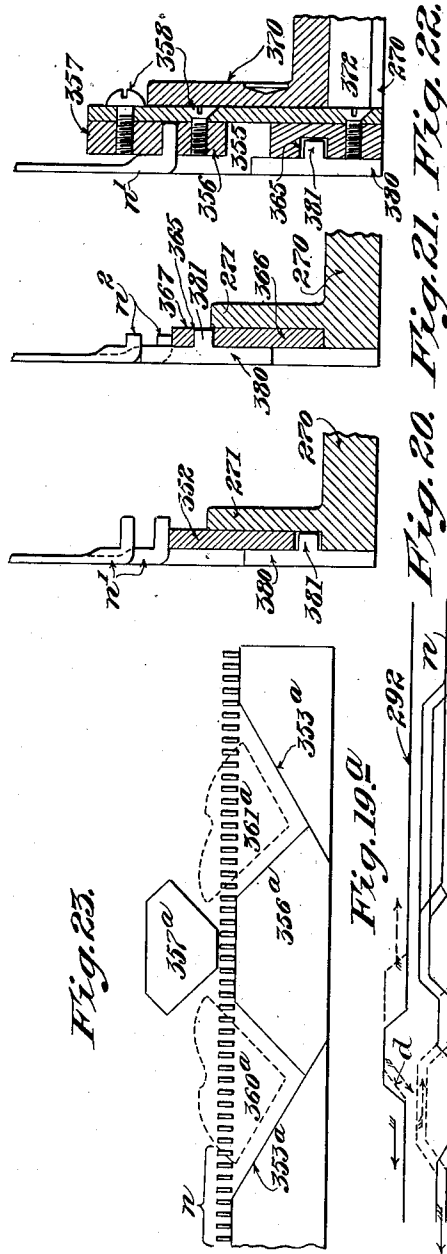


Fig. 20.

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APPLICATION FILED FEB. 3, 1913.

12 SHEETS—SHEET 12.



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UNITED STATES PATENT OFFICE.

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CIRCULAR-KNITTING MACHINE.

1,152,850.

Specification of Letters Patent.

Patented Sept. 7, 1915.

Application filed February 3, 1913. Serial No. 746,070.

To all whom it may concern:

Be it known that I, ROBERT W. SCOTT, a citizen of the United States, and resident of Boston, in the county of Suffolk and State of Massachusetts, have invented a certain new and useful Improvement in Circular-Knitting Machines, of which the following is a specification.

My invention relates particularly to circular knitting machines of the independent needle type and, while it will be understood that the devices shown and described are applicable without change to the operation of many different types of needles, and to coöperation with many different types of needle carriers and other adjuncts of known knitting machines, I have chosen to illustrate and describe that embodiment of it in which independently movable latch needles are the knitting instruments proper.

An object of my invention is to improve and simplify the existing mechanical arrangements for the operation of knitting needles.

A further object is to improve and simplify the devices for coöperating with the devices for operating the knitting needles, to cause the automatic adjustment of said operating devices in an improved and more efficient manner.

A further object of my invention is to provide a mechanism for performing the necessarily great number of changes and shifts of the relation of parts with respect to the knitting instruments during the production of a garment, for instance a stocking, which shall be compact, direct in its action, cheap and simple to construct, and which will provide for the addition of further automatically operated parts without necessitating change in the standard parts shown and described.

In the accompanying drawings, Figure 1 is an end elevation of the left hand side of a machine for knitting stockings, the tubular column, the inner tubular fabric guide, and the yarn guiding top being broken away for clearness; Fig. 2 is a front elevation broken away in part; Fig. 3 is a right hand end elevation of the base of the machine showing particularly the drive mechanism and the pattern chain holder; Fig. 4 is a rear elevation; Fig. 4^a is a detail of one of the guiding combs; Fig. 5 is a vertical section on the line 5—5 of Fig. 6; Fig. 6 is a hori-

zontal section through the main and crank shafts on the line 6—6 of Fig. 3; Fig. 7 is a bottom plan view partly in section of the cam cap for actuating the web-holders; Fig. 7^a is a perspective view of a supplemental sinker cam for actuating certain high butt web-holders; Figs. 8 and 8^a are elevations on an enlarged scale of high and low butt web-holders respectively; Fig. 9 is a view in plan of the knitting head and a part of the machine frame or housing; Fig. 10 is a horizontal cross section of the head below the web-holder bed on the line 10—10 of Fig. 12; Fig. 11 is a detail vertical section through the mounting for one of the narrowing pickers on a line 11—11 Fig. 10; Fig. 12 is a vertical section through the knitting head, the knitting cam ring and the knitting head table or bed on the line 12—12 of Fig. 9; Figs. 12^a and 12^b are enlarged details of Fig. 12; Fig. 13 is a detail elevation viewed from the axis of the knitting head of the top of the thrust bars, showing the yarn guides in elevation; Fig. 14 is a detail side elevation of the latch ring bracket and the tops of the thrust bars, showing the latch ring in its elevated inoperative position; Fig. 15 is a detail elevation viewed from the axis of the knitting head of the widening picker and its bracket and coöperating devices; Fig. 16 is a diagram showing the normal relation of long and short butt needles, high and low butt web-holders and needle jacks; Fig. 17 is a development showing in diagram the various cams carried by the pattern drum; Fig. 18 is a perspective of the positioning cam for one of the narrowing pickers; Fig. 19 is a development of the interior of the knitting cam cylinder, showing one form of needle cam device adapted for use with the remaining devices; Fig. 19^a is a diagram development of the needle and web-holder paths; Fig. 20 is a section through the cam cylinder of Fig. 19 on the line 20—20 of Fig. 19; Fig. 21 is a similar section on a line 21—21 of Fig. 19; Fig. 22 is a similar section on the line 22—22 of Fig. 19; Fig. 23 is a development of a portion of a cam ring showing a simple form of the knitting cams suitable for usual products; Fig. 24 is a plan of the yarn take-up and tension mechanism on an enlarged scale; Fig. 25 is a left hand side elevation of the structure shown in Fig. 24; Fig. 26 is a detail elevation of

the cam 382 and its mounting viewed toward the center of the needle cylinder; Fig. 27 is a detail elevation on an enlarged scale of the double-throw cam for operating the devices shown in Fig. 26; Fig. 28 is a view showing the three different kinds of needles employed; Fig. 29 is a detail perspective view of the web-holder bed showing the attached cam for operating the sectional splicing devices; Fig. 30 is a section on the line 30—30 of Fig. 9 showing the latch ring and the brush wheel for opening the needle latches at certain times; Fig. 31 is a perspective showing the construction of the pattern chain; Figs. 32 and 33 are details of the sectional splicing mechanism showing the relations of the yarn guide, the thrust bar and cams for operating said bar in two different positions of the pattern drum; Fig. 34 is a view from the axis of the knitting head showing the yarn guide throat; Fig. 35 is a front elevation of the internal yarn guide and clamp member showing the yarn cutter.

It will be convenient to consider the devices in the following order corresponding to the main agencies of the machine:—

I. The machine frame; the driving and pattern mechanism.

II. The knitting instruments proper including the needles, the needle and cam cylinders, the web-holders, and their supporting and operating means.

III. The pattern mechanism for pre-determining the operation of the various parts, and its connections.

IV. The mechanism for narrowing and widening the knit tube.

V. The particular devices for the operation of which the pattern mechanism is especially adapted.

I. The machine frame; the driving and pattern mechanism.

The machine frame comprises a table A recessed at *a* for an oil-trough, Fig. 5, which table supports end-frames B surmounted by a table C from which projects to the left, Fig. 2, a bed-plate D having therein a bearing for a bevel-gear 30 carrying for rotation and oscillation a needle-cylinder 260, again referred to below. Motion is communicated to gear 30 by a bevel gear 31 fast on the left end of a main shaft 32, actuated through a clutch-collar 33 splined at 34 on said shaft.

Referring to Figs. 2 and 6, the clutch collar may be thrown to the left to engage an otherwise loose reciprocal gear 35 mounted on said shaft 32 between the boss *b* on the left end frame B and the end of the key 34 on said shaft 32; or to the right to engage a clutch face 37 on the inner end of a tubular sleeve 39 which turns freely in a long bushing 46 fast in a right frame B, and

which sleeve 39 carries a fixed pinion 38 and a fixed pulley 42, which may be attached by a fixed hand crank 45 having a dog 44^a engaging the hub of said pulley 42. A loose pulley 43 is mounted on said hub. Shaft 32 is reduced at its right end to find a bearing within sleeve 39, and may extend past the frame B, Fig. 6. Said bushing 46 carries for rotation a sleeve having gear-teeth 49, integral with or fixed to a pulley 47, said gear-teeth meshing with a gear 65 fixed to a crank-shaft 55 held to rotate in a gland 56 mounted by screws in an opening of right frame B, which may have an integral casing *b*² for gear 65. Fixed to or integrally cast with said shaft 55 is a gear 60 carrying crank-pin 61 in a boss 62. Gear 60, which may be mushroom-shaped, meshes with said pinion 38 on sleeve 39. Actuation of pulley 42 drives clutch-face 37 through sleeve 39 at the speed of said pulley. Actuation of pulley 47 drives said clutch face 37 at the speed determined by the gear-train 49, 65 and 60, 38. The ratio, for one instance only, between gears 49 and 65 may be as 1:3 and between gear 60 and pinion 38 may be as 4:1, whereby the rate of motion of clutch-face 37 when directly driven by pulley 42 is to the rate of said clutch-face when driven through pulley 47 as 3:4. The speed of the machine is therefore increased when the pulley 47 is the driving pulley. Actuation of either pulley drives the gear 60 at a rate fixedly related to the rate of clutch-face 37, as determined by the ratio of gears 38 and 60. By this means, the movements of crank pin 61 and of the needle-cylinder 260 are definitely related, whatever the speed of the system as a whole, whenever clutch-collar 33 engages face 37. The same devices determine oscillation of the needle-cylinder at the desired speed when clutch-collar 33 is in engagement with reciprocal gear 35. Crank pin 61 is connected by pitman 70 and pin 71 with a sector 75 meshing with gear 35, and mounted on a sector-shaft 76 at the back of the machine below the main and crank shafts, as usual in the art, the radius of pins 71 and 61 being such as to determine a forward and back motion of gears 35, 31 and 30 and the needle cylinder substantially through one whole revolution in each direction. Drive during reciprocation is usually through pulley 42, sleeve 39 and pinion 38, but it is apparent that the reciprocal speed may be increased if desired by driving through pulley 47. Means for shifting the driving belt are described below.

The pattern mechanism.—Beneath shaft 32 in bearings in frames B, B, and preferably offset forward, as shown, to enable access to parts carried thereby, I mount a pattern cam shaft 80. Said shaft is driven by a rack wheel 81 fast thereon having irregu-

lar teeth which may be engaged and advanced by the pawl 82 carried by a pin 77 in a crank arm 78 formed integrally with the sector 75 as plainly shown in Fig. 5.

5 The wheel 81 may not, however, be allowed to advance at all times, without performing too short a cycle in the motions of the shaft 80, and to permit its intermittent movement the pawl 82 is prevented from entering any

10 tooth of its ratchet or rack-wheel 81, or is selectively permitted to engage a short tooth only if a short tooth is the next tooth to be actuated, by means of a pawl-controller 83. Said pawl-controller projects forward (see

15 Fig. 5), at its left hand side in the plane of a sprocket wheel 84 and pattern chain 85, described below, and is provided with an indicator or chain reading lug 83^a and a finger grip 83^b for manual movement of the pawl controller. The central portion extends as

20 a sleeve surrounding the rod 93 to a point in line with the space between the ratchet 81 and the drum 90 at which point an integral attachment 83^c of said pawl controller

25 extends downwardly between said ratchet and said drum, fitting in the space between them, to prevent the accidental sliding movement of said pawl controller. The upper face of said portion of the pawl controller

30 is curved to furnish a bearing surface for the toe 821 of the pawl 82, terminating in a sharp upward slope 83^b, which is perforated for attachment to a spring 95 fast at the other end to a pin 98 extending from the

35 right end frame B.

Loose upon the shaft 80, a sprocket wheel 84 carries a pattern chain 85 and a ratchet 86 integrally formed therewith, coacting with which to constantly move it is a pawl 87 on an eccentric pin 88 held by the sector 75. To advance the pattern chain by short

40 steps during recovery of pawl 82, the pin 88 is nearly upon the dead center with respect to the shaft 76 and the line of thrust of the pawl, and the motion of the pawl 87 is, therefore, short as compared with the motion of the pawl 82. The pattern-chain controls the pawl controller 83, to determine

45 the times at which the pawl 82 may engage the rack-wheel 81 and advance the cam shaft 80. To this end said pattern chain carries a series of pattern lugs 851, 852, 853, etc., of three heights or dimensions, projecting from the left hand face of the open chain

50 links, as viewed in Fig. 2. The highest lug 851 determines the maximum rocking movement of the pawl controller 83 and permits the pawl 82, the said toe 821 being wide enough to straddle the rack-wheel 81 and

55 portion 83^c of the pawl controller 83 to enter upon the rack-wheel at the most withdrawn part of its forward and back stroke, to take into the longest tooth upon said rack wheel.

65 The links of the chain 85 are of a familiar

form having hooks 85^a interlocking with opposite grooved ends 85^b of another similar link, when the links are at an angle to each other, as shown in Fig. 31. To avoid

70 carrying a long pattern chain on the customary tensioning sprockets, or the use of idling or multiplier devices for the chain, I may provide immediately under the sprocket wheel 84 a chain-trough or holder

75 200 consisting of a metal spacer or frame 201 bent at right angles and screwed to the underside of the machine table A at 202, and having sheet metal side plates 203 and 204 of the form best shown in Fig. 3. The

80 internal width of said holder 200 is such as to permit the chain depending from the sprocket wheel 84 to move freely between the parallel side plates 203 and 204 without cramping, but it is too short to allow the

85 sidewise movement of one link with respect to another sufficiently to permit said links to become disengaged.

As viewed in Fig. 2, the left hand side plate 204 is cut away at the vertical plane of the front of the table A, carried up-

90 wardly and bent to the left, where it is screwed at 205 to the underside of said table A. This construction permits some vibration of the holder while insuring sufficient rigidity to prevent its breakage. The side

95 plates 203, 204 may be attached to the spacer 201 by screws 206 as shown, but I find a convenient construction follows from the electrical welding of said side plates 203, 204, to said spacer 201 by "spot-welding" at

100 intervals of a few inches.

The internal shape of the chain holder is of great importance to its proper operation. At a point sufficiently below the bed-plate A and sprocket 84 to conveniently permit the

105 operator to grasp the chain 85 in her hand to move it forward, said holder presents a lip 207 formed by a forward bend of the spacer 201 and the local outward bending of the plates 203, 204 for the entrance of the chain,

110 which may flow freely under gravity to substantially the point indicated at 208, at which point the spacer 201 slopes inwardly and downwardly on a curve substantially

115 such as that shown. The effect of this construction is to predetermine folds of chain 85, as shown, lying toward the right of Fig. 3, upon the previous accumulations of chain, until the straight downward run thereof is

120 swung as a pendulum to the rear of the machine to a distance determined by its weight and stiffness. A new fold will then begin to be formed in the opposite direction, to allow for which I provide the forward bend

125 or swell 209. Here, however, the slope of the inner bottom wall of the holder 200 is so sharp as soon to occasion another fold toward the rear of the machine.

The accumulation of folds of the chain flows by gravity, aided by the vibration of

130

the machine (which, however is not essential to the proper performance of functions of the holder 200) down the curved slope, without entanglement. The other end of the accumulation of the endless chain may be withdrawn even more readily than with a sprocket and frame arrangement. The chain has, however, been subjected at points to the maximum bending permitted by the construction of its links and hooks, and an occasional pair of links will not be straightened out on the upward run of the chain by the mere gravity of the links. I therefore provide a tension device comprising the springs 212 mounted upon the spacer 201 and a block 213 on the face 204, to wipe and straighten the chain before it reaches its sprocket on its upward run. One spring 212 is of less thickness than the chain to permit the passage of lugs 851, etc. The tension device 212 is also of aid in preventing over-running of the ratchet 86. I provide in connection with the springs 212 a spring plate 214 screwed to the spacer 201, and having a bent lower edge shown in Fig. 2 co-operating with the plate 204 to return any chain links laterally misplaced into proper engagement with each other.

I find in practice that an extremely long length of chain may be stored in the holder 200, its automatic entry and removal therefrom taking comparatively less energy, and preserving the chain from dirt and lint in a manner superior to the commonly used sprocket-and-frame arrangement, as well as providing a very compact device. One of the attachments of the shaft 80, and the ratchet 86, may be provided with friction brakes, of a well-known type, such as those shown at 90^a in Figs. 3 and 5, to prevent overthrow and backlash of the rack or ratchet wheels and their attachments. Mounted centrally upon said cam shaft 80 is a cam drum 90, for determining the movements of the clutch collar 33. I have found it desirable for accuracy in shifting the clutch to provide an improved connection between said clutch collar, which is broadly an element known in the art, and said cam drum, which also is not greatly different from prior art structures. It will be seen that the active part of the clutch consists of the tenon 331 (which may be a hardened pin with beveled ends in said collar) taking into beveled depressions respectively in the gear 35 and the face 37 of the sleeve 39 carrying the pinion 38. The pinion 38 is continuously moved forward, though at times at different rates, while the pinion 35 constantly makes reciprocal movements. Owing to the relations of sector 75, pawl 82, and cam shaft 80, the active movement of said shaft 80 comes at a time when the reciprocal gear 35 is in full movement for that stroke of the reciprocation which is in the same direc-

tion as for rotary knitting. The shift of the clutch collar 33 must therefore be made between clutch-faces both of which are in full motion at different rates, that one at the pinion 38 moving substantially four times as fast as that on gear 35. Accuracy of timing of the movement of the clutch collar is thus absolutely essential. There have been difficulties with the prior art structures, which present a similar problem, with respect to timing these operations, which difficulties I ascribe largely to the errors in the movement caused by operating the clutch collar by connections formed as levers, which move in an arc, and which may vibrate, thus destroying the accurate effect of the cam surfaces, as of the drum 90, relied upon to quickly and certainly move the clutch collar. It is moreover apparent that in a machine in which compactness is of the essence of merit, a lever structure between shafts which should be near together is to be avoided. I have therefore provided for the connection from the cam drum 90 to the clutch collar 33 a short, strong and rigid slide 92 mounted for accurate movement parallel with the shafts 80 and 32 on a fixed rod 93, fixedly mounted on the front face of the end frames B in perforated lugs 6^a. The slide 92 is provided with a boss 88 having a cam follower therein, (which may be a hardened roll 89 rotating on a pin in a bore in said boss, and taking into the cam track in the cam 90) and separated depending perforated bosses 94 fitting upon said rod 93 and having a sufficient freedom of movement between the lugs 6^a to permit the operative movement of the clutch. The slide 92 is arched in form between the bosses 94, to provide a free space on the rod 93 upon which the pawl controller 83 is pivoted. The upper end of the slide 92 terminates in the clutch fork 91 fitting in a peripheral groove in the clutch collar 33, the curvature of the fork thus preventing rotative movement of the slide 92 on its rod 93.

It will be apparent that the slide 92 is effective to shift the clutch 33 by a short and positive movement of the cam drum 90, which movement is rigidly parallel with the elements of the surface of the drum 90, and is an accurate function of the slopes of the cams on said drum. The outboard end of the rod 93 is extended beyond the lug 6^a to form a slide bearing for a belt shipper fork 100, which is further guided upon a pin 101 held parallel with the rod 93 in a bore in the frame B. The outboard end of the cam shaft 80 carries a cam 102 having a peripheral flange for acting upon the depending lug 103 of the belt shipper 100. Said cam is provided with integral portions 104, 105, terminating in slopes to the level of the body of the cam 102, to move the belt shipper and shift the belt from one to the

other of the pulleys 42 and 47. Said cam 102 is also provided with a portion 106 removably attached by screws 107 for moving the belt shipper 100 to an extreme outward position to take the belt on to the loose pulley 43 to stop the machine. The belt shipper 100 and its attachments are under the influence of a spring 110 attached at one end to said shipper and at the other end to the machine frame, tending to hold the lug 103 on the cam faces of the cam 102. The latch 112 pivoted at 113 to the frame of the machine engages a lug 114 on the belt shipper when it is in its extreme position and the belt is on the loose pulley. A handle 115 is provided for moving the belt shipper independently of its cam.

Referring to Figs. 1, 4, 5, and 6, the sector shaft 76 extends through its bearing in the left end frame B to provide a stud upon which a hollow pattern drum 120 having an integral or attached gear 121 is mounted for rotation. The end of the pattern cam shaft 80 above described similarly extends beyond its bearing in the left end frame B, and is provided with a similar gear 122. The gears 122 each mesh with an idler gear 123 mounted upon a stud 124 projecting from said left frame at an intermediate point. The motions of the shaft 80 are, therefore, transmitted without change in direction or extent to the pattern drum 120. It should be noted that the position of the pattern drum 120 brings it to a point directly behind the cylindrical space defined by verticals from the knitting head and under the shelf or table D, at a point relatively close to the knitting head. I am thus enabled to provide a comparatively large drum, having thereon the desired large number of pattern indications necessary to an automatic machine, performing a complicated cycle of operations, without taking up lateral or vertical space which can ill be spared.

The pattern mechanism will be treated more in detail below. It will suffice for the present to recall that the movements of the shaft 80 are intermittent movements through a variable angle of advance, and that lugs provided on the pattern chain 85 in the path of the indicator lug 83^a of the pawl controller 83 (it being borne in mind that said pattern chain is constantly advanced by its ratchet 86) cause rocking movements of said pawl controller on rod 93 to determined the times at and extents to which the pawl 82 may engage the rack wheel 81.

Assuming the lug 106 of the cam 102 to have engaged the lug 103 of the belt shipper 100, and the machine to have been stopped, with the latch 112 in engagement with the belt shipper, upon the release of said latch the belt will move inward to pulley 47, engaging with pulley 42 and actuating it during its passage. The pulley 42 directly con-

nected to the pinion 38 through sleeve 39 and to shaft 32 through the clutch 37, 33 will start the machine through said direct connection. At this time the clutch slide 92 is in position to the right, and the clutch-collar 33 is engaged with the face 37 and the gear 38. When the driving belt under the influence of the spring 110 has reached the pulley 47, the machine will be driven through the gear train comprising the gears 49 and 65, the shaft 55, the gear 60, the pinion 38, face 37, the clutch collar 33, the drive shaft 32 and the bevel gears 30 and 31. The drive shaft 32 will therefore rotate in the same direction at a higher rate than if the belt were upon the pulley 42.

The movement of the crank shaft 55 results in the actuation of the sector 75 and of the reciprocal pinion 35 whether the gear 60 is part of the driving train for the pinion 38 or whether the pinion 38 is the driving element for said gear 60. It will be apparent that the rocking movements of the sector 75, of the pawl 82 and the pawl 87, will be related to the main drive shaft and therefore to the rotative motion of the knitting head, by a constant ratio determined by the relative diameters of the pinion 38 and the gear 60, whatever may be the absolute speed at which the system is driven. At a later time in the operation of the machine the pattern chain 85 having advanced to cause one of its lugs to cause the forward movement of the shaft 80, the clutch slide 92 is thrown to the position shown in the drawings. Just previous to the movement of the clutch slide the cam 104 will have acted upon the lug 103 of the belt shipper 100 to shift the belt to the intermediate slow speed directly connected pulley 42. It will be evident that the pulley 42 may thus become the driving element and the speed of the machine may be reduced to the extent determined by the gear ratios during such an extent of round and round knitting, or constant forward movement of the shaft 32, as may be necessary. The drive of the machine has now been shifted, by the movement of the clutch-collar 33, to reciprocal movements derived through the crank pin 61, the gear 60, the pitman 70 and the segment 75. These movements are made at the rate of one complete forward and back stroke for each revolution of the gear 60. If the gear ratios are as those above described (which may of course be varied), gear 60 rotates once for each four revolutions of the driving pulley 42. I am thus enabled, by utilizing gear 60 carrying the crank-pin of the reciprocal-motion train as a part of the speed-changing train for the main shaft drive-pinion 38, (which train includes in crank-shaft 55 a driven axis for said gear) to provide for a wide shift between the speeds of rotation and reciproca-

tion, to render the change in rotative speed independent of the movements of the clutch, and to preserve intact the ratio of the movements of the pattern-operating pawls to the rotation-speed of the knitting head, whether the head is rotating at high or low speed. I attain these objects by the described structure with a substantial gain over existing structures in cost, in simplicity and in the dimensions occupied by the speed-changing and reciprocating mechanism, resulting in part from the provision of the crank-shaft 55 as an element of both mechanisms.

II. The knitting instruments proper.

The immediate instruments for knitting may comprise independently movable latch needles held in grooves on the surface of a needle-cylinder or carrier capable of rotation and reciprocal movements with respect to relatively fixed actuating cams for said needles and their adjuncts.

The bed-plate D projecting from the left hand side of the main frame or housing, upon which it is rigidly fastened, provides a bearing for the bevel gear 30 above mentioned in a depending cell or pocket internally machined to provide a face bearing surface 250 and a central bore to maintain said gear 30 for rotation about a fixed axis, which is that referred to as the axis of the knitting head.

The central part of the gear 30 is cut away to provide a free opening through which the forming fabric descends, and is surmounted by the upwardly extending integral sleeve 251 upon which the needle cylinder 260 is removably mounted. The cylinder 260 is held to rotate with the sleeve 201 by the key 252 sliding in a longitudinal keyway on the inner side of said cylinder 260. The cylinder 260 may thus be moved in a vertical sense with respect to the gear 30 and the sleeve 251, without disturbing its rotative adjustment with respect to said gear 30 or the other elements of the machine.

The cylinder 260 may be of any approved construction, but I prefer to employ an inserted wall or built-up needle cylinder such as that illustrated in the drawings, and shown and described in the application of Harry Swinglehurst, Serial Number 653,004, filed October 5, 1911, patented March 3, 1914, No. 1,089,021, which briefly consists of a grooved casting having independently removable needle guiding walls 261 inserted in the grooves and held in place by a beveled collar 249. I have, however, provided on the outer face of said needle cylinder, above the longitudinal grooves for the needles determined by the inserted walls 261 an unusually wide groove 262 for a group of three spring bands 263, and provided a counter-bored or enlarged upper internal end 243. Otherwise the needle cylinder is that of the

prior art, and might be of any other type selected to meet the needs of a fine-gage high-speed knitting machine. Concentric with the bore 251 in the bed-plate D, I provide an enlarged opening 253 to receive the horizontal flange 270 of the stationary cam cylinder 271. The gear 30 is of a thickness to fill the cell within which it rotates, the stationary flange 270 being relied upon to maintain its contact with the bearing 250 upon which it rests. The cam cylinder 271 is retained in the recess by screws 254.

The above described elements comprising the gear 30, the sleeve 251, and the cam cylinder 271 (which carries the knitting cams) are fixed in a vertical sense. The needle cylinder 260 is vertically movable, to adjust the length of the stitch and for other purposes, as well as free to be removed upward upon merely lifting it out of the machine. To provide for such vertical movement the gear 30 is bored through, as at 255, Fig. 12, in three places, to receive supports 256, which may be hard steel pins, all of the same length. The bores 255 are in line with the bottom of the needle cylinder, the collar 249 of which freely rests upon the ends of said pins by gravity and by reason of the stress due to the coöperation of needles frictionally held in their grooves with fixed cams whose advancing slopes are flatter than their retracting slopes, presently to be described. The pins 256 in turn rest upon, and by reason of the motion of gear 30, rotate with respect to, a ring 257 which may be a hardened and polished steel ring, or be provided with a suitable anti-friction surface, as by making it of bronze, which ring has a bearing within the inner machined face of a depending cylindrical flange 259 of the bed-plate D. The ring 257 is vertically movable within said flange 259 by the vertical movement of a hollow tubular column 280 concentric with the knitting axis which fits within said flange 259 at its upper end and upon which the ring 259 rests. Automatic means for moving the column 280 will presently be described. The adjustment by the described means of the vertical position of the knocking-over plane determines the length of the stitch with accuracy.

The machine in the present case is equipped with independently movable latch needles *n* of a well-known type, (which may be tensioned needles, laterally bent to cause friction in their grooves) and the plane below which the yarn may not be carried is determined by the upper faces of the upper inwardly extending arms 291 of web-holders 292 held in the grooves of a radially grooved bed or dial 295 rigidly mounted upon the extreme upper end of the outer face of the needle cylinder, upon a flange 96 having deep longitudinally milled grooves in line with the needle grooves to provide

spaces for the removal of the needles. The grooves of the web-holder bed or dial 295 stand midway between spaces occupied by the needle grooves and the inboard ends of the web-holder 292 are received and guided by a nosing 297 fast in the enlarged or counterbored end 248 of the needle cylinder 260.

The construction of the web-holders 292, of the nosing 297, and the web-holder bed 295, may be the same as that illustrated in the patent to George D. Mayo, 726,178, April 21, 1903, with the exceptions above and presently to be described. It should particularly be noted that, with respect to the construction shown in said patent, the nosing 297 occupies a relatively larger diameter with respect to the diameter defined by the backs of the needles, owing to the counterboring of the needle cylinder to receive it. I am thus enabled adequately to guide the inboard arms of the web-holders 292 without so much obstructing the internal diameter of the knitting cylinder.

For a purpose presently to be described some of the web-holders 292 are provided with long butts 298 and some with short butts 29. For a purpose also presently to be described the upper surface of the inwardly projecting upper arms 291 of said web-holders is sloped upwardly at an angle as shown at 299. This angle begins at a point slightly in advance of the web-holding hooks 290, which may be of the usual form, and perform the usual function.

By reason of the attachment of the web-holder bed 295 and the nosing 297 to the needle cylinder 260, the knocking-over plane defined by the upper surface of the arms 291 of the web-holders (which is that plane above mentioned below which the yarn of the last knit course may not accompany the needles) may be lifted or lowered to increase or decrease the stitch length at all of the needles with respect to the bed D, the fixed cam cylinder 270, and the knitting cams carried thereby, by the agency of the pins 256, the movable ring 257, the column 280, and automatic means coöperating with said column. At a point directly at the front of the machine the flange 270 of the cam cylinder 271 carries a rigid upright post 400. Mounted on a reduced portion 301 of the web-holder-bed by means of a depending flange 302, and hold-down clamps 318, a web-holder cam ring 300 is adjustably held against rotation with the needle cylinder in either direction by stop screws 303 in lugs 304 straddling the post 400, and permitting a sufficient lost motion to render the adjustments for opposite rotations independent of each other.

The underside of the web-holder cam ring (see Fig. 7) is provided with a concentric groove 305 for the control of the butts 298,

29 of the web-holders 292, as usual. At a point opposite the lugs 304 and directly at the back of the machine as viewed in Fig. 2 said ring 300 is provided with a cam portion 306 held by a screw 307, which cam presents two withdrawing inclines 308, 308', to give the web-holding hooks 290 their outward radial movement at the knitting cams. The incline 308 is displaced toward the following stitch cam, in the direction for rotary work, to delay the withdrawal of the web-holders until after the passage of the needles down the face of the top center cam 357. This construction is useful when making a starting selvage as will presently appear, as described in and claimed in my application Serial No. 766,401, filed May 8, 1913, which application is a continuation in part of the present application. Adjustable cams 309 pivoted at 310 on each side of the outthrow cam 306 determine the inward throw of the web-holders 292. Said cams 309 are housed in deep slots milled through the depending flange 302, which flange is also cut away at 303 to provide a discharge opening for broken parts. Said web-holder cam ring 300 also carries means for controlling some of the web-holders for a local variation in the length of stitch, as described below.

The needle cams.—The machine is equipped with a switch cam, and with stitch cams for giving the advancing and retracting movements to the needles during rotary and reciprocatory knitting.

Referring now to Figs. 9, 10, 11, 12, 16 and 19, I have herein illustrated one form of knitting cam mechanism comprising the cam cylinder or ring 271 which is a short rigid cylindrical structure terminating at its upper end in a ledge 350 upon which the butts of all of the knitting needles *n* travel when they have finished their stitch-forming movement. Said ledge is at a level insufficiently high to carry the needles to a point at which the stitches engaged in the hooks 290 of the web-holders 292 will be cleared below the latches. At a point at the rear of the machine the cylinder 271 is cut away at 351 for the reception of hardened cams 352, 352 together forming a broad V-shaped opening from which the slopes 353, 353 lead in opposite directions to return to the ledge the butts of any needles which may be depressed into said opening. Central of this opening at the back of the machine and fast in a vertical slot milled a part way through the thickness of the cylinder 271 is a vertical standard 355 upon which a bottom center cam 356 and a top center cam 357 having their inner faces flush with the inner face of the cylinder 271 are mounted by screws 358. The lower surface of the bottom center cam 356 is level with or higher than the stitch cams, and its

upper surface is level with the ledge 350, and only a sufficient passage for the butts of the needles is provided between the cams 356 and 357. Cam 357 is flat at the top and is provided with slopes 359 to guide needles lifted above the normal level. Surrounding approximately that half of the cam cylinder 271 at the rear thereof, I provide a half-cylinder or segment 370 having a base flange 371, to serve as a carriage for the stitch cams 360 and 361. When knitting operations are being performed said segment is in the position shown in Fig. 10, fitting closely upon the periphery of cylinder 271, and resting at its base 371 upon the upper face of the flange 270 of the cam cylinder 271. Said segment is held to move radially outward on the plane central between the stitch cams 360 and 361 by means of a gib or key 372 on the underside of flange 371 taking into a radial slot 373 formed in the flange 270, and under a lug 402 of a post or bracket 401, and is further guided by slots 375, formed in the ends of the flange 371 and parallel with said key 372. Hold-down screws 376 aid in retaining said segment upon said flange 270. I thus provide a rigid but readily movable support for the stitch cams, to accurately hold them in their vertically fixed position. Movement of the segment away from the needle cylinder may be manually effected by the lever 377 pivoted at 378 on the cam cylinder, against the stress of a spring 379 held at its ends by shallow bores in the segment and said lug 402. The cams 360, 361 are of sufficient thickness to reach from the inner face of the segment 370 to an internal diameter flush with that of the cylinder 271. Said cams 360, 361 are respectively provided with upper slopes 362, curved in form, to clear the loops below the latches of such needles as travel upon ledge 350. The advancing surfaces 362 and 353 are of a slope materially flatter than the retracting surfaces at cams 357 and 360 or 361. Said cams 360, 361 are further recessed at their tops at 363 to provide resting points for the narrowing pickers presently to be described. These resting points hold the pickers to receive a needle at a height at which the needle has finished its upward rise to clear its loop below its latch.

I have illustrated my machine in connection with additional needle controlling devices at the cam cylinder not herein claimed with which, as well as with the usual knitting cams illustrated in Fig. 23, the remaining devices are well adapted to cooperate.

For certain purposes, including starting knitting on the bare needles by the formation of a selvage structure, and the formation of a stop course or courses, in addition to the usual knitting functions as fully described in and claimed in my said application

Serial No. 766,401, I may provide in the lower part of the cam cylinder 271 and completely surrounding the inner periphery of said cylinder a groove 365 as shown in Figs. 19 to 22. At a point well in advance of the leading stitch cam 361 for rotary knitting, an A shaped opening is formed in said cylinder 271, beneath which an advancing jack cam 366 is fastened.

Coöperating with the cam 366 a series of needle jacks 380 having butts 381 may be provided for the above or other purposes. Usually a jack 380 is provided for every alternate needle, but it will be evident that they may be distributed at will. Said jacks are free in the needle grooves, and are held from being thrown centrifugally outward by contact of their shanks with the inner face of the cylinder 271 and of the cams 366, 367, 368, etc. The height of the cam 366 and the length of the jacks cooperating therewith are such as to advance such needles *n* as are provided with jacks at a point well in advance of the leading stitch cam sufficiently upward to clear their stitches, as clearly indicated in Fig. 19. I may thus utilize said jacks for the performance of special operations calling for the separation of the needles into an idle and operative set intercalated among each other, and to this end provide a supplemental cam such as radially movable cam 382 preceding the forward end of the leading stitch cam 361, at a level to bring its leading end between the needles *n* advanced by the jacks and the needles without jacks moving upon the ledge 350. Needles affected by said cam are carried beneath the said stitch cam 361 and beneath the bottom center cam 356, on a level too low to engage the yarn fed to the remainder of the needles for the said purposes. The machine is provided with a switch cam for elevating some of the needles for making heels and toes.

At a point in advance of the jack cam 366 on a radial spindle 410 held in the bearing block 411 on the cam cylinder flange 270, which block has a cam slot 412 coöperating with a screw 413 on said spindle, I may for instance provide a switch cam 415 for the usual purpose of throwing the instep needles having longer butts into and out of action. Said cam, when in the elevated position shown in Fig. 19 will engage needle butts encountering it to move them to substantially the level of the crest of the stitch cams. The cam slope of the cam slot 412 (which has a portion perpendicular to the spindle as shown in Fig. 9) moves the said spindle 410 axially when said spindle is rotated, to lower the point of the cam 415, to withdraw the point and face of the cam sharply during the first half of the lowering movement, and then to hold said spindle withdrawn so as to cause said switch cam to

engage only those needles not provided with low butts, when its point is at its lowest position, at rest on ledge 350. When in its upper position said cam engages and moves to the level of the top of the stitch cam needles of any length of butt. A spring 414 tends to hold the point of the cam in its lowered position. A collar 408 having an operating arm 409 is fixed on the end of spindle 410.

The motions, position and dimensions of the switch cam 415 are such as to cause needles advanced by the jack cam 366 and jacks 381, on a back or reverse stroke, as when knitting the heel or toe, to pass safely under said cam, which will be close to the face of the needle cylinder if in the position shown in Fig. 19, by the effect of cam slot 312. The rear end of the cam is beveled at 415^a to carry down any needle thrown upwardly abnormally at this time. Mechanism for operating spindle 410 will presently be described. It will be understood that a switch cam similar to the prior art will be operative in the same situation and may be controlled by the same connections, when the special operations performed by the cam 382 and the jacks 381 are not to take place, for instance when the machine is provided with a simple cam cylinder of the type shown in Fig. 23. In a radial bore in the post 400 on a stem 417 a guide cam 416 is mounted to position the needles at their upper idle level to cooperate with a widening picker presently to be described, which picker is housed when it is set for the actuation of the next needles to encounter it in a notch 418 in the underside of said cam 416.

When employing the cam 382, the jacks, and the other devices of Fig. 19, as described in my said application, Serial No. 766,401 some of the longer butt needles may be provided with butts not quite so long as the others, referred to as medium butt needles n^3 , to permit the entrance of cam 382 during the passage of the following end of the high butt series, as indicated in Fig. 16, which is a diagram showing a greatly less number of instruments than are actually employed, for clearness, and the normal relation of the different kinds of needles, jacks and web-holders to each other for the knitting of a stocking of a usual type. Substantially one half of the grooves in the needle cylinder are occupied by an unbroken series of short butt needles n^2 employed to knit the back of the leg, the heel, toe and sole of the stocking. The other half of the needle cylinder is fitted with needles having longer butts n' and n^3 , which needles are to be rendered idle during the knitting of the heel and toe.

Referring to Figs. 19 and 22, during normal round and round knitting the butts of all of the needles travel on the ledge 350 in

the direction of the arrow γ . The position shown in Fig. 19 is that for such knitting. For the remainder of the rotary operation the needle butts n' , n^2 , n^3 will travel upon said ledge 350 except as they are interfered with by the knitting cams or the jacks 380. Such needles as are provided with jacks 380 will be cleared by the cooperation of the cam 366, and said jacks at a point immediately following the switch cam 415. The remaining needles will pass to the cam 361, encounter the upper surface 362 of said cam to be cleared thereby, and joining the series previously cleared, said needles will pass down the slope of the center cam 357, take yarn during their passage underneath said cam, encounter the stitch cam 360 and knit, when they will be returned to the ledge 350 by the slope 353. These needles when they pass down the active face of the stitch cam 360 draw the runs of the yarn extending between them down against the hooked ends of any needles which, by the operation of cam 382, have been caused to pass under cam 356. It is an invariable effect of this operation to throw the run of yarn so held behind those needles which did not take it. This is due in part to the inward motion of the web-holders, which begins during the stitch forming movement and is completed during the rise of the needles at the slope 353. When some of the needles bearing loops of a previous course pass the stitch cams by the operation of cam 382, the resulting stitch is that sometimes known as the "draw-stitch," in which a loop of a previous course is held out to knit at a later, but not at the succeeding course, the yarns of the intervening courses not being included in the loop held out, but passing to the back thereof. The structure is effective, even when occurring in a single course, to form a stop for the running of a line of drop stitches, as pointed out in the patent to Loretto A. Costello, No. 976,555, November 22, 1910, and it will be understood that the devices of Fig. 19 are in part for producing the stocking covered in said patent, and shown in Fig. 4, thereof.

Motions of the cam 382 for the above purpose comprise the entry of the cam, during the passage of the medium butt needles n^2 to a position to encounter and move the long butt needles 1 following the series n^3 ; the movement of said cam inward during the passage down its face of the following long butt needles affected by it to a position to encounter the short butts; and the subsequent withdrawal of said cam, after it has been retained in its inward position during one revolution or multiple of revolutions of the machine, to its original withdrawn position. The withdrawing movement will also be made in two steps or stages, taken during

the passage of the long butts, to permit the last long butt needle to encounter said cam to be fully actuated by it and the cam to be removed before the next long butt needle reaches it.

Fig. 16 indicates the presence of jacks 380 in the needle grooves beneath each alternate needle, which arrangement is preferable, but not essential, for the production of the stop course of draw stitches. Also as fully disclosed in my said application, the special devices comprising the jacks 380, the cam 382 and the movable web-holders may be employed in cooperation with yarn feeding devices and means for controlling the motion of the machine, to make a starting selvage of the genus disclosed in my Patent No. 1,045,621, dated November 26, 1912. I have illustrated my machine as organized to make this structure at the beginning of an article, in order to provide the product with a fast edge or selvage of the character set out in said patent, and in order to insure that the machine shall begin to knit with certainty at each of its needles, after a period of idle operation, during which the needles are bare. As fully explained and claimed in said application, Serial No. 766,401 the cams 366 and the cam 382 may be caused to cooperate at the first course knit, which is begun upon beginning to feed yarn at a point above the center of cam 357 to the needles bare of any previous loops. Such needles as are provided with jacks will then take yarn at the knitting point, and upon the passage of the cam 360 the intervening bare needles will pass up the slope 353 in front of the floats or runs of free yarn between said needles, the thrust of the web-holders having thrown the floats behind the intervening needles, as will be apparent from the diagram Fig. 19^a showing the relative movements of needles and web-holders. Needles provided with jacks will continue to take the yarn for a first course during the inward position of the cam 382, those needles which have previously taken it casting off the first taken yarn if more than one revolution of the machine ensues. To make the selvage structure of said patent all of the needles are operated at the second course, except the few long butt needles following the needle 1, among which those needles without jacks may not take yarn until the third course.

It will be understood that the mechanical movements of the machine, the pattern devices, the mechanism for feeding and tensioning the yarns, the narrowing and widening devices, and the other agencies of the machine are also useful to cooperate with knitting devices, knitting cams and needles corresponding to the prior art, as well as with the illustrated special mechanisms, I may employ in any use the new mounting

for the stitch cams and the details of construction at the cam and needle cylinders. I have illustrated in Fig. 23 knitting cams comprising only the stitch cams 361^a, the top center cam 357^a and the bottom center cam 356^a in cooperation with the slopes 353^a and needles *n* as typical of the devices capable of use with the remaining new devices. The machine when so equipped is not intended to knit a beginning selvage or a drop-stitch stop device, and the jacks 380 may be removed from the machine, and the cam cylinder need not be equipped with the cam 366 or the groove 365, or the cam 382, although their presence in the machine is of no detriment.

The latch ring and latch opener.—It has been above noted that the bed-plate D upon which the knitting head rotates is provided with two fixed diametrically opposite posts or standards 400 and 401. That standard at the rear of the machine, 401, is substantially X-shaped, as most clearly shown in Fig. 13. In bores on its upper arms, well above the top of the sinker cam ring 300, I pivot the latch guard ring 550 on a stud 552, in a bore in its arms 553, for movement to an upper idle position. A spring washer 99 between said arms and standard 401 retains the latch ring and its attachments when lifted. Said latch guard ring is an open drum-shaped casting having between the rearwardly extending arms 553, see Fig. 9, a wide parallel-walled slot central upon a plane radial to the needle cylinder, to provide a space for the operation of the yarn levers F, which are journaled on a fixed stud 554 held in lugs bridged by the cap piece 555, all of which may be integral with said latch ring 550. At the front of the machine the latch ring is provided with a lug 556 having a positioning gib 557 taking into a groove in the top of the post 400. The latch ring is held down in its operative position by a pin-and-spring latch 558 mounted on the post 400. When in this position the lower beveled edge of the latch ring is in a plane perpendicular to the axis of the knitting head, and the inner cylindrical face of said latch ring is concentric with the axis of the knitting head and at such a distance from the face of the needles as to prevent movement of the latches encountering it in an open or a closed position.

The yarn guide slot between the arms 553 is closed at the bottom by a throat plate 559, forming, at the intersection of the inner faces of the arms 553 with the inner surface of the latch ring, the bottom of a rectangular throat 560, from either corner of which the yarns may pass directly to the needles traveling in the groove between the center cam 356 and 357. (See Fig. 34). It is intended to employ in this machine an unusually large number of yarn-changing yarn

guides, of which as a mere example I have shown five, and it will be understood that the gap in the latch guard ring at the throat 560 may be larger than usual to accommodate said yarn guides.

In my application Serial No. 686,384, filed March 26, 1912, I have shown, described and claimed a device comprising an incomplete annulus such as that shown herein at 565 having pointed ends 566, and means to hold said annulus for rotation (such as the clamp 567, Fig. 9) upon a bearing on the inner face of the latch guard ring, to cause one of its ends to close the upper part of the gap formed by the yarn-feeding throat. I employ this structure in my present machine, but actuate it by different means presently to be described.

To insure the opening of all of the needle latches during the two or three revolutions of the machine which may occur between the end of one stocking and the beginning of the next, during which the needles of the machine are bare and move idly, I provide a rotary brush latch-opener 425 at the relative position clearly indicated by Fig. 19, where it will encounter needles rising along the slope 353. As shown in Fig. 30 said latch opener 425 comprises a thin brush wheel having radial tufts 426 mounted for rotation on a screw 427 projecting at an angle of substantially 45° to the knitting axis from a threaded bore in an arm 428 in which it is locked by a jam nut 429. Said arm 428, see Figs. 9 and 14, is adjustably screwed upon an arm 553 of the latch guard ring 550, which is cut away at 551 to permit the brush 426 to contact with needles at a point immediately above the upper part of their rise due to the following incline 353 of the stitch cams in the direction for rotary work. The cut out portion 551 of the latch ring may be a mere enlargement of the cut usually made at this point to give the opening latches room to swing in, and, as usual in the art, the unbroken wall of the latch ring extending around needles whose butts are traveling on the ledge 350 or in a more elevated position prevents the open latches from closing until the needle has been lowered beyond its influence.

The location and inclination of the latch opener is such as to cause it to cooperate with a needle advancing up the incline 353 to present some of the ends, and then the sides of other of the bristles at one end of a tuft, against the inside of the spoon of the vertically movable needle latch, thus insuring the operation of some of the bristles to open the latch whether the bristle points have or have not penetrated between the latch and the hook. This effect is due to the fact that the latch is as usual equipped with a spoon wider than the material of the needle-hook, and which thus when closed

projects at the point of the latch upon each side of the needle hook. The overhanging spoon upon the penetration of the hook proper into the inclined series of bristles, the sides of which present virtual cam inclines, is strongly influenced outwardly to open.

So far as I am aware brush latch openers when applied to independent needle machines have not heretofore been located in a position in which the moving needle is forced to penetrate a tuft of bristles inclined to the direction of its movement and point-on toward the head of the needle. In practice I find this position important to the machine, and very certain in operation, as I have set out and claimed in my divisional application Serial No. 845,845 filed June 18, 1914.

The provision of a rotary wheel brush, it will be seen, is not essential, its use being merely for the purposes of increasing the length of wear and providing against accumulations of lint.

The latch ring 550 and all of its attachments is free to be elevated about the stud 552 as a center, to permit the transfer of a rib-top, or access to or removal of the needle-cylinder.

Variation of stitch length locally.—I have equipped my machine with devices for sharply changing the length of stitch between two or more adjacent segments of the tube of fabric, by the provision of means to change the relation of those needles desired to knit the lengthened wales to their co-operating abutments or knocking-over instruments at the time when the needles are active to draw their stitches, comprising means, to be adjusted at the beginning and end only of the part of the tube containing the slackened area, for acting on a special part provided throughout one or more segments (which part may be an operating butt of a different length) on one member of each pair of instruments working together to draw the stitch, thus to determine a relation of said instruments to each other in one segment sharply different from the relation to each other of the instruments of the adjoining segment. I further provide means for readily adjusting the degree of slackness in the slackened area.

On the web-holder cam ring 300 opposite the outthrow cam 306, and opposite the deepest part of the groove 305 the flange 302 is milled through as best shown at 311 in Fig. 12^a for the reception of a thin cam 312 which is pivoted at 313 in one end of the slot 311. The active face 314 of the cam 312, when it is swung inward at its free end toward the axis of the machine is close to and in advance of the active face 315 of that cam 309 which is the inthrow cam for the web-holders during rotary knitting. A stop pin

316 taking against the periphery of the web-holder cam ring 300 determines the extreme adjusted position of the cam 312. Said cam 312 is of a thickness and in a position to
 5 encounter only such web-holders 292 as are provided with long butts 298. Its effect when in its adjusted position is to advance said long butt web-holders at an earlier time with respect to the loop-drawing move-
 10 ment of the needles than would be occasioned by the face 315 of the cam 309, to position the hook 290 and slope 299 of the web-holders within the plane of the needles at the knitting-point, and thus to determine to
 15 an adjustable degree drawing a longer loop by the needles at the web-holders so moved, as indicated at *d*, Fig. 19^a. I attribute the effect of said movement of the web-holders within the plane of the needles at an earlier
 20 time to increase the length of stitch for the same draft upon the needles, to stopping or lessening the extent to which a preceding needle is robbed of yarn taken by a follow-
 25 ing needle. Yarn from an adjacent following needle is readily yielded from the source of supply and it is well known that if the adjacent preceding needle is not permitted to return from its extreme stitch-forming position as when there is a flat on the lower
 30 end of the stitch cam, no robbing of yarn can take place from or through said needle, and all the yarn that enters into the stitch being formed must come direct from the source of supply and longer stitches will re-
 35 sult from the same draft. If, however, the other member of the stitch-forming pair, the web-holder, is given a drawing movement at or immediately following the stitch-drawing point this comes to the same thing—robbing
 40 is stopped and longer stitches are formed for the same draft. The movement inward of the cam 312 to advance the active movement of the web-holders into conjunction with the stitch-drawing movement of the
 45 needles thus provides one ready means to stop robbing of the preceding stitch. The effect upon the stitch-length of movement inward of cam 312 is greater in extent than the increased elevation of slope 299 will ac-
 50 count for, the inward adjustment of said cam 312 providing means to widely vary the length of stitch at those needles paired with web-holders having long butts. While I prefer to employ web-holders with slopes
 55 299, their use is not essential to the effect of the cam 312 to increase the length of stitch when moved inward. The cam 312 is free upon the pivot 313 and is moved outwardly to its inoperative position by the thrust of
 60 the web-holder butts except when it is interfered with by the mechanism presently to be described, in contact with the outer edge of said cam 312.

It will be seen on reference to Fig. 16 that
 65 the web-holders 292 for a little more than

that part of the cylinder occupied by the short butt needles n^2 , are provided with long butts 298, the remainder of said web-holders having the normal shorter butts 29. Thus
 70 three long butt web-holders 298 are shown at one end two at the other end of the long butt series of needles, as a mere instance of a readily variable distribution of long and short butt web-holders.

The above arrangement of web-holders is
 75 for the purpose of cooperating with the cam 312 to selectively operate those sinkers having long butts so as to cause them to co-operate with the needles between which they enter to draw a longer stitch, as for in-
 80 stance in cooperation with a splicing-yarn device feeding an additional yarn to those needles only, in which case a local variation of the stitch length may be determined by the presence of web-holders 298 in a contin-
 85 uous series of the necessary, and a readily variable length. I may for instance employ a group of long butt web-holders extending through only a short part of the circle of
 90 needles in order to accomplish thereby the purposes reached by the different mechanisms of the patent to Scott, Williams and Swinglehurst, 653,562, July 10, 1900, which
 95 patent describes means for altering the position of the stitch cam cooperating with the yarn changing yarn guides, to produce a local elongation of the stitch in the preced-
 100 ing course and in the course of the double yarn stitches produced by the overlap of an inserted yarn prior to the removal of a re-
 105 moved yarn. I have, however, shown the machine in the present instance as equipped for determining a local elongation of the stitches at the wales occupied by sectional
 110 splicing.

It is sometimes desirable to high-splice less than the diametrical half of the ankle of a stocking and less than the diametrical half of the sole, and it will be understood
 115 that the arrangement shown in Fig. 16, which is for lengthening the loops for the splicing of more than half of the tube, is merely typical of an alterable arrangement of the high and low butt web-holders. For
 120 some purposes the operation of the web-holders to locally lengthen the stitches may be useful without reference to the feeding of an additional yarn, for instance to form a slack knee pocket, or to relieve the tension in a fine gage stocking upon the back of the
 125 leg and the bottom of the sole, but the structure will usually be employed in connection with a yarn splicing device such as that described below. I am thus enabled to locally and automatically vary the length of the
 130 stitch to a predetermined adjusted extent throughout such part of the fabric as is desired without reference to the length of the butts of the needles, and without altering the position of the stitch cam, which it is
 135

highly objectionable to move vertically in a high-speed machine.

III. The pattern mechanism for predetermining the operation of the various parts.

The operation of the various agencies of the machine, which are wholly automatic, is under the initial control of the cam or pattern shaft 80, which carries directly the cam drum 90 for determining the change in the motion of the knitting head from rotary to oscillatory movement, and the cam 102 for predetermining the speed and, in the case of the use of the lug 106, the stoppage at the end of the cycle of operations of the movement of the machine. All the other operations of the machine are under the control of the pattern drum 120 above mentioned, see Figs. 1, 4, and 17, which rotates on the sector shaft 76 (upon which it is held by the collar 761) by means of the gearing 121, 122, 123 between said drum and said shaft 80.

I have adopted the position shown for the pattern drum in order to enable the use of short, rigid and direct connections between the pattern indications carried by said drum and the many elements to be operated at the head of the knitting machine, and hence to avoid a great part of the expense, complexity and lack of reliability of existing knitting machines flowing from the complicated and uncertain constructions which have been employed to transmit the indications of automatic pattern devices to the devices at the knitting head to be operated by said connections.

Referring to Figs. 1, 4, 10, 12 and 17 I provide on the left end frame B of the machine a rigid stud 450 extending parallel with the overhanging shaft 76 and in front of the vertical plane of said shaft. A comb or slay 451, which may be formed as shown in Fig. 4^a by milling slots 452 through one face and the angle of a bent plate is adjustably attached by screws 453 to the stud 450, for the reception of a series of rigid thrust bars 460^a to 460ⁱ; said bars are beveled at their lower ends at 461, which rest by gravity, and other stresses to be explained, radially against the face of the cam drum 120, are spaced apart by the slots in the comb 451, and are prevented from moving forward with the drum by the stud 450. The thrust bars 460, which may be made of tool steel of a rectangular cross-section, are separated apart at their lower ends, as plainly shown in Fig. 4, primarily to enable the cams carried by the drum 120 to be made of a width to permit their removable attachment by screws 20, and I prefer this construction, although it will be evident that they might be closer together at the bottom than I have shown them. Said thrust bars

460 extend upward in a straight line through an opening 461 provided through the shelf or bed D and the standard 401 at the rear of the machine, to a comb 462 mounted on lugs 463 extending forward from the standard 401 at the rear of the knitting head. The comb 462, which is channel-shaped in cross section, as shown in Figs. 12 and 13, is provided with slots closer together than the comb 451, the dimensions being such as to bring the upper rounded ends of the thrust bars 460 nearly into lateral contact at a point somewhat above the level of the upper edge of the latch guard ring 550. The bars 460 may be reduced in thickness at their upper ends to permit them to be brought more closely together, as will be understood on reference to Fig. 13. I have shown the machine as provided with nine bars, of which eight pass through the opening 461 and are guided by comb 462, but it will be evident that this number may be varied if necessary. Said thrust bars 460^a to 460ⁱ, taking them in order from left to right, coöperate with cams 500, 501, etc. to 507, fastened by screws on the surface of the cam drum best shown in Fig. 4 and in the diagram development of the surface of said drum shown in Fig. 17. Said figure arbitrarily shows the various cams in profile, for clearness, and rotated to bring them all to one imaginary line of indicating instruments coinciding with the ends of bars 460, although some of the pattern cams on drum 120 operate indicating instruments at points 90° and 180° in advance of said line, as will appear. Thus the dotted line X—X of Fig. 17 represents the position upon the drum of each of the indicating instruments in contact with it at the beginning of the knitting of a woman's stocking. Motions of the drum are in the direction of the arrows on said figure. Thus the bar 460^a coöperates with the outermost ring of cams 500, 500^a. This bar 460^a controls the devices for closing the gap in the latch ring and for operating the supplemental web-holder cam 312. The upward extent of said bar is of no utility except to permit it to be guided in the comb 462 and may be cut off as shown immediately above said comb 462. The next bar 460^b is employed for actuating the splicing yarn-guide. The next four bars 460^c, 460^d, 460^e, 460^f are employed to operate four yarn changing yarn-guides F¹, F², F³, F⁴, pivoted in the latch ring. Bar 460^g is employed in connection with a yarn cutter 608 and clamp 606 coöperating with the yarn guides. Bar 460^h, which may be of the same length as bar 460^a, and which is the member to the right of the series as viewed from the front of the machine, is employed to coöperate with the beginning selvage and drop stitch stop devices. Bar 460ⁱ, although guided in the comb 451, is spaced apart

from the other bars and extends upward outside of the bed-plate D to an overhead yarn take-up and tension device E².

The special web-holder cam and gap closer device.—Leaving for the present the bars employed to operate the yarn guides and cutter device, and the yarn take-up mechanism, the bar 460^a coöperates with the cam 312 for varying the time of the inward movement of the web-holders having long butts 298, and with devices for the operation of the gap-closer ring 565. This is possible because the function of the gap-closer ring is to provide an unbroken latch ring for those needles which are lifted during the making of the heel and toe, whereas the above described special operation of the long-butt web-holders is initiated and ended at other times. It is thus possible to move said thrust bar 460^a through one distance to operate the web-holder cam, and through another distance to operate the gap closer. It will be seen by reference to Figs. 7, 9, 12, 12^a, 12^b and 13 that said bar is close to the necessary position of the cam 312, which, as an attachment of the web-holder cam ring 300, has a short oscillating movement when the motion of the machine is changed, corresponding to the lost motion between the points of the screws 303 and the faces of the standard 400. This lost motion is less in extent than the dimensions of the outer face 317 of cam 312. To contact with said face 317 I attach for adjustment on said bar 460^a a cam arm 470, slotted for its attaching screws, as shown in Fig. 12^b, which arm extends as shown in Figs. 12 and 13, to a point near the periphery of the web-holder cam ring 300. A short lifting movement of the thrust bar 460^a will bring the cam portion 471 of the cam arm 470 in contact with the face 317 of the cam 312 and hold said cam in a predetermined and adjustable inward position to determine the extent of elongation of the loops drawn at the stitch point against the slopes 299. The cam drum 120 is therefore provided with a cam surface 500^a to lift said bar at the desired time to the extent necessary. On a stud 472 projecting from the left face of the standard 401 a bell crank lever 473 whose vertical arm is under the influence of a spring 474 attached to the latch guard ring at a clamp 567 employed to guide the gap closer 565, is provided with a horizontal arm 475 extending close to the outer face of said thrust bar 460^a, upon which a lug 476 is adjustably mounted by screws 477. A wire link 478 transmits the movement of the vertical arm of the bell crank lever to the gap closer ring 565, to which ring said link is connected at 479. The position of the lug 476 is such as to cause it not to encounter the arm 475 when the cam portion 471 of the cam arm 470 is in its operative position on the edge

of the cam 312. The cam drum 120 is provided with cams 500^b, of a height to lift the bar 460^a sufficiently far to cause the said lug 476 to operate the gap closer at the proper times, that is, during the making of the heel and toe. It will be evident that the number and extent of said cam surfaces coöperating with said thrust bar may be varied at will, and that I may move said bar to actuate the web-holder cam and to operate the gap closer to extents and at times entirely dependent upon the form of the cams 500^a and 500^b. For knitting stockings I do not intend to locally vary the stitch length by means of the cam 312 during the making of the heel and toe, relying instead on the devices for elevating the needle cylinder for this purpose, and for this reason the cam portion 471 of the cam arm 470 is permitted to be elevated beyond the edge of the web-holder cam when the gap closer is actuated.

The selrage and stop course device.—As above mentioned the cam 382 is at times operated for a special distribution of the needles as disclosed and claimed in my said continuing application Serial No. 766,401. The improved pattern mechanism is adapted for the operation of such a cam, comprising a thrust bar 460^b which may be cut away above the guiding comb 462 and provided, Fig. 27, with a cam 485 adjustably attached by screws 486. This cam may have three active levels *f*, *g*, *h* to operate a short horizontal lever 487 pivoted on a stud 488 on base 489 of bearing-block 490 for cam 382, which bearing block is rigidly attached to the flange 270 of the cam cylinder. As best shown in Fig. 26, said cam 382 is formed at the inner end of a short flat bar held to slide in a slot in the angular face of the standard 490 by means of a plate 491 and screws 492. In a bore 493 parallel with the slideway in the face of the said bearing block a plunger 495 having a spring 494 thrusts outwardly against the down-turned end 383 of the said cam 382. One end of the lever 487 rests against said end 383. Movement of bar 460^b will position cam 485 and lever 487 to move the cam 382 to the following positions: I, a completely-withdrawn position; II, a position at which the cam 382 will encounter the long butt needles and not encounter the medium butts or the short butts; III, a position at which said cam 382 will encounter and move all the needle butts.

The usual operations of the cam 382 come in two stages close together, the entrance stages being separated from the exit stages by a time represented by a little more than one complete revolution of the needle cylinder. I have above pointed out the constant ratio of the strokes of the advancing pawl 82 for the pattern cam shaft 80 and the pattern drum to the rotation of the knitting head. In the numerical instance given the

knitting head makes four complete revolutions during one forward and back reciprocation of said pawl. It will therefore be seen that the movement of the pattern drum 120 during one of its longer forward motions, occasioned by a maximum length of stroke of the pawl 82 and one of the longest teeth of the rack wheel 81 will occur during two complete revolutions of the head, and the moving drum 120 may be utilized for both the entrance and the exit of the cam 82, during a single forward movement. It will be necessary to position the bar 460^h to successively bring its upper surfaces *g*, *h*, into contact with the lever 487 during the early part of the movement of the cam drum 120, and to successively take said bar 460^h through the same positions in a reversed order toward the end of the stroke, after the knitting head has made the desired forward movement of a little more than one complete revolution. To so operate the bar 460^h the cam drum 120 is provided with cams 507, each positioned on the cam drum to pass entirely under the beveled lower end of the thrust bar 460^h during one long stroke of the rack wheel 81. Each of said cams 507 comprises a central portion for lifting the bar 460^h to the position shown at III in Fig. 27, while the end portions of each of said cams are provided with dwells 507^e, to elevate the bar 460^h to the position II of Fig. 27. It will be understood that the passage of the cams 507 under the bar 460^h is made at the full speed of the pawl 82 and that the intervals represented by the dwells 507^e are very short, in terms of the rotary movement of the needles past the cams 382. Said periods are however sufficient to enable the described operations of the cam 382 and its connections.

While gravity may be relied upon to operate bars 460, which are free in their substantially vertical guideways, I prefer in the case of the bar 460^h to provide a spring 480 fast to the comb 451 at one end and to a pin on the face of said bar 460^h at the other end, to cause the lowering movement of the cam 485 to follow the down-going slopes of the respective cams 507 with accuracy.

Between the surface of the cam drum occupied by the cam 507 and frame of the machine, peripheral space on the drum is provided for cam indications for the yarn take-up, represented generally at 508, to operate the switch cam 415 and the widening picker 680, as shown generally at 509 and 510, and a series of four operating cam rings 511, 512, 515, and 516, for altering the length of the stitch at predetermined times by giving lifting and lowering movements to the column 280.

Devices for determining the stitch-length at all of the needles.—I provide on the stud 450 a two armed lever 281, Figs. 1, 2 and 4,

having a sleeve bearing on said stud and a depending head 282 resting near the front face of the drum 120. Said head 282 carries four plungers 283 having adjusting screws 284 and lock nuts 285. Said plungers follow the respective cams 511, 512, 515 and 516 on said drum. The other arm of the lever 281 terminates in a flat 286 taking on the underside of a lug 287 screwed on the column 280. The lower end of said column rests freely in a ring bearing 390 bolted on the underside of the table A, but is restrained from falling by the cam lug 391 screwed thereon, said cam lug having a recess with a sloping face 392 resting upon a plunger 393 fastened for adjustment by a set screw in a vertical bore in said ring 390. In a boss in the cam lug 391, and projecting radially toward the front of the machine I provide a knee lever 394 by means of which the column 280 may be rotated to cause the cam recess 392 to ride up the plunger 393 to elevate the needle cylinder through ring 257 and the pins or supports 256 when desired; for instance, so as to position the web-holders to guide a transfer cup when transferring a rib top. Gravity of the needle cylinder 260 aided by the downward thrust of the needles due to the sharper retracting surface of the needle cams, in comparison with their advancing surfaces, maintains cylinder 260 in contact with said pins.

Referring now to Fig. 17, the previous stocking will have been completed when one of the plungers 283 is under the influence of the cam 516, which elevates the lever 281 to make comparatively loose fabric for the "loopers-rounds" following the open toe. Upon the advance of the pattern drum 120, for instance to cause one of the cams 507 to perform the cycle of operations for making a beginning selvage, the cam 512 will have influenced its plunger 283 to adjust the stitch length for the garter top of the stocking, which may be of a different yarn or multiplicity of yarns necessitating a different length of stitch. The cam 512 is for this purpose provided with a screw 512^a to enable an adjustable local variation of the stitch length at this time. The pattern drum may now advance for the operation of the second of the cams 507 without altering the stitch length, the position of the lever 281 from this point and thereafter being under the control of the cam 515, which is sloped toward its following end, to permit the gradual fashioning of the leg of the stocking by several successive short advances of the drum 120. No further change in the stitch length through the intervention of the column 280 will occur until the knitting of the heel and toe, during which said column may be lifted by the cams 511, to accommodate a heavier yarn fed at this time. The remaining cam indications carried by the

drum 120, and their coöperating connections will be described below in connection with the agencies which they operate.

5 *IV. The mechanism for narrowing and widening the knit tube.*

Provision is made for narrowing and widening the back of the knit tube to form the heel and toe pockets, in coöperation with the switch cam 415 for rendering the needles having longer butts idle. For this purpose I employ narrowing or lifting pickers 650 capable of engaging and elevating the leading needles of the series of short butt needles at each stroke of the reciprocatory movement, and a single widening picker 680 capable of engaging and carrying down into action the leading pair of needles of the series moving in either direction in an upper idle path above the stitch cam 357. Said pickers 650, which are of symmetrically opposite but like form, are placed equidistant from the center of the stitch cams, at a point permitting the picking instrument proper to rest in the notches 363 at the top of the leading and following stitch cams 361 and 362 in a substantially radial and horizontal position. This position for the picker is determined by the position of the vertical axis or stem 651, which is made as a short shaft having an integral head 652 overhanging at one side the tubular support 653 in which said axis 651 is held to rotate by a pin 654 and washer 655. The support 653 is counterbored at 656 and cut away as shown at 657 to provide a space for the movement of the half cylinder or segment flange 371. Substantially one half of the lower portion of said support 653, as shown in Fig. 10, remains, and is provided with a flange 658 held on the cam cylinder flange 270 by screws 659. The overhanging head 652 of the stem 651 is vertically slotted at 660 to receive the picker 650, which is pivoted on a pin 661 in said slot, the bore for the pivot pin 661 passing centrally through head 652 and an integral flat enlargement 552 of the picker, which is thus mounted for rotation in a horizontal and in a vertical plane upon axes intersecting at right angles in the axis of the picker proper. In a bore in the bottom of the slot 660, in the overhanging part of the head 652, I provide a cell 663 for a spring plunger 664 impinging against the under side of the tail of the picker. The support 653, which is concentric with the axis 651 at its upper portion, carries a hardened cam sleeve 665. When a picker 650 is in the radial position shown for the picker at the left in Fig. 10, it rests upon a low part of said cam sleeve 665, and freely in the notch 363 of the stitch cam. Movement of said picker about its axis 651 in a direction toward the stitch cams will cause it to ride up the cam elevation of said

sleeve 665, to move on its pivot 661 and lift the needle on to one of the slopes 359 of the top center cam 357, when the picker leaves the needle butt by reason of its movement around the axis 651 as a center. In the head 652 of each of said pickers at the same eccentric distance from the center of the stem 651 I provide a pin 666 which serves as a crank pin for a link 667 slotted at 668, 668, for attachment to the pins 666 for lost motion, thus connecting the two pickers so that rotation about their respective axes 651 will occur simultaneously in the same direction and to the same extent. The provision of lost motion at 668 is to enable the idle picker to snap down the incline of its cam 665 under the influence of the plunger 664 without accelerating the movement of the active picker to disengage it from the needle butt which is moving it. The pickers are under the influence of no springs except the spring plunger 664, the effective thrust of which is straight downward toward the upper surface of the sleeve cam 665. Said upper surface (see Fig. 18) is horizontal except for the rise to give the picker its working stroke joining its upper and lower levels, and when the picker is at either end of its permitted arc of motion the effect of the spring plunger 664 is merely to restrain it from accidentally moving, by the friction of its cams.

Inasmuch as the effort of the spring plunger 664 is in no sense relied upon to position the picker, except in the sense of keeping it upon its cam, the spring pressure may be a very light pressure and the strain upon the needle butts will be correspondingly lessened. It will be noticed that the movement of the idle picker back to the notch 363 is against only the frictional resistance of its cam surfaces, and it has little inertia, so that the burden of returning the idle picker is not a material addition to the work required of the needle butt. That picker 650 which is the leading picker upon the back or first reciprocating stroke of the machine is beveled away at 669 on the side toward the center of the stitch cams, and the cam sleeve 665 for said picker is provided with an integral stop 670 to restrain movement of said picker in a direction to the left of Figs. 10 and 19, (see Fig. 18.) This is to enable the picker to rest upon and ride down the butts of the needles which strike it in a reverse direction when the stitch cams 360 and 361 have been radially removed by the coöperation of the lever 377 and the half cylinder 371, to enable the needles to be leveled for the transfer operation by the rotation by hand of the machine in the direction for rotary work, through the coöperation of the cams 356 and 357. Through upward movements of the needle cylinder at this time, and from other causes,

it is possible for needles between the picker 650 and the cam 357 to encounter said picker, and in that case the coöperation of the bevel 669 and the stop 670 will cause
 5 said needles to be thrown downward to the level of the ledge 350. This avoids any necessity to remove the pickers from the neighborhood of the needle cylinder when leveling for transfer, since the described construction of the left hand picker and its co-
 10 operating stop 670 enables the presence of the picker to be of benefit to the leveling operation, rather than a detriment.

Special provision for the automatic control of the narrowing pickers is unnecessary since the idle position (which is that shown in Fig. 10) for said pickers is reached when the last needle has been lifted above the cam 357 in the direction for rotary work.
 20 When this position has been reached the left hand picker rests in its notch 363 ready to receive the first needle of the short butt set upon the first back stroke of the machine. The operation of the narrowing pickers thus begins upon the change in the motion of the knitting head and ends upon the operation of the cam 415 to restore the long butt instep needles to the level of the ledge 350.

30 The widening picker 680 is mounted for horizontal movement on a pin 683 in the slot 684 formed axially in a short shaft 681 in a bore 682 of standard 400, which is cut away at 685, to permit vertical movement of said picker with the shaft 681, which is re-
 35 strained from endwise movement by a cotter pin and a washer 686 at one end and an integral shoulder 687 at the other end. A coiled spring 688 tends to rotate the shaft 40 681 to lift the inboard end of the picker. As mentioned above the positioning cam 416 for the widening picker is mounted on a stem 417 in a bore in the standard 400. A spring 688 may conveniently be attached to
 45 a set screw 689 for holding said stem 417 at one end and at the other end to an operating arm 690 projecting from the shaft 681.

In order to determine the depressing
 50 movements of the picker to one side or the other permitted by the universally-jointed mounting above described, I may employ the radius bars or wings 691 under the influence of springs 679 surrounding the pivot
 55 screws 692 screwed into extensions of said standard 400. Said wings present notches 693 to receive and ride down the picker when struck by a needle butt moving to the right or left. The stress of springs 679 is
 60 sufficient to maintain the wings 691 in the position shown in Fig. 15, the notches 693 defining for the picker 680 a radial position, in which the picker is normally held by the stress of spring 688 in its active or most ele-
 65 vated position against positioning cam 415.

A pair of needles moving in either direction having encountered the picker and moved downward in the path determined by a wing 691, the picker returns to its upper radial position by the effect of spring 688
 70 and the notch defined by both of said wings 691.

The above construction for the widening picker is an improvement upon that described and claimed in the application of
 75 Harry Swinglehurst, Serial No. 635,875, filed June 28, 1911, Patent No. 1,057,782, dated April 1, 1913. I have dispensed with certain devices of said patent for the auto-
 80 matic control of the position of the working end of said picker, employing instead connections now to be described for moving the
 85 said picker out of its operative upper position to the lower idle position during the operation of the narrowing pickers, while
 90 narrowing, and for thereafter moving the widening picker into its operative position, for widening.

Devices to control the widening picker and switch cam.—Journaled on the stud 124
 90 for the gear 123 projecting from the left frame B I provide an indicator lever 215 projecting into the path of the cams 509 and 510 on the cam drum 120. The outer end of
 95 said lever 215 is connected to a vertical gravity rod 216 which extends upwardly through a bore in the shelf D to contact with the underside of the arm 409 of the
 100 actuating spindle 410 for the switch cam 415. Projecting from a bore in the head of said rod I provide an arm 218 secured by a set
 105 screw 219, and having a bent end 220 to contact with the arm 690 of the horizontal pivot 681 for the widening picker 680. The adjustment of the arms 218 and 690 is such
 110 as to cause the picker to begin to be moved upon a downward stroke of the rod 216, when the switch cam has reached the position at the end of its arc of movement opposite to that illustrated in Fig. 19. It will be
 115 apparent that further movement of the arm 216 downward will move the picker 680 downward to a position in which it can not encounter any of the needle butts.

Referring now to Fig. 17, the circular
 115 knitting is done while a higher cam 510 is in contact with the lever 215, and therefore while the rod 216 and the point of the cam 415 are in their most elevated position. At
 120 this time the picker 680 rests in the notch 418, but its position is nevertheless idle, since there are no needles on the upper path to encounter it. The machine having ap-
 125 proached the time for the formation of the heel, the lever 215 leaves the end of the cam 510 during a forward movement of the cam drum 120, resulting in the lowering of the point
 130 of the cam 415 to switch up the high butt needles. This movement occurs during the passage of the low butts. As a result there-

of the arm 218 will encounter the arm 690 of the picker pivot 681 and rotate it against the spring 688, to bring the working end of the picker 680 to a low point shown in dotted lines at 680^a. Fig. 19. Said picker remains in this lower idle position until sufficient needles have been lifted by the operation of the lifting pickers to narrow the fabric, whereupon the cam drum 120 is actuated to bring a cam 509, which is lower than the cams 510, into contact with the lever 215, to lift the rod 216 sufficiently to release the picker 680 to the position shown in Fig. 15, but not far enough to operate the switch cam, in which position said picker will encounter and move down the first two needles of the lifted series. The narrowing pickers remain in work, but the needles are moved downwardly two at a time by the picker 680, and upwardly one at a time by a picker 650, resulting in the gradual widening of the series until all of the short butt needles have been restored to action. Pattern drum 120 at this point moves forward to again bring a cam 510 in contact with lever 215, to lift the switch cam 415 to restore the long butt needles to the active level. This operation takes place, as in the prior art, simultaneously with the shift of the clutch collar 33 to resume rotary knitting.

It will be seen that my improved device for controlling the pickers dispenses with any control except of the widening picker, the narrowing pickers becoming active upon the operation of the switch cam and the change in motion of the needle cylinder, and that I have reduced to a minimum the movements for positioning required to be given to the widening picker by causing its normal position to be its active position and by providing for controlling it by moving it out of its active position when there are needles in the upper idle path to encounter it, during narrowing, thus permitting the mere release of said widening picker to cause it to functionate, and permitting the mere operation of the switch cam to restore all of the needles to their active level to cause said widening picker to cease its activity without interfering with the instrument itself.

The mechanism at the latch ring for feeding, cutting and clamping the yarn.—As above referred to, the independently movable yarn guides F are pivoted to swing on the stud 554 in the integral yoke above the slotted latch ring 550, and the present machine is provided with five such yarn guides F. Referring now to Figs. 12, 13, 32, 33 and 34 said yarn guides are metal bars, preferably of hardened steel, and are curved in form as shown in Figs. 12, 32 and 33, so that when in a lower position, which is the position in which they are operative to feed yarn to the needles, their feet F^e will rest

upon the throat-plate 559, which forms the closure at the bottom of the slot between the arms 553 of the latch ring. In this position the heads of the yarn guides are just outside of the periphery of the needles, and yarns carried in bores F^f in the noses of the yarn guides may reeve from the corners of the throat 560, to be taken by such needles as are traveling in the groove between the cams 356 and 357. Each of said yarn guides F is provided at a point on the underside of the enlarged portion pivoted on the stud 554 with a spur for the engagement of a spiral spring F^g, hooked at the other end into a hole in a flange of the plate F^h encircling the latch ring pivot 552. Said yarn-guides are movable by springs F^g and their respective thrust bars 460 into and out of their lower operative position, as determined by cams 501, 502, 503, 504 and 505 on drum 120. The engagement of each yarn-guide, as well as of the other operated elements carried by latch ring 550 with said thrust bars is an engagement of contact only, leaving such operated parts as are carried by the latch ring free to be lifted away from said thrust bars and returned to their adjusted positions when the latch ring is swung upward and then returned. It will also be apparent that the actuation of all the parts carried by the latch ring has, by the device of the thrust bars 460, been concentrated at the neighborhood of the standard 401 upon which the latch ring is hinged, and that this position of the parts insures a minimum effect upon the adjustments due to wear and the necessary slight variation in the operative position of the latch ring with respect to its fastening means 558 and support on the post 400, as well as providing the shortest possible distance between the operative yarn levers and the pattern cam for their actuation. The thrust bars 460 may be manufactured to rigidly standardized dimensions, and the assembly of the parts by the described construction is much facilitated. The device of the bars 460 also enables the operator of the machine merely to remove the bar 460 of a yarn guide desired not to operate, with the utmost convenience.

Sectional splicing.—That yarn guide to the left of the series, F^a, in contact with thrust bar 460^b is utilized to knit the sectional splicing of the stocking, as for the high-splice at the back of the heel, or the reinforcement at the sole of the stocking. Bar 460^b is provided with a lug s' on the face of the bar at a point beneath the comb 462, and normally above the plane of the web-holder dial 295. Said bar 460^b is also provided with a rounded nose s², preferably in a plane further removed from the pivot 554 for the yarn guides than are the rounded upper ends of the remaining thrust bars; and with a recess s², which, when said bar

460^b is lowered is opposite the rear member of the comb 462. Movement of the bar 460^b toward the rear of the machine through a small arc is thus permitted when said bar is in its lowermost position, which is that illustrated in Figs. 12 and 32. Bar 460^b carries an adjustable stop lug *s*⁴ for contact with the upper face of comb 451 to provide a pivot point upon which said bar may swing through the limited arc allowed by the recess *s*², whenever the cams 501 on the drum 120 permit said bar to drop to its lower position. Coöperating with the nose *s*³ of said bar I provide upon the yarn guide *F*^s a cam lug *s*⁵. On the flange of the web-holder dial 295 (see Fig. 29) and thus rotating with the needle-cylinder and needles, I provide an attached cam 296 having adjustable end faces 296^a and 296^b. As will be seen by reference to Figs. 12 and 32, when the bar 460^b has been permitted to drop, its lug *s*⁵ will be in the path swept by the cam 296. These cams may be adjusted or replaced by others to vary the peripheral segment desired to be sectionally spliced. As I have above pointed out, this segment may be more or less than a diametrical half of the tube.

The operation of the splicing yarn guide *F*^s will be apparent. Upon the passage from under the bottom end of the bar 460^b of one of the cams 501, the yarn guide *F*^s which before has been held in an elevated idle position by the upward thrust of the said bar, will be permitted to drop until its feet rest upon the plate 559, thus placing its yarn in action at the needles; but upon the passage of the cam 296, the bar 460^b will be rocked upon the stop *s*⁴, now resting upon the lower comb 451, as a center, permitting the nose *s*³ in coöperation with the lug *s*⁵ to throw the splicing yarn guide sharply to its idle position at a predetermined needle, and upon the end of the cam 296 running off the lug *s*⁵, the spring *F*^s will restore the splicing yarn guide to operation at another predetermined needle. The cam 296 is usually associated with the long butt web-holders 298 in order to enable the spliced loops, and only these loops, to be locally elongated by the above described devices coöperating with said long butt web-holders. I am thus enabled to associate the local variation in the length of stitch with the area spliced with the most rigid accuracy.

It will be noticed that the construction of the yarn-feeding end of the yarn splicing guide *F*^s is different from its fellows in that it is provided with a laterally offset overhanging projection *s*⁷ to straddle the line of the needles, having a notch *s*⁸ on the underside of its extreme point. The purpose of this device is to coöperate with the end of the splicing yarn held in an internal guide presently to be mentioned, to present a short guided run of yarn extending from the bore

*s*⁸ to said notch thus avoiding inaccuracies of entrance of the splicing yarn due to slackness and vibration of the yarn between the point of the moving splicing yarn guide and the internal fixed guide.

The yarn clamp and cutter.—Coöperating with the yarn-feeding devices above described I employ an internal yarn guide, clamp and cutter, which except in detail may be substantially the same as that shown, described and claimed in the application of Harry Swinglehurst, filed October 5, 1911, Serial No. 653,601, and therefore forms no part of my present invention except in so far as I provide different means to actuate said device and to coöperate with the device for the sectional splicing. Said device comprises briefly an overhanging arm 601 attached to the latch guard ring, and thence extending inwardly and downwardly to join an integral base plate 602, the edges and bottom respectively of which provide guide surfaces for the fabric and for floating yarns connecting angularly spaced wales of said fabric. The upper side of said plate 602 is provided with a fixed guide 603 upwardly curved at 604 to receive and guide between it and the face of plate 602 a yarn thrown out of work.

A yarn clamp lever 606 is pivoted at 607 on an upstanding central lug 605 on the upper face of the plate 602. One end of said lever is perforated to take over a pin 612 on a vertically movable slide 608 carrying at its lower end a movable shear blade 613, which blade is rounded at the bottom and sharpened on its top edge and projects toward the left of Figs. 9 and 35. Slide 608 is pressed upwardly by a spring plunger (not shown) in a bore in the body of the lug 605, which lug also presents a vertical channel to guide slide 608. Said lug 605 is also provided with an integral guiding extension 616, which stands above the plane of the plate 602, and slightly inward of the vertical plane of the shear blade 613. Near the juncture of said extension with the body of the lug 605 a fixed or ledger blade 614 is provided to coöperate with the movable blade 613. That part of the plate 602 nearest the shear cutter and the extension 616 forms an opening 617 leading to the open shear blades 613, 614, in one position of said shears, and leading beneath the lower rounded edge of the blade 614 when said blade is in its upper closed position.

The float-yarns from the splicing-yarn guide *F*^s do not enter the cutter 613, 614, which is not actuated upon each movement of the splicing yarn guide, but with its associated clamp 606, is permitted to remain closed during actuation of said guide *F*^s. When the guide *F*^s is elevated and passes inwardly over the needles, its yarn extends from the last needle which took it, by reason

of the rotation of the machine, under the fixed guide 603, 604, and above the plate 604. The end of the closed clamp lever 606 is squared off to provide a stop for said yarn, which upon further rotation is taken under the extension 616 of the lug 605, and through the opening 617 leading to the under face of the plate 602, passing under the closed shear blade 613. The yarn at the time of its next insertion thus extends from the back of fabric at the front of the machine, under the shears and the extension 616, through the opening 617, and under the guide 603 at a point opposite the end of lever 606, in line with the laterally offset position of the notch s^3 , which takes over it just before said lever F^3 reaches the needles on its downward stroke.

Pivoted on an upstanding lug 610 formed on one of the arms 553 of the latch ring 550 an operating lever 611, loosely pivoted to said slide 608 at one end and extending at the other end over the rounded upper nose of the thrust bar 460* is provided. Said thrust bar coöperates with the cams 506 on the drum 120, at its lower end. It will be noticed that a cam 506 is provided to lift the thrust bar 460* and therefore to open the shear cutter and open the yarn clamp, at each change of the position of any of the yarn guides F' , F^2 , F^3 , F^4 , and that I have provided one cam 506* to actuate the cutter after the completion of the toe and after the yarn guide F^2 , supplying the yarn to knit the toe, has been thrown out of action by the cam 503* to press off and eject the stocking by the operation of the knitting needles after removing the yarn from them. Such movement of the yarn guide F^2 and of the cutter 613, 614 is the last step in the cycle of operations resulting in a complete stocking.

The yarn supporting guide and yarn take-up.—Mounted in the integral boss c of the bed or table C, a stout standard E carries the usual yarn-guiding top E' , a horizontal arm E^2 supporting a yarn take-up or tension device these forming the subject matter of my divisional application Serial No. 43,407, filed August 3, 1915, for the yarns employed in knitting the heel and toe, and a bobbin-stand G of usual construction.

Referring to Figs. 24 and 25, the arm E^2 may be a casting of the T-shaped form shown, having stiffening webs 625 and a central aperture 626 to receive and guide the upper end of the thrust bar 460¹, which may be bent toward the rear of the machine substantially as shown in Fig. 1, to enable the yarn eye 627 at the front of the casting E^2 to be placed substantially over the yarn guide levers. A short transverse web 628 is provided with eyes 629 and the body of the casting E^2 is cut away between the eyes 627 and 629 to receive the hook ends 630 of wire tension arms 631 adjustably fastened to

rocker arms 632 journaled at 633 on the lower web 625. A lug 634 of each rocker arm 632 stands under the downward extension 635 of a gravity tension disk 636 which rests in a bore in a disk 639 having a hub fast in a bore in said casting E^2 . A transverse flange 638 carries eyes 637 to guide the yarn on its run between said eyes 637 and 620 close to the upper face of the disk 637, which may be adjusted by means of a set screw 640. Like tension springs 641 fast at one end to separately adjustable wire arms 642 screwed on the under face of the casting E^2 determine the elevating tensions of the arms 631, 631.

In two separate bores in the upper end of the bar 460¹ adjusting screws 643 hold against the face of said bar, by means of grooved washers 644, bent wire tappet arms 645, which may be separately adjusted by sliding them in the grooves in the washers or rotating them with respect to the screws, said arms having bent upper ends 646 to contact with the rocker arm 632 to hold the take-up arms 631 in the position shown in Fig. 25, except when the thrust bar 460¹ is elevated. Referring to Fig. 17, said thrust bar is under the control of cams 508 which lift the bar 460¹ during such times as the machine is reciprocating, thereby releasing the arms 631 and permitting the tension disks 636 each to place its yarn under tension, until the downward sweep of the take-up arm 631 lifts the tension disk and releases the yarn. Yarns from the yarn guiding top E' are led to the yarn guide levers F through holes in a plate 600 screwed to the latch guard ring 550. The splicing yarn bobbin is carried on a bracket g , whence the yarn leads through guide g^2 to its lever F^4 .

The fabric take-up and cage.—It is sometimes desirable to operate a stocking knitting machine to make a string-work of stockings, for instance when knitting women's stockings not involving the transfer of a rib top, which are afterward to be finished by turning down a welt or hem at the upper portion and looping together the toe seam. In this case it is desirable to provide a fabric take-up and fabric storage device for the product of the machine.

It will be understood that one of the chief advantages of my machine as above disclosed lies in the ease with which merely by altering the indications on the pattern drum 120 or removing one or more of the bars 460, and making other apparent alterations of adjustment, I may change the dispositions of the machine to provide for making a wide range of different fabrics. Coming in the same category of permitted adjustments of the machine I may well operate it with or without its take-up and fabric cage, without making other change than for instance, merely to remove or re-

place the lugs 503^a and 506^a from the pattern drum so as not to cast off the stocking or cut the yarn connecting the two stockings at the end of a cycle. In this event I may
 5 also move one of the cams 507 so as to cause its function to be shifted from making a beginning selvage to making an extra stop-course for drop stitches. Of course, similar changes may be made, in the distribution
 10 of the yarn changes, but the removal of the lugs 503^a and 506^a will have converted the machine from one capable of knitting and ejecting a complete stocking to one capable of knitting a string-work of stockings in-
 15 complete in the particulars noticed. I have therefore shown in Figs. 1, 2 and 12 the machine as equipped with a detachable fabric take-up and fabric cage which is in detail no part of my present invention, and which
 20 may be one of the devices of the prior art, or such for instance as that disclosed in the application of Harry Swinglehurst, No. 673,391, filed January 25, 1912. (Patent No. 1,061,024, May 6, 1913.) Such a device may
 25 comprise a fabric tube 700 having an attached upper end 701 clutched to the rotating gear 30 by a hardened lug 702 on said gear taking in a notch in the head 701. It will be seen that the large tubular column
 30 280 is of a diameter sufficient to accommodate a tube 700 of the customary size. Said tube 700 carries take-up rolls 709 (which may be of the usual construction and are not shown in detail) and an actuating device therefor
 35 720 having as an element a bolt 703 which may be actuated by a cam slope 704 on the underside of the ring bearing 290. Beneath the rolls 709 an enlargement of the tube 700 provides a fabric cage 706, through the top
 40 of which, through the side of the tube 700, and through the side of the tube 280, suitable hand holes *h* may be formed at convenient points. The whole structure 706, 700 rotates and reciprocates with the gear
 45 30 on a step bearing, which may be a stud 708 held in a rigid bracket 707 removably bolted on the underside of the bedplate A. It will be understood that the structure 700, 706, 707 may be bodily removed from the
 50 machine when its mutable pattern devices are set so as to make it unnecessary to employ a fabric take-up. The removable lug 106 for moving the belt shipper 100 to stop the machine will also be dispensed with when the
 55 continuous production of stockings, whether in a string-work or as separate articles automatically ejected from the machine, is contemplated. When making half-hose beginning with a transferred rib-top, said lug 106
 60 is applied to stop the machine after the completion of the "looper's rounds."

Fig. 4 shows the appearance of the rear elevation of the machine when the lug 106 and the fabric take-up and the fabric-cage
 65 have been removed.

The operation of the machine as a whole will now be apparent without any further specific description in view of the description of the operation of its main agencies and of their coördinating pattern mechanism given above in connection with the descriptions of their structure. It will be seen that the machine automatically performs in due time, and without intervention of the operator, the necessary operations going to
 70 make its typical products, and that I have provided a durable, simple and convenient device free of complications, which may be readily used for the manufacture of the most desirable types of circular seamless
 75 hosiery and which may readily be converted from the manufacture of one sort to the manufacture of another sort with the exercise of a minimum of intelligence and labor.

I do not herein claim the yarn-feeding devices made the subject of my continuing application Serial No. 845,844, filed June 18, 1914 or the devices for determining the length of the stitches at all of the needles, nor the devices for determining the stitch-length locally at a predetermined part of the needles, nor the combination therewith of means for feeding a splicing yarn, the said matters forming the subject of a divisional application Serial No. 870,797, filed
 80 November 7, 1914.

What I claim is:

1. In a knitting machine devices for leveling the needles for transfer comprising a cam carrier having advancing and retracting
 85 cams thereon in a position excluding a free level for the needle-butts and fixed with respect to said cam carrier, a stitch cam, and means whereby said stitch cam may be moved into and out of contact with the
 90 needles.

2. In a knitting machine devices for leveling the needles for transfer comprising a cam carrier having fixed advancing and retracting
 95 cams thereon on either side of planes defining a free level for the needle-butts with respect to said cam carrier, a stitch cam having a depressing face normally across said level and means whereby said stitch cam may be moved out of
 100 contact with the needles.

3. In a knitting machine, devices for leveling the needles for transfer comprising a cam carrier having a ledge at a level upon which the needles travel at intervals between
 105 knitting, a top center cam fixed with respect to said ledge, in a position to retract needles encountering it to the level of said ledge, stitch cams, and means whereby said stitch cams may be moved out of contact with the needles.

4. In a knitting machine, a cam carrier having fixed advancing cams and a fixed retracting center cam thereon in a position to define a free level for the needle-butts with
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- respect to said cam carrier, a leading stitch cam having an advancing surface to encounter needles at said level and a following stitch cam having a depressing cam surface
- 5 coöperating with said center cam, in combination with means permitting said stitch cams to be moved out of contact with the needles to permit them to be positioned at said level.
- 10 5. In a knitting machine, a cam cylinder having a horizontal flange and a terminal ledge interrupted at one point to form an opening the slopes of which constitute advancing cams, a center cam centrally mounted
- 15 with respect to said opening on an attachment of said cam cylinder, symmetrical stitch cams, and a mounting for said stitch cams guided to slide horizontally in a direction parallel to the radial plane at said center
- 20 cam.
6. In a knitting machine, needle-leveling means comprising needle and cam carriers, advancing and retracting cams on said cam carrier defining between them a free
- 25 level for the needles, a stitch cam and a mounting therefor comprising a segment of a cylinder bearing said stitch cam on its inner face and means permitting said stitch cam and its mounting to be moved with respect
- 30 to the center of the cylinder of which it is a segment to bring the needles to a level comprising a flange, and retaining means coöperating with said flange at the extremities of said segment.
- 35 7. In a knitting machine, a knitting head, a main drive shaft, gears co-axial with said shaft, means to drive said gears at different rates and means to clutch said shaft to one
- 40 or another of said gears comprising a clutch collar on said shaft, a fixed guide parallel to said shaft, a clutch shifter free to slide thereat, a cam drum rotating on an axis
- 45 parallel to said shaft and said guide, a follower on the clutch shifter engaging the cam drum, and means to operate said drum, whereby the clutch shifter is moved to engage
- 50 said gears in a direction parallel to an element of the surface of the drum at times related to the movement of said gears.
8. In a knitting machine, a knitting head, a main drive shaft, a reciprocal gear and a
- 55 direct drive pinion co-axial with said shaft, a clutch member on said shaft adapted to engage said shaft with one or another of said drive means, a cam shaft and cam drum, a clutch shifting slide engaging said drum and said clutch member, a guide rod
- 60 for said slide, a sprocket wheel and pattern chain on said cam shaft, a ratchet and pawl for advancing the pattern chain, a ratchet and pawl for advancing the cam shaft, and a pawl controller for the cam shaft pawl journaled on the guide rod and extending
- 65 thereby over the pattern chain to be actuated
9. In a knitting machine, a knitting head, a main drive shaft, a reciprocal gear, and a direct drive pinion on said shaft, a clutch member on said shaft adapted to engage
- 70 said shaft with one or another of said drive means, a cam shaft and cam drum, a guide rod parallel with said shafts, a clutch shifting slide engaging said drum and said clutch member having widely separated
- 75 bearings on said rod, a sprocket wheel and pattern chain on said cam shaft, a ratchet and pawl for advancing the pattern chain, a ratchet and pawl for advancing the cam shaft, and a pawl controller for the cam shaft pawl journaled on the guide rod be-
- 80 tween the clutch slide bearings and extending over the pattern chain to be actuated thereby, and means to prevent sliding movement of said pawl controller on said rod.
10. In an automatic stocking knitting machine, a knitting head, a main drive shaft
- 85 therefor, a pattern cam shaft and means to advance said pattern cam shaft, a pattern chain and means controlled thereby to control the advance of the pattern shaft, in
- 90 combination with means for supporting and holding said pattern chain comprising a sprocket wheel, means to advance said wheel and a fixed trough or holder beneath said sprocket wheel to guide and receive folds of
- 95 the idle run of chain depending from the said sprocket.
11. In a pattern mechanism for knitting machines, the combination of a sprocket wheel, a mutable-link pattern chain of open
- 100 links capable of connection and disconnection by sliding movements of one link with respect to another in a direction at right angles to the length of the chain on said
- 105 wheel, and a holder for the idle run of chain depending from said sprocket wheel comprising side walls spaced apart at a distance sufficient to permit free movements of the chain and to prevent disengagement of one link from another.
- 110 12. In a pattern mechanism for knitting machines, a sprocket wheel, a mutable-link pattern chain of links capable of connection and disconnection by sliding movements of one link with respect to another in a direction
- 115 at right angles to the length of the chain, and a holder for the idle run of chain depending from said sprocket wheel comprising side walls spaced apart at a distance sufficient to permit free movements of
- 120 the chain and to prevent disengagement of one link from another, and having a curved bottom surface to aid in the formation of folds by pendulum movements of said chain.
- 125 13. In a pattern device for knitting machines, an endless pattern chain and means to advance it comprising a sprocket wheel, a holder for the idle run of chain comprising a trough open at the top in which said
- 130

chain can pile up in folds, and a tension device to straighten out the run of chain moving toward said sprocket wheel.

14. In a pattern mechanism, an endless chain and means to advance said chain, in combination with a support or holder for the idle length of chain, comprising a trough having a curved bottom in the plane of the sprocket wheel, the walls of said holder being placed with respect to the vertical extending from the down-going face of said sprocket to provide freedom for pendulous movement of the down-going run of the chain on either side of said vertical.

15. In a knitting machine, needle-leveling means comprising fixed needle and cam carriers, advancing and retracting cams on said cam carrier defining a free level for the needles a stitch cam, and a mounting for said cam comprising a segment of a cylindrical structure bearing said stitch cam on its inner face, and means to hold the stitch cam and its mounting for radial movement with respect to the center of the cylinder of which it is a segment comprising a flange, and retaining means cooperating with said flange at the extremities of said segment whereby said segment and its cams may be moved to bring said needles to a level by the action of the fixed cam.

16. In a knitting machine, a knitting head, including knitting needles and devices cooperating therewith to knit, a main drive shaft, a pattern cam shaft and a pattern surface driven thereby, means at the knitting head to determine the operative position of certain of said devices cooperating with the needles, and actuating connections movable by said pattern surface for said means comprising a series of endwise movable thrust bars cooperating at one end with the pattern surface and at the other end with the said devices.

17. In a knitting machine, a knitting head, including knitting needles and devices cooperating therewith to knit, a main drive shaft, a pattern cam shaft, and a pattern surface driven thereby, means at the knitting head to determine the operative position of certain of said devices cooperating with the needles, and connections between said means and said pattern surface comprising independent thrust bars for movement by said pattern surface and at their upper ends in direct contact with said means, and means to support said bars for endwise movement and against movement with said pattern surface.

18. In a knitting machine, a knitting head, including knitting needles and devices cooperating therewith to knit, a main drive shaft, a pattern cam shaft and a pattern surface driven thereby, means at the knitting head to determine the operative position of certain of said devices cooperating

with the needles and connections between said means and said pattern surface comprising combs and vertical bars guided in said combs resting at their lower ends on said pattern surface.

19. In a knitting machine, a knitting head having a rotatable element, and means to rotate it on a vertical axis comprising a main drive shaft substantially in the plane of said vertical axis, a pattern cam shaft beneath said main shaft, means to move said pattern cam shaft at predetermined times, a pattern drum on an axis parallel with said cam shaft, means to drive said drum, knitting devices at the knitting head comprising movable parts for operation at predetermined times, and a series of endwise movable elements each directly actuated by said drum and coacting at the other end with said movable parts.

20. In a knitting machine, a knitting head having a rotatable element and means to rotate it on a vertical axis comprising a main drive shaft at one side of said axis and substantially in the plane of said vertical axis, a pattern cam shaft beneath said main shaft, means to move said pattern cam shaft at predetermined times, a pattern drum geared to said pattern shaft on an axis parallel with said cam shaft and at the rear of said vertical axis, cams on said drum, means at the knitting head comprising movable parts for operation at predetermined times, a series of endwise movable elements and means to guide said elements in an upright position for contact at one end with said cams and at the other end with said movable parts.

21. In a knitting machine, a knitting head having a rotatable element and means to rotate it on a vertical axis, comprising a main drive shaft substantially in the plane of said vertical axis, a pattern cam shaft beneath said main shaft, means to move said pattern cam shaft at predetermined times, a pattern drum carrying pattern cams on an axis parallel with said cam shaft, means at the knitting head comprising movable parts for operation at predetermined times, a series of thrust-bars and combs to space and guide said bars for contact at one end with said drum and cams and at the other end with said movable parts.

22. In a knitting machine a knitting head and drive means therefor, knitting devices thereat, a pattern cam shaft and pattern means actuated by said cam shaft comprising a pattern surface, one or more thrust bars contacting with said surface and with said knitting devices, and means on said surface for operating one of said thrust bars through different distances for the separate operation of each of a plurality of said knitting devices.

23. In a knitting machine in combination

with knitting cams two universally mounted picking instruments having freedom of movement about parallel axes, eccentric pins carried by said axes, and a link connecting said pins.

24. In a knitting machine, the combination of picking instruments adapted for operation in symmetrically opposite directions, each of said instruments comprising a picker, a directing cam therefor and a spring device for holding said picker against said cam in combination with a tension connection between said instruments for positioning one of them during the operative stroke of the other.

25. In a knitting machine, the combination of picking instruments adapted for operation in symmetrically opposite directions, each of said instruments comprising a picker, a directing cam therefor and a spring device for holding said picker against said cam in combination with a tension link between said instruments for positively positioning one of them during the operative stroke of the other, said connection permitting lost motion, whereby the idle picker may follow its directing cam without effect upon the operative picker active to position it.

26. In a knitting machine, independently movable needles and means for reciprocatory knitting upon said needles, in combination with a picker for cooperation with one end of the series of needles in work, another picker for cooperation with the other end of the series of needles in work and a tension member connecting said pickers, whereby the actuating movement of one picker will restore the other to position to encounter a needle.

27. In a knitting machine independently movable needles and stitch cams for reciprocatory knitting upon said needles in combination with pickers mounted on vertical axes for rotation in a horizontal sense, said axes being symmetrically placed with respect to the stitch cams, and a connection between said axes to cause them to rotate together upon the working stroke of either picker.

28. In a knitting machine, independent needles and cams for reciprocatory knitting upon said needles, in combination with needle picking instruments mounted on vertical axes for rotation in a horizontal and a vertical sense, a directing cam for each of said picking instruments having an upper and a lower horizontal surface, a spring tending to rotate said picker about its horizontal axis, and a connection between said instruments to cause them to rotate together upon their vertical axes.

29. In a knitting machine, a needle picking device comprising a picker, a freely rotatable vertical axis therefor, a head on said

axis, and a pivot for the picker in said head transverse to said vertical axis, in combination with a directing cam and a spring device acting in a constant direction to rotate the picker upon said pivot to hold it against said directing cam, whereby said picker remains inert at each end of its operating stroke.

30. In a knitting machine, a picker, a mounting therefor comprising a bracket, a vertical axis fixed against axial movement in said bracket, a head on said axis, a pivot in said head, a picker movable on said pivot, a directing cam for the working end of said picker and a spring device constantly acting in the direction of said vertical axis to rotate said picker upon said pivot and against said directing cam, and means for positively positioning said picker.

31. In a knitting machine, a picker rotatable on a vertical axis for its working stroke, a directing cam, and means permitting movement of said picker about a horizontal axis to follow said cam, in combination with a spring device for holding said picker against its cam rotatable with said picker about said vertical axis, whereby said picker is free from stress of said spring tending to rotate it about said vertical axis.

32. In a knitting machine, independently movable needles and cams for rotary and reciprocatory knitting upon said needles, in combination with pickers, for lifting needles moving in respectively opposite directions, mounted upon vertical axes symmetrically placed with respect to the stitch cams, a connection between said axes to cause them to rotate together upon the working stroke of either picker, and a stop for one of said pickers to prevent its movement in a direction opposite to the direction of its working stroke, said picker having a cam surface for coaction with the needle butts.

33. In a knitting machine, independently movable needles and cams for rotary and reciprocatory knitting upon said needles, in combination with pickers pivoted for vertical movement and mounted on vertical axes for rotation in a horizontal sense, a connection between said axes to cause them to rotate together upon the working stroke of either picker, a directing cam for each of said pickers having horizontal portions and an inclined portion, springs for holding said pickers against their cam and means for permitting lost motion of one of said picker axes with respect to the other.

34. In a knitting machine, a cam cylinder having a needle guiding ledge, and a relatively fixed center or guide cam above said level, in combination with symmetrical stitch cams and means permitting said stitch cams to be withdrawn in a direction parallel to a radius at the center cam, lifting pickers cooperating with said stitch cams and means

independent of the stitch cams to hold one of said pickers against movement about a vertical axis in one direction to aid in leveling the needles.

5 35. In a knitting machine, needles and narrowing pickers automatically operative upon the ends of an oscillating segment of the said needles, a single widening picker and means acting to hold said picker nor-
10 mally in position for operation, in combination with means active to hold the widening picker in an inoperative position during narrowing only.

36. In a knitting machine, the independ-
15 ent needles and means for knitting thereon comprising narrowing devices, a widening picker, and means for holding said picker normally in an operative position in which it will encounter the butts of needles in an
20 inactive position, and means for returning said picker to said operative position, in combination with devices for moving said picker to an inoperative position during narrowing and for permitting its return to
25 operative position for widening.

37. In a knitting machine, independent needles and means for knitting thereon, comprising means for elevating the needles to an idle position, a widening picker having a
30 universal mounting and means for returning said picker to a position to encounter and move elevated needles moving in either direction in combination with devices for holding said picker in a lower inoperative
35 position, and for permitting said picker to return to its active position at predetermined times.

38. In a widening device for knitting machines, a widening picker mounted for uni-
40 versal movement, means holding said picker normally in position to encounter leading needles of a series of needles moving in either direction in an elevated inoperative path, and means for directing said picker

downwardly when moved laterally in either 45 direction in combination with means for swinging the picker downwardly to a lower inactive position at predetermined times.

39. In a knitting machine, a widening or lowering picker, means to position said 50 picker to encounter needles moving at an upper idle level, a switch cam for cooperating with the needles to be placed at such level, and means cooperating with said switch cam and with said picker to move said picker out 55 of its active position when the switch cam is actuated to move the needles to the idle level.

40. In a knitting machine, a widening or lowering picker, means to position said 60 picker to encounter needles moving at an upper idle level, a switch cam for cooperating with the needles to be placed at such a level, and means cooperating with said switch cam and with said picker to move 65 said picker out of its active position when the switch cam is actuated to so move the needles, and devices to move said means to permit said picker to occupy its active position. 70

41. In a knitting machine in combination with needle and cam carriers, independently movable needles and stitch cams in said carriers, respectively, a switch cam, a widening picker for moving needles from an idle 75 path down into action, a movable connecting device, and means actuated by said connecting device to move the switch cam when in one position and the widening picker when in another position. 80

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

ROBERT W. SCOTT.

Witnesses:

MINOT G. CROZIER,
MARY F. GRIFFIN.