

are lowered to bring their butts under the control of the knitting cams, and the motion of the machine is again changed from reciprocating to rotary.

This effect of the fashioning operation just described has been to

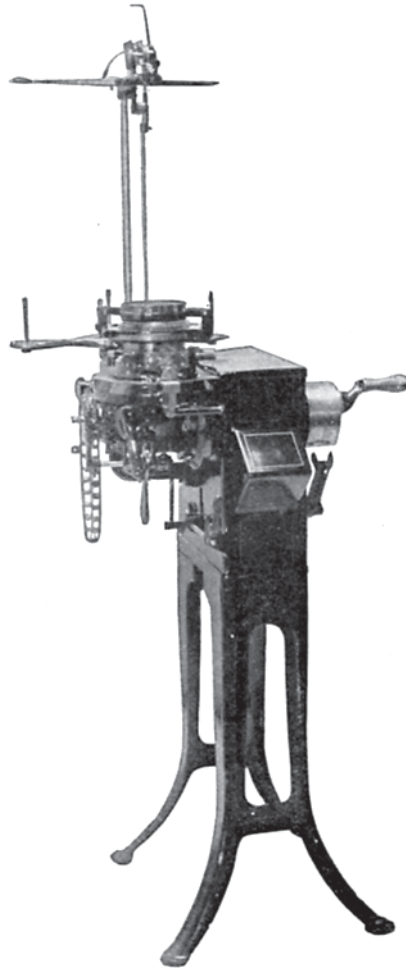


Fig. 129. Branson Full Automatic Machine.

produce a seamless pocket upon one side of the knitted tube, which constitutes the heel of the finished stocking, as shown in Fig. 131. *f* represents the narrowed web; *g*, the central circular courses; and *h*, the

widened web. After the heel has been completed the tubular web is resumed and continued until the same is of the length desired for the foot of the stocking, whereupon the operations resorted to in order to form the heel are repeated for the toe of the stocking.

The circular courses may be omitted from the instep and center of the heel, the narrowed web *f*, in this case, being united directly to the

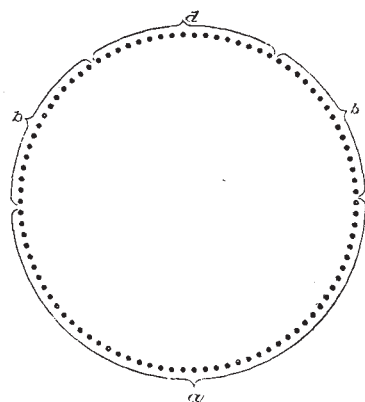


Fig. 130.
Diagrammatic View of Needles.

widened web *h*, or in other cases a series of courses extending around the entire heel, but not over the instep, may be formed after the narrowing operation and before the widening operation. In this case only the needles *b* are thrown into action after narrowing and they are again thrown out of action after the desired courses for the center of the heel have been produced.

After the completion of the toe a few tubular courses are knitted and if the socks or stockings are being produced singly, the stitches

may then cast off the needles of the machine to free the web therefrom, preparatory to starting a new stocking or applying a new ribbed top. If the machine is intended to operate continuously, and produce stocking after stocking in succession, the production of tubular web may, after the formation of each toe, be continued to form the leg of the next stocking, and so on, the web being afterward severed near each toe, so that each stocking blank will represent the appearance shown in Fig. 131; the toe being completed by uniting the edges *i i* in the usual manner.

FULL AUTOMATIC KNITTERS. ACME TYPE

A circular knitting machine of the Acme type, Fig. 132, comprises a stationary needle cylinder, an encircling rotating cam cylinder, and latch needles with butts or lateral projections in their shanks. The needle cylinder has a series of longitudinal, parallel grooves on its outer surface, and the cam cylinder is provided with suitable cams or inclines on its inner surface. The needles lie in the grooves of the needle cylinder, with their butts projecting outward. As the cam

cylinder revolves, the butts come in contact with and slide up and down the inclines or cams, and so cause the requisite up-and-down movement of the needles in the operation of knitting.

Operation. The needle is lowered to knit, by what is called the stitch cam, which has a diagonally inclined edge, and thus moves the needle down as the cam cylinder revolves. The cam cylinder also carries a yarn guide through which the thread is laid in the hook of the needle just before the needle is moved down by the stitch cam. As the needle moves downward, the latch is pulled up by the loop on the shank of the needle so as to close the hook of the needle, thus safely drawing down a new loop through the old one. When the needle rises again, the yarn in its hook pulls open the latch and turns it down upon the shank of the needle until the yarn has passed entirely below the latch, forming a loop around the shank through which, in turn, another loop is pulled down. Thus each needle pulls a series of loops, one through the other, forming a knitted fabric.

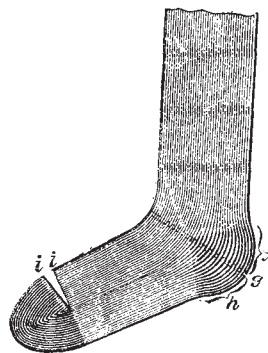


Fig. 131. Stocking as it Comes from Machine.

When the needle descends with a new loop the old loop is cast off over the closed hooked end of the needle, and forms a part of the tubular fabric which hangs down within the needle cylinder.

In knitting the tubular portions of a stocking, all the needles are in operation, and knit one course at each revolution of the cam cylinder. In knitting the heel or toe of a stocking, only a portion of the needles are in operation, and the cam cylinder is reciprocated, or moved first in one direction and then in the opposite direction. The heel and toe are in the form of a pouch or pocket, and they are knit by what is known as the narrowing and widening operation.

In this operation about one-half the number of needles are first raised to a higher level, or into an idle position, so that their butts will not be operated upon by the stitch cams. The other needles remain in an active position where their butts may be operated upon by the stitch cams. In the operation of narrowing, which then takes place, one of the active needles is shifted to a higher level, or to the idle series, at each reciprocation of the cam cylinder, by raising or elevating the

butt of the needle. When the narrowing is completed, the widening takes place by exactly the reverse operation; one of the idle needles is shifted to a lower level, or to the active series, at each reciprocation of the cam cylinder, by lowering or depressing the butt of the needle.

Sinkers. To operate this type of circular machines there are required devices known as jacks, sinkers, or web holders. These are thin blades of metal, one of which is placed between each two adjacent needle shanks. Each sinker has a longitudinal movement, inwardly and outwardly toward and from the center of the needle cylinder, in suitable guides near the upper edge of said cylinder; its movement being regulated by a cam which accompanies the movement of the cam cylinder. Each jack has a finger which, when the jack is advanced, overlies the last course of yarn which forms the upper edge of the fabric, and so holds the loops on the needle shanks from rising, as they otherwise would do, when the needles adjacent to the jack are pushed upward through the loops last formed by them, in order to receive the yarn for the loop of the next course. The bottom of the notch or recess formed by the overhanging finger bears against the edge of the fabric, and thus the jacks on either side of a given needle, when advanced, tend to pull the yarn tight around the shank of the needle. After the needle has risen and received the yarn, the jacks adjacent to it are moved outward a short distance so that the fingers will be out of the way of the yarn drawn down by the descending needle, which thus forms the new edge of the fabric. The jacks are again advanced, previous to the next rise of the needles, to hold down the edge of the fabric just formed.

Thus the primary elements of the circular knitting machine, are the *latch needles, grooved needle cylinder, cam cylinder, stitch cams, and sinkers*, and they alone would be necessary for knitting a plain tubular fabric by what is called circular knitting, in which all the needles are kept in continuous operation.

In knitting a stocking, however, which is the principal purpose for which these machines are employed, we find a further problem. In knitting the heel or toe, about one-half of the needles are lifted so that their butts are above the level of the stitch cams, and these needles thus remain idle; no longer being pulled down to knit. These are often spoken of as the long heeled needles, because their butts are longer than those of the other needles, so that they may be engaged by

a cam and lifted out of the row of operative needles. On the remaining needles a progressively narrowing strip of fabric is knitted, and then a progressively widening strip is knitted, until a pouch is com-

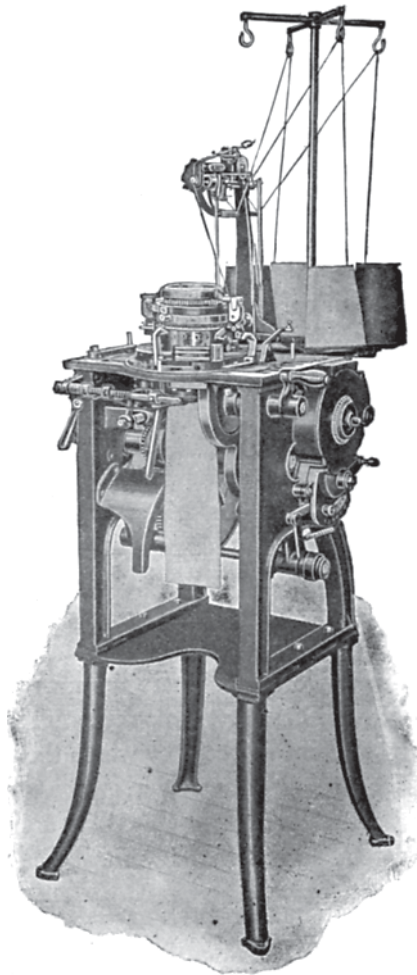


Fig. 132. Acme Full Automatic Machine.

pleted which forms the heel. After the heel is completed the long needles are thrown back into action and circular knitting is resumed for the foot of the stocking.

Narrowing. The cam cylinder, when knitting the heel or toe of the stocking, is not rotated, but reciprocates first in one direction and

then in the other, and with each reciprocation of the cam cylinder the needle at the forward end of the row of active needles (*i. e.*, the one which would be first encountered by the stitch cam and be lowered so as to knit) is lifted up into the plane of inactive needles. Thus the fabric knit by the needles grows narrower by one loop with each reciprocation of the cam cylinder, and this is accordingly called the "narrowing" operation.

Widening. After the narrowest portion of the fabric has been arrived at, only a small number of needles being left still in operation, the "widening" operation begins. This operation consists in first throwing one needle out of operation and then throwing two needles into operation on each reciprocation of the cam cylinder. This is continued until all the needles removed in the narrowing process have been brought back and the pouch has been knitted. Then the long heeled needles are all brought down simultaneously into active position, and circular knitting is resumed. This is called the *two-and-one method*.

The two-and-one method has been adopted in the widening process for the following reasons: In the one-and-one method the last needle to knit in the widening operation, as the cam cylinder moves in one direction, is the first needle to knit on the next course on the return reciprocation of the cam cylinder in the opposite direction. This needle, therefore, draws two loops, with the result that a series of small holes is left along the line or seam where the narrowed and widened portions are joined in the heel or toe pocket. This disadvantage is overcome by the two-and-one method, by which the last needle to knit in a given course is thrown out of operation on the return reciprocation of the cam cylinder, and therefore it is not the first to knit on the next course. To express the effect in another form, in knitting each course one needle knits beyond the needle which is the first to knit in the next returning course.

In the earlier machines of the Acme type, all the rotary knitting of the body of the stocking was automatic, while the reciprocating knitting of the heel and toe was done by hand. When the rotary knitting was partially or wholly completed, or when the heel or toe were to be knit, the machine was stopped, and about one-half the needles shifted to an idle position. In the narrowing and widening operation which followed, the individual needles were raised by a pick

or hook in the hand of the operator, and depressed by the finger of the operator. As the result of this use of a pick to shift the needles, the term "*picker*" has come to designate the means by which the needles are shifted in an automatic machine, and the machine itself is called the "*picker machine*."

The pickers, which raise the needles are known as elevating or lifting pickers, or *lifters*, and the pickers which depress the needles are known as the depressing pickers, or *droppers*. Two lifting pickers are used in automatic reciprocating knitting, one operating when the cam cylinder moves in the opposite direction and the same, of course, is true of the depressing pickers because there must be two stitch-cam arrangements on the cylinder in reciprocating knitting, one operating when the cylinder is moved in the opposite direction.

In order to automatically shift the needles in narrowing and widening, pickers are mounted on the cam cylinder, each of which in turn, as that cylinder is reciprocated, comes in contact with the butt of the needle or needles to be shifted, and is so organized that it thereupon automatically shifts the needles while the needle moves the picker.

There are four of these pickers upon the cam cylinder, namely, a pair of "*lifters*" for raising the needles from operative to inoperative position, one operating on the reciprocation of the cam cylinder in one direction, and another on the reverse reciprocation, and lastly a pair of "*droppers*" for similarly lowering the needles from inoperative to operative position.

These (lifting) pickers are provided, at their ends, with recesses or notches for receiving the needle butts, the notches being so formed that there is a lip or finger underlying the needle butt when it is in engagement with the notched end of the picker. The pickers are mounted upon the cam cylinder so that they move in an inclined or diagonal direction, and when a needle butt engages the notch of the picker, that picker is moved backward and upward, with relation to the cam cylinder, and the lip of the picker engages the underside of the needle butt, carrying the needle upward out of the active series, the needle butt being transformed from the notch of the picker to an inclined guide or cam which completes its movement, from the active or working series, to the idle series.

The devices for transferring the needles, individually, from the idle to the working series, during the widening operation are similar to the

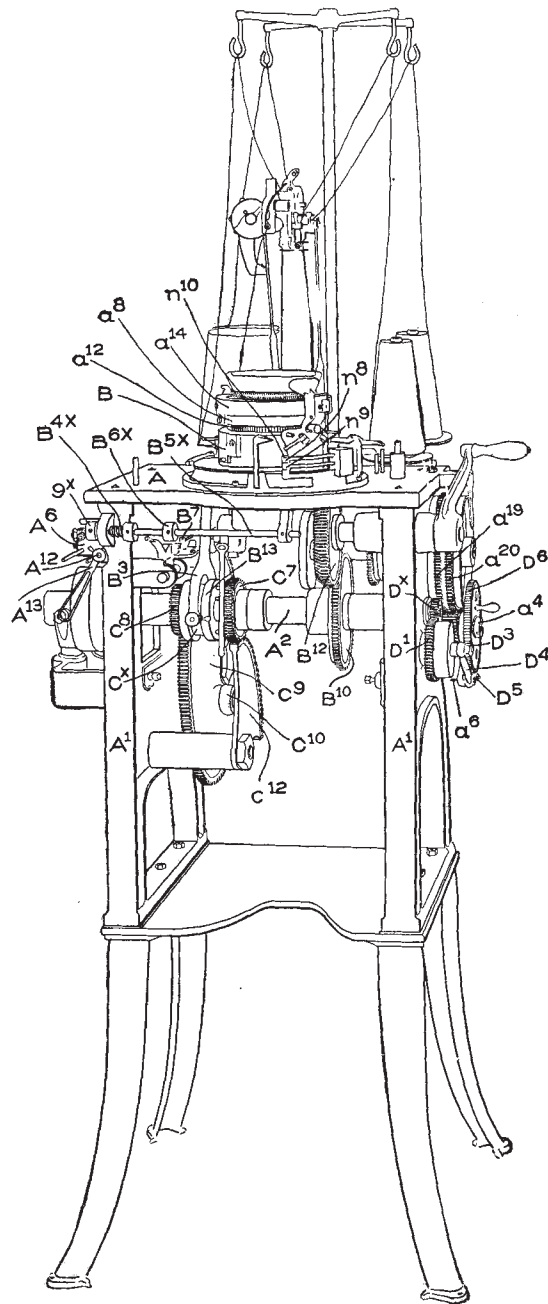


Fig. 133. Acme Full Automatic Machine.

pickers for transferring the needles from the working to the idle series during the narrowing operation, the only difference being that the depressing pickers are provided with lips which overlie the needle butt, which is in engagement with the notched end of the picker, and the picker is arranged to move downward when engaged by a needle butt and thus carry the needle downward from the idle towards the working series.

In other words the pickers operate as follows, taking, for example, the lifter: As the cam cylinder rotates, the notched end of the lifter comes against the butt of the first needle in the row of active needles. The needle, being held in a vertical groove in the stationary needle cylinder, cannot move sidewise, and so its butt stops the lifter from further motion with the cam cylinder, or in other words, forces it backward relatively to the advancing cam cylinder. The lifter is so mounted that it can retreat only in a diagonally upward path, and since it has a finger which underlies the needle butt, it carries the needle butt with it, and thus lifts the needle to inoperative position, the needle rising in its groove. The butts or heels of these needles which are in operation are just above the ledge of the cam cylinder, so as to be in the path of the stitch cam and be thereby pulled down so as to knit. The inactive needles are in a higher plane, with their butts above the guide plates, so as to be completely out of the path of the stitch cams.

The Acme machine employs a rotary winder device for winding the free end of the thickening or extra thread around the main thread.

Winder. The construction of this winder is such that, when the winding of the free end of the thickening thread about the main thread has been completed, the free end of the thickening thread can be pulled out from the winder by the main thread, without being unclamped from the winder. It consists of a stationary stud or boss having in it two thread passages, one for the main thread, and the other for the thickening thread. The main thread runs continuously through its passage, thence through a thread eye and take-up to the needles. Mounted upon the stationary boss, so as to be capable of rotation thereon, is the shell or sleeve, which forms the winder. Upon the end of the winder or sleeve are formed a number of projections of wire or bristles in the form of a ring-like brush.

When it is desired to withdraw the thickening thread from the main thread, the hook upon the three-armed lever pulls the thickening

thread to one side so as to engage one of the spaces or slots between the bristles at the end of the winder, and the further movement of the lever causes its lower arm to strike an arm connected with the jaw, and so to sever the thickening thread, the end of which remains in the slot in the end of the winder until the next operation thereof.

The Acme machine illustrated in Fig. 133 is a full automatic, built in what is sometimes termed a box pattern style. The head or knitting cylinder is located in the bed plate so that the work is directly in front of the machine. The skeleton cylinder is one of the distinctive features of this machine, which is also true of the pattern wheel system for regulating the length of the tubular knitting, the length of the stitch and also to operate the stop motion at the completion of the stocking.

When the machine changes to the reciprocating motion to knit the heel or toe, the pattern wheel is automatically thrown out of action and a ratchet wheel is provided to take its place while knitting the heel or toe. This ratchet feeds one tooth for each needle required to narrow, and one tooth for each needle required to widen, and requires one full revolution to complete the heel or toe. When the machine changes again to rotary motion, the pattern wheel is automatically thrown into action and completes the tubular portion of the stocking.

A transfer cup or quill ring is used for transferring, instead of changing cylinders.

These machines are built in $\frac{1}{4}$ inch sizes, from 2 to $4\frac{1}{4}$ inches with any number of needles up to 17 to the inch.

The Needle Cylinder is represented as a vertical section in Fig 134. This illustration also shows some of the parts connected with it. a^2 and a^7 are the needle cylinder proper, supported in the cylinder guide O which surrounds and retains the lower end of the needle cylinder. At this end of the needle cylinder, between it and the cylinder guide, is a cam ring n^1 with the projection n^0 which, when the cam ring is rotated and also by reason of the inclined portions of the cylinder bottom, allows the cylinder to descend by gravity, thus shortening the stitch and reducing at the desired place the size of the stocking. A guide block r^2 (See also Fig. 136), which is fastened in the cylinder guide and extends into the vertical slot, r^0 , in the cylinder, serves to guide the needle cylinder in its vertical movement and to prevent it from turning.

The upper end of the needle cylinder a^2 is made broader or thick-

er by the addition of the ring a^7 to its interior. The ring is fastened to the cylinder with a screw 4 and has a projecting ledge a^9 which supports the jack support-ring a^8 , which is in turn secured to the cylinder by means of the screw 5. The jack supporting ring is slotted on the top edge to form a support for the outer ends of the jacks a^{10} , and similar grooves are provided in the upper end of the part a^7 of the needle cylinder, for the inner ends of the jack. Each jack is made with a projection a^5 to enter the annular groove in the ring a^{14} , which is movably mounted to rotate on the jack supporting ring a^8 . It is the function of the jack ring a^{14} , with its cam shaped groove, to operate the jacks and withdraw their fingers a^6 out of the paths of the needles when a stitch is being formed.

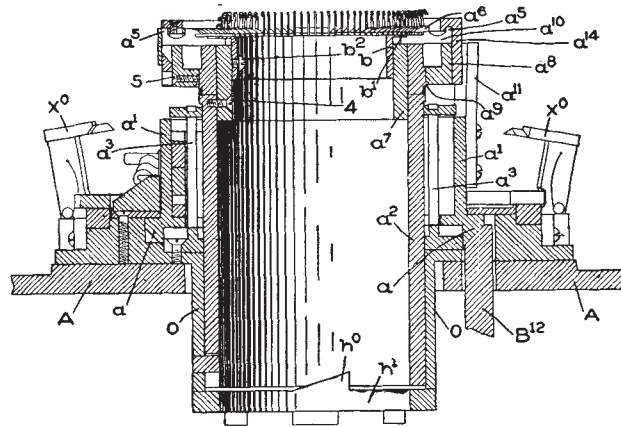
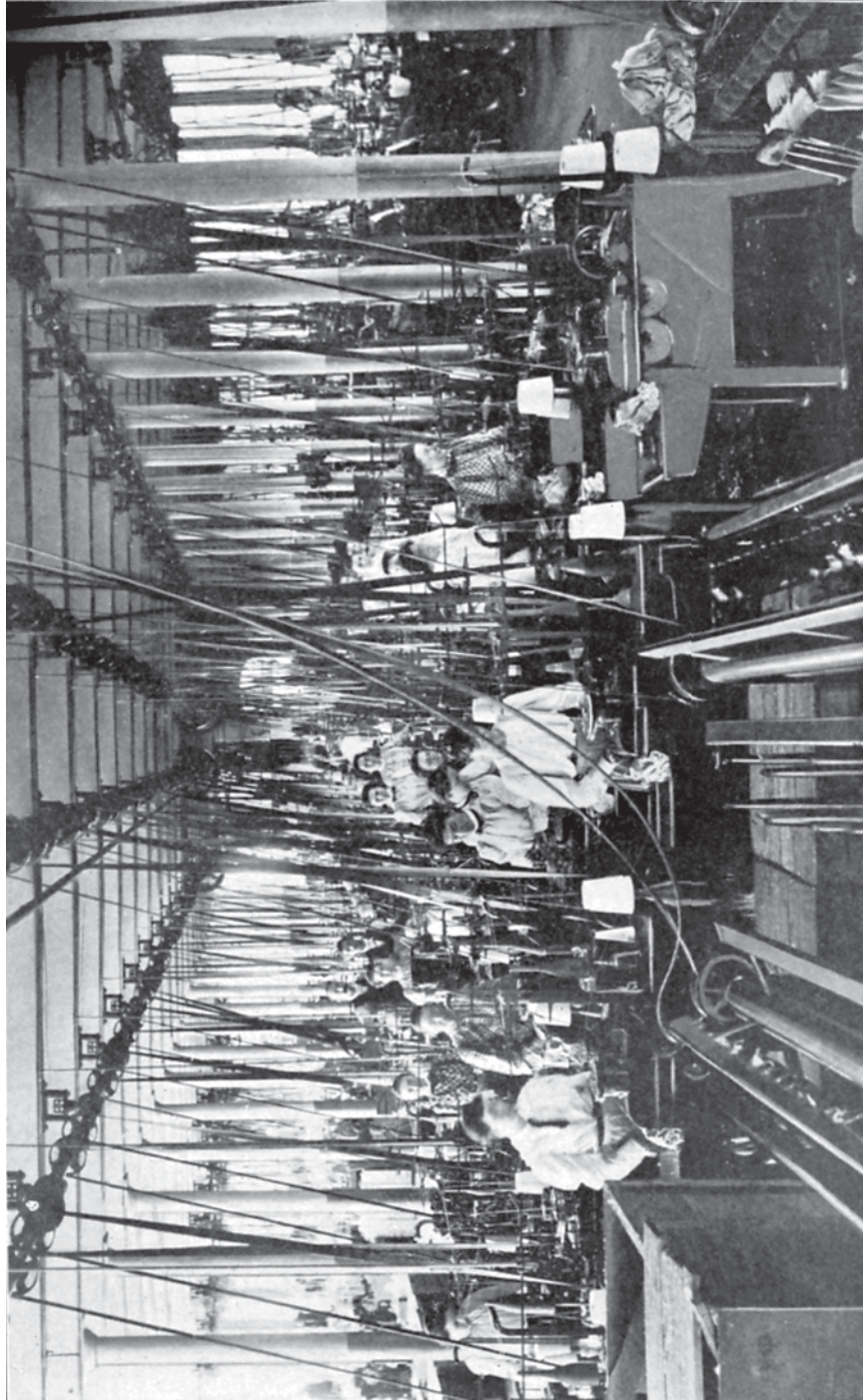


Fig. 134. Needle Cylinder.

The ring a^{14} rests directly upon, and is supported by, the ring a^8 , and is operated from the cam cylinder a^1 by means of an arm a^{11} , which is fixed to the latter and engages with the stops projecting outward from the jack ring a^{14} . Adjusting screws are inserted in the stops and are acted upon by the arm a^{11} —one when the cam cylinder is moved in one direction, and the other when the cam cylinder is moved in the opposite direction. This enables the cam for moving the sinkers, and the knitting cams to be put in their proper relative positions during the knitting operation, as is necessary in machines using sinkers, there being more or less lost motion between the sinker cam ring and the cam cylinders during the changes in reciprocating knitting.



VIEW IN KNITTING ROOM OF SHAW STOCKING CO., SHOWING SHAW AUTOMATIC POWER JACQUARD STOCKING LOOMS

The *Jacks* a^{10} which take the stitches as they are formed and push them back from the needles thus taking-up the work as fast as it is knit, are prevented from being raised (by the work) by the ring b which is provided with the flange b^1 . Between the flanges and the

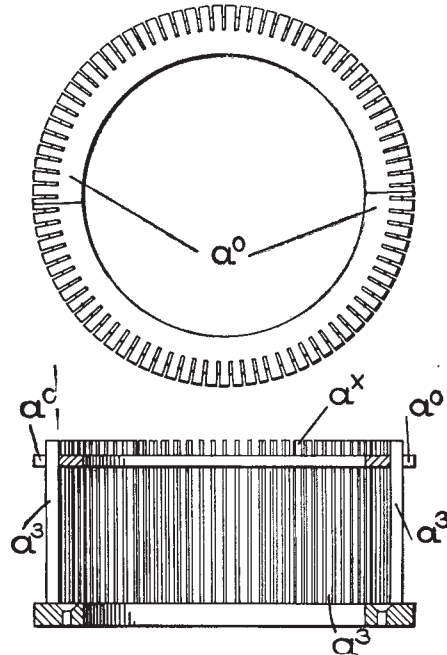


Fig. 135. Skeleton Cylinder.

top of the needle cylinder, are contained the jacks, free to be actuated horizontally in the groove in the jack cam ring a^{14} . The ring b is secured to the needle cylinder by means of a set screw b^2 .

In circular knitting the cam for moving the sinkers is so located with relation to the drawing down surfaces as to pull the sinkers out as the needles commence their descent, the groove of the sinker operating cam ring pushing the sinkers inward preparatory to the rising of the needles to take the stitch of yarn.

The *sinker cam ring* is provided with adjusting screws to time the action of the sinkers. The sinkers also perform the function of web-holders. The sinker ring is fastened to the needle cylinder with screws, and is not to be removed therefrom except when necessary for unusual repairs.

The droppers and lifters X^0 are operated by a cam and swing outward, carrying the needle up or down as required, and locking themselves in position for the next needle. The stitch gauge is on the front of the machine and the stitch may readily be changed in any part of the stocking without interfering with any of the other working parts.

The Acme is of that type of automatics in which the quill ring or transfer cup is employed for making socks or half hose with rib tops, or when rib legs are to be footed, as in the case of boy's stockings, consequently the needles are run up on a level and then lowered into the cylinder by raising the needle cylinder.

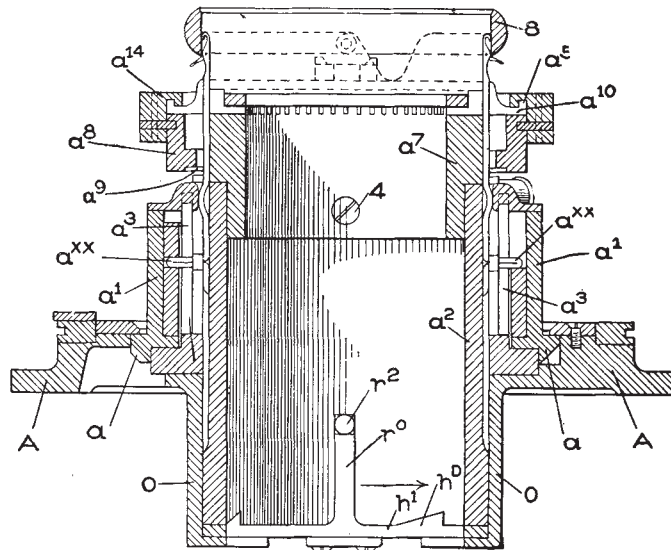


Fig. 136. View of Cylinder Showing Latch-Guard Ring.

A **Skeleton Cylinder** (Fig. 135 and a^3 in Figs. 134 and 136) is placed between the needle cylinder and the cam cylinder, and fastened to the bed plate, or needle cylinder socket, of the machine. The bars or walls a^x of the skeleton cylinder line with the lands or walls of the needle cylinder proper. The slots in the needle cylinder are cut deep enough to provide a good bearing for the needles, and the bars of the skeleton serve as guides to the butts a^{xx} of the needles, which extend outwardly between the bars and through to the cam cylinder in which are disposed the cams to actuate them. As the skeleton cylinder is fastened to the bed plate by means of screws, it can be readily removed

and substituted by another having a greater or less number of bars, according as it is desired to adapt the machine to knit coarse or fine fabrics. When the skeleton is changed it will, of course, be necessary to change the needle cylinder so that the spaces and slots will correspond and be of the same gauge.

The Cam Cylinder is so constructed that the needles are drawn down from a common level to take the stitch and then returned to the same level. When the needles are on this level, the latches are above the stitches that are on the needles, and to prevent the latches from closing and casting off the stitch, a latch guard ring (8, Fig. 136) is provided, which also feeds or guides the thread to the needles.

The cam cylinder is rotated or reciprocated, as the character of the knitting requires, by means of a bevel toothed gear, B¹², engaging with the bevel teeth a cut in the lower edge of the cam cylinder *a*¹.

Method of Driving. In the illustrations shown at Figs. 133 and 137 the table or bed is represented by A and rests on the supports A¹, to which are also secured the several mechanisms contained in the machine for effecting the different knitting processes. The main shaft A², sometimes called the cam shaft, is provided with two loose pulleys for the driving belt, which is under the control of the shipper fork and its actuating mechanism. This mechanism consists of a block A⁶ which slides on a stud and is acted upon by the spiral spring B⁸ to keep the belt upon the outer pulley; the belt being shifted by means of a link A⁹ connected to the block and to an arm of a rock shaft A¹², which is mounted in bearings at the side of the machine, and has a handle A¹³ which is used to start the machine. When the handle has been turned far enough to shift the belt on to the inner pulley, the arm will rest on or just above one arm of the pivoted elbow lever B⁴. The link has an adjusting screw which may be adjusted so as to strike the arm sooner or later after the pivot, which connects the link and arm, passes the line of center of the rock shaft, to thus determine the ease of motion of the link.

The cam shaft has fast on it a gear B¹² which engages the beveled teeth *a* in the lower end of the cam cylinder *a*¹. On the main shaft A² is the hub part of a clutch B¹³ held fast to turn with the shaft by a feather, B³, but loose to move endways, the hub being grooved on the outside to receive a two part ring C⁸ which is connected by means of studs to the forked clutch arm B³ which is pivoted at B¹ and connect-

ed by the link B^6 with the pin 2 located at the inner end of the clutch lever D^{13} (Figs. 139 and 140). The clutch lever is pivoted at D^{14} .

The hub B^{13} (See Fig. 137) has at its sides, spring-actuated pins a and b projecting through the washers on the sides of the hub. A short distance from the hub is a loose gear C^7 mounted on a flanged bushing and collar arrangement secured to the shaft by a set screw and provided with a hole in the clutch face to receive the pin. At the opposite side of the hub and loose upon the shaft, is the pinion C^8 which is secured to the sleeve of the loose pulley A^3 . When the machine is in motion this pinion engages and drives the large gear C^9 . In the face of the pinion is a hole to receive the pin b in the clutch hub.

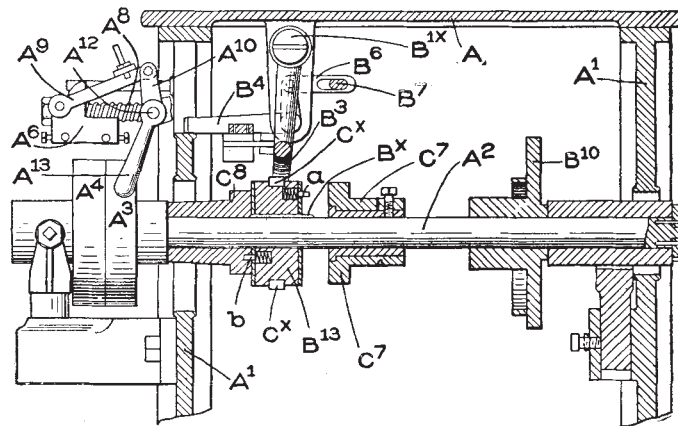


Fig. 137. Method of Driving.

The gear C^9 has a crank pin (See Figs. 138 and 139) provided with a link C^{10} which, at its opposite end, is attached to a stud on the segment gear C^{12} pivoted at C^{13} , the segment engaging the loose gear C^7 and oscillating it continuously. When the pin b of the clutch hub B^{13} engages the gear C^8 the main shaft will be rotated for circular knitting, and the segment will move the loose gear C^7 back and forth on the bushing, but when the hub is shifted, so that the pin a of the clutch engages the gear C^7 , the latter becomes fastened to the main shaft, and the segment actuating it will oscillate the shaft for reciprocal knitting for heel and toe work.

The Pattern Wheel System. The main shaft A^2 has secured to it at one end (See Figs. 133 and 138) the pinion D^x by means of which motion is transmitted through the connecting pawl operating mechan-

ism. This mechanism consists of the gear D^1 ; the adjustably mounted crank pin D^3 , which is attached to the link D^4 ; the pawl carrier D^5 , which is pivoted on the stud a^4 and on which is mounted a spring actuated pawl to engage the teeth of the ratchet wheel D^6 . This ratchet wheel is the prime mover of the pattern wheel system peculiar to this machine.

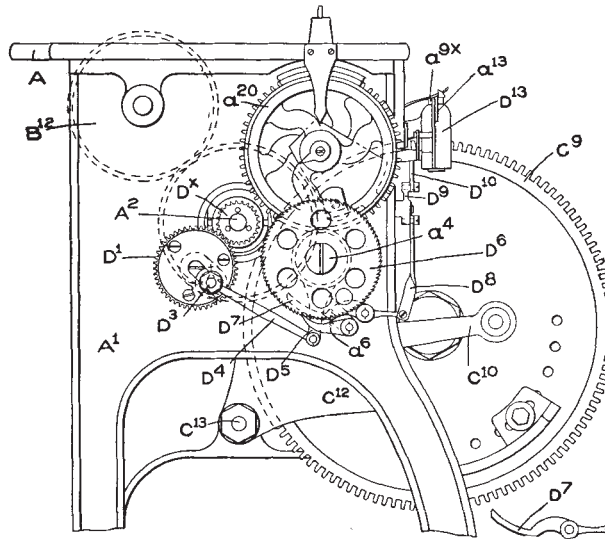


Fig. 138. Gears and Ratchets.

The crank pin D^3 may be adjusted to control the stroke of the pawl, so that it will move the ratchet wheel the distance of one or any desired number of teeth; the greater the movement of the ratchet wheel the shorter the stocking, and *vice versa*. The pawl has in its side, a pin a^6 which, when the knitting is to be changed from circular to heel and toe knitting, during which time the pattern wheels a^{19} and a^{20} in Figs. 142 and 138 are left at rest, is struck by one end of a lever D^7 , connected with a link D^8 , Fig. 138, with an elbow lever D^9 pivoted at D^{12} (See Fig. 139) to a lug 4, projecting from the clutch lever D^{13} (also shown in Fig. 138) which latter is moved when the change from circular to reciprocal knitting and *vice versa* is to be made by the pattern wheel.

The outer end of the clutch lever D^{13} (Figs 138 and 139) is forked to embrace the wheel C^9 , each fork being provided with sliding pins

a^{9x} and a^{10x} (See Fig. 140), each pin having at or near one end a projecting cross pin, entering inclined slots in the sliding bar a^{13} which is moved in one or the other direction, according as it is desired to change from circular to reciprocal knitting or *vice versa*.

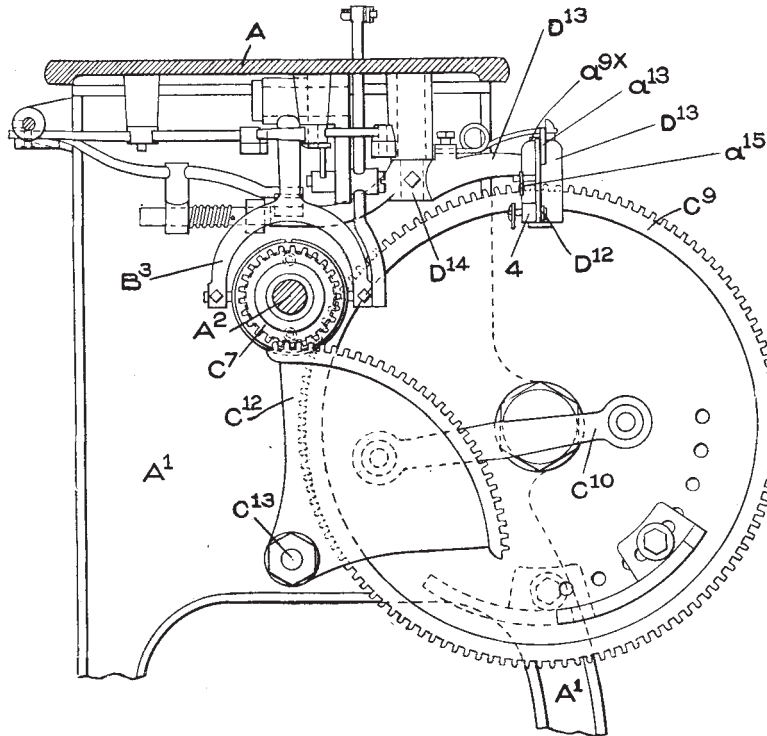


Fig. 139.

The bar a^{13} has connected to it a lever pivoted at D^{12} and having connected to it a link slotted at one end to embrace and slide on a screw stud carried by a change lever a^{17} (Fig. 141) with three arms, and being pivoted on a stand attached to the bed.

The change lever a^{17} is acted upon its right-hand end when the change from circular to reciprocal knitting is to be made, by a latch b^3 which forms a part of the pattern wheel system, and is carried by the radius bar b^1 (Fig. 141) mounted loosely on the hub b^{5x} of the disc b^5 fast on the shaft E (see also Fig. 142) having as its bearing the short sleeve c^3 , the bar having an attached clamping dog b^4 , bearing against the outer edge of the disc with sufficient friction to cause the

bar to rotate with it and strike the lever a^{17} at the proper time. A spring b^6 acts on the latch b^3 to hold it normally away from the bar.

The left hand end of the change lever is acted upon, when the change from reciprocal to circular knitting is to be made, by a latch pivoted on a radius bar c^1 , the ring of the bar surrounding the hub c^2 of a disc, loose on the sleeve c^3 which is secured to the table or bed support A^1 . The bar c^1 is adjustable about the hub by means of a set screw in a slot of the arm c^1 . A spring acts on a latch to normally press it away from the bar c^1 .

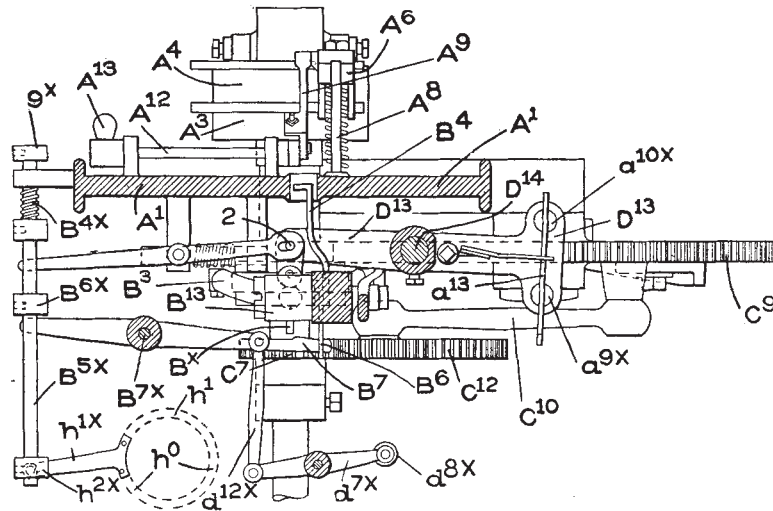


Fig. 140.

The switch D for raising up the needles not to be used for heel and toe work, and for letting them down when they are required for circular or round and round work, has, see Fig. 143, its stem projecting through the plate N attached to the outer side of the cam cylinder B. The stem outside the plate has feather-splined on it a gear n^1 , which is kept on by the screw n^2 . The gear meshes into the rack n^3 , which is connected to the slide block n^4 , fitted into the guideway n^5 of the plate N. When the rack is moved up it turns the gear on the stem of the switch and sets it in position to raise up and put out of action those needles which are not required for knitting the heel and toe, the rack being lowered to put the switch in position, after a heel or toe has been

finished, to lead down all the needles previously lifted, and then to be raised in circular knitting.

The rack has a cam face at one side, with which co-operates a locking device n^8 , which serves to hold the rack in position as left by its actuating device. When the narrowing in the heel and toe work is about to begin, the projecting pin n^7 (See Fig. 143) is struck by the lower one of the pair of switch shifter levers n^8 and n^9 (See Fig. 144) pivoted at n^{10} . One shifter rests above the other, and each is acted upon by a spring n^{12} to keep the acting ends pressed toward the cam cylinder. The lower switch shifter has a place milled out as at 5, into which enters a projection n^{13} , carried by the shifter ring c^{14} which has imparted to it a slight movement in the direction of the arrow, shown at Fig. 144, just as the change from the straight or round and round work to the heel or toe knitting is to be

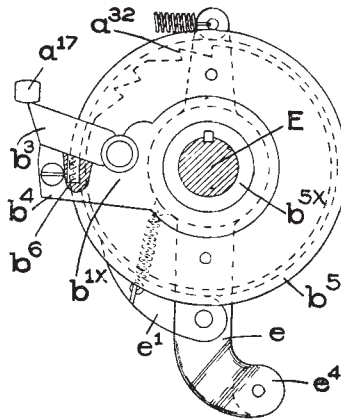


Fig. 141.

effected which moves the projection into the milled place on the lever or shifter n^8 permitting the cam shaped end to move into the path of movement of the pin n^7 , Fig. 143. At the same time the projection n^{13} acts against and moves the upper shifter in the opposite direction.

After the heel or toe has been completed the ring c^{14} is moved in the opposite direction, causing the projection n^{13} to act on and move outwardly the shifter n^8 , and let the shifter n^9 come into action to strike the upper side of the pin n^7 and move the rack and switch D to guide all the needles again into position for straight work or circular knitting

Changing the Length of Stitch. When a stocking is to be started, the stitches in the larger part of the leg should be a little looser or longer than in the lower part of the leg and in the foot. This is accomplished by mechanism for raising and lowering the needle cylinder. Notches are provided in the lower end of the needle cylinder which rests on the ring h^1 and which is provided with projections h^9 (See Figs. 140 and 136). To move this ring so that the projections will

enter and move out of the notches and thereby raise and lower the cylinder, power is obtained from the cam d^6 on the inner end of the shaft E (See Fig. 142) by means of the connecting levers d^{7x} , d^{12x} , B^7 , and the rod B^{5x} connected to the lever h^{1x} attached to the movable needle cylinder elevating ring h' (See Fig. 140).

At the commencement of a stocking, where the largest tubular portion is desired, the cam roller d^{8x} should stand on the lower part of the cam d^6 just beyond the high part 12, and in such condition that the lever B^7 acts against the collar B^{6x} and compresses the spring B^{4x} . As the knitting progresses the cam travels along by the roller and when the leg should be contracted, the cam d^9 acts on the roller. The lever is gradually moved back from the collar B^{6x} thus permitting the spring B^{4x} to move the rod B^{5x} and with it the lever h^{1x} , bringing the projection on the ring into the notch in the cylinder thereby letting it descend into the position for the shortest stitches to be made. The extent of this movement is regulated by the adjusting collar 9^x .

When the toe is about completed, the cam d^9 meets the roller d^{8x} and just at this time the lever e is moved, causing the pawl e^1 to engage the ratchet teeth a^{22} shown at Fig. 141, and impart to the plate d a quicker movement than would be effected by the gear wheels, thus giving to the levers d^{7x} and B^7 quick movements causing the outer end of the lever B^7 to act upon the collar B^{6x} and push the rod in the direction to turn the needle cylinder elevating ring, and thus lift the cylinder quickly to provide for stitches of the greatest length, and as the roller passes over the high part 12 (Fig. 142) longer stitches will be made for a slack course. The slack course forms a line around the stocking to indicate the loops to separate the stocking from the continuous string.

The Stop Mechanism. The elbow lever B^4 , shown at Fig. 137, has connected to it a slotted link B^6 , in which is placed one end of the tension lever B^7 shown at Fig. 140, and pivoted at B^{7x} . The tension lever is moved by the high part 12, at the completion of each stocking, to turn the arm B^4 and cause it to act on the arm A^{10} and turn it far enough to let the spring A^8 act to shift the belt onto the outer pulley, and thus stop the machine.

Just as the stocking is finished, if the machine is to be stopped, the first abrupt end of the cam meets the roller d^{8x} on the lever d^{7x} and

stops or rests on the cam d^b , just behind the high part 12, in position to start the machine.

The machine having been stopped and the stocking run off, it may be again started, and if the stocking is to be short and knitted to a ribbed top, then but one abrupt part d^{6x} and the high part 12 will be necessary, but in case it is desired to knit stockings connected together, the web of stockings to be separated after being taken from the machine, remove the link B⁶ shown at Fig. 141, so that after one or more regular courses have been knitted, the needle cylinder may again be

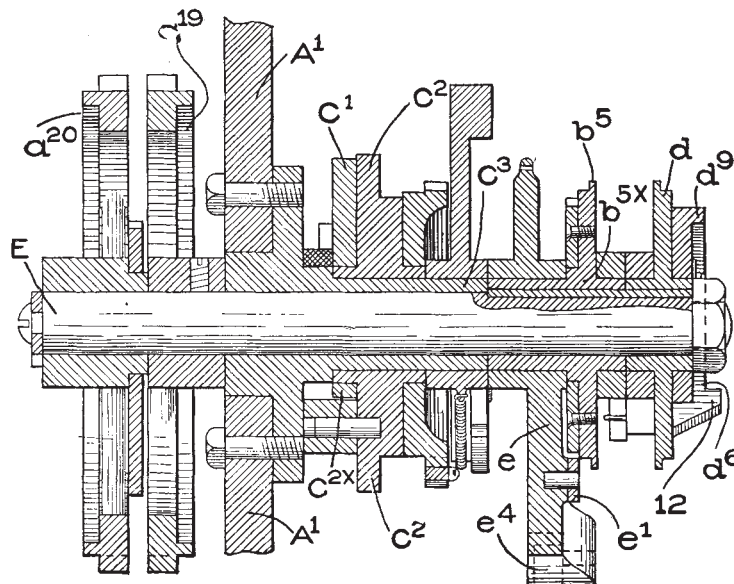


Fig. 142. Cam Shaft.

raised to make a second slack course by means of which to accurately separate or sever the leg of one stocking from the toe of a previously knitted stocking, and then return to the regular knitting.

The automatic twister or reinforcing attachment is provided for twisting the end of the reinforcing or thickening thread around the main or knitting thread to reinforce or thicken the heel or toe. Means are also provided to cut out the reinforcing thread when the heel or toe is finished, leaving the thread in position to be automatically twisted in again for the next heel or toe. Another attachment is provided for automatically changing the yarn in the heel and toe to a

yarn of a different color. Provision is also made for making plated stockings, *i. e.*, wool surface with cotton inside. Attachments are also provided to make a lace effect.

Setting-Up and Starting a New Machine from the Factory. It is a good practice to set the machines 13 or 14 inches apart. The belt should be nearly as wide as the pulley on the machine, and may be run

from a floor shaft, or from an overhead shaft. If driven from a floor shaft, the driving shaft should have such a speed as to allow the pulleys to be 10 or 12 inches in diameter, while if driven from an overhead shaft, the driving shaft may have such a speed as to allow the use of 7 or 8 inch pulleys. The speed of the machine should ordinarily be from 240 to 265 revolutions per minute, though on some kinds of work a speed of 300 revolutions may be used.

After the machine has been set in its proper place and all grease and dirt removed, see that the latches on the cam cylinder lock the dropper and lifter in place, replace the disconnected parts and connect them; then put on the yarn

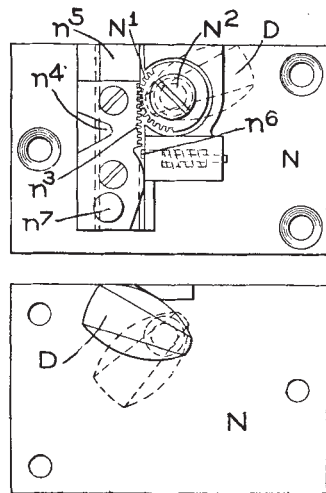


Fig. 143.

and lower the center block switch cam, the stem of which protrudes through the cam cylinder bracket directly under the yarn tube in the latch ring, or thread carrier. This will allow the butts of the needles to pass under the stitch cam. Turn the machine a few times by hand to be sure that everything is working properly before starting up with power on.

To Replace a Broken Needle. Raise the center block cam, so that the needles will all be on a level, and then raise the latch ring or yarn guide. Then raise the elevating cam on the cam cylinder opposite the automatic switch, set the automatic switch so that it will not pull the needles down and hold back the switch cam shifter so that it will not change the switch. Turn the machine by hand and the needles will all raise above the cams. Then pull out the plugs which hold the brass ring in place, and raise the cylinder out of machine. Take

out the broken or damaged needles and put in new ones; replace the cylinder and lock the brass ring in place. Push the elevating cam down, and push down ten or twelve needles directly above the switch cam shifter. This will allow the automatic switch room to change. Turn the machine and the needles will all go down to the level. Then drop the center switch cam.

To replace a sinker, take off the sinker cam plate, replacing and adjusting it again after replacing the sinker.

To Set a Pattern for Stockings or Hose. In starting a stocking or

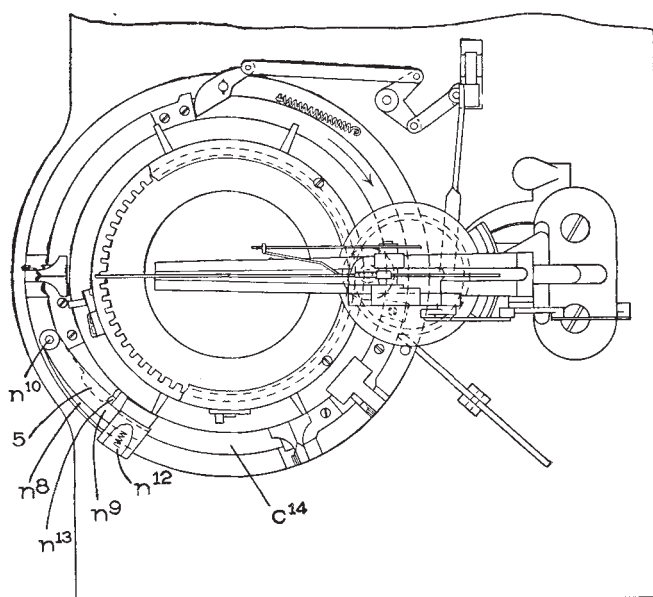


Fig. 144.

hose, the two indicators on the outside end of the pattern wheel should stand together. On the inside end of the pattern wheel are two discs or wheels. Each of these discs has a trip or pawl fastened upon it by a clamp, which can be moved back and forth by loosening the screws which hold it in place. These trips operate upon the change motion to change from the circular motion to the reciprocating motion. The inside disc is for the toe, and the second one is for the heel. Upon the side of the toe disc is a high point and an incline. The high point operates the stop motion to stop the machine when the hose is com-

plete, or to make a loose course when making a lady's hose as string work. The incline operates the stitch gauge to regulate the length of the stitch of the leg and ankle. The toe trip should be set so it will be about one and one-half inches back of this high point. This distance regulates the number of courses knit on the toe of the stocking or hose to seam or loop by, and will allow about eight or ten courses. If too much, set the trip farther from the high point; if not enough, set the heel trip nearer to the high point on heel disc about five-sixths of the distance around the disc, back of the toe trip. This regulates the length of the foot. If the foot is too long, set the trip still farther around; if too short, do not set it around so far. Always get the length of the foot by changing the heel trip, and do not change the toe trip after once getting the proper number of courses to seam or loop by.

On the outside end of the pattern wheel, are two large gears. Between these gears is a segment with three or four teeth cut in it to match the teeth in the large gear and which is fastened to the outside gear with a clamp. Loosen the clamp and set the segment back to lengthen the leg of the stocking or hose; or set it forward to shorten the leg. After setting the segment forward or backward, clamp it to the outside gear so that the three or four teeth in it will be sure to line with the teeth in the outside gear. Always feed one tooth on the pattern wheel ratchet in making ladies' stockings or hose.

To Set-Up Pattern for Socks or Half Hose. Have the toe trip in about the same position as for ladies' hose, moving it forward or backward to get the proper length to loop or seam by. Set the heel trip about opposite the toe trip or about one-half way around the disc back of toe trip, and set the segment forward or backward, as on ladies' hose, to get the proper length of leg. Feed two teeth on the pattern wheel ratchet to make socks or half hose.

To Set-Up Pattern for Footing Rib Legs for Misses' or Boys' Hose. Set the toe trip nearer to the high point than for ladies' stockings, moving it a little forward or back to regulate length to seam or loop by. Set the heel trip about one-third around the disc back of the toe trip or as far as necessary to get proper length of foot. Regulate the length of the ankle by the segment between the outside gear, and feed from four to eight teeth on outside ratchet, according to the size of hose desired. Four teeth will make about size $9\frac{1}{2}$, and eight teeth will make size $4\frac{1}{2}$.

The Operation. In describing the operation of knitting a stocking or hose upon this machine, we will represent the needles by a series of small lines as shown in Fig. 145. These needles may be said to be divided into three sets; one set, namely, those inclosed with the bracket A, extending one-half way round the cylinder; two sets BB each extending about one-sixth of the way round the cylinder on opposite sides of the same, and one set C between the sets B B. A thread is fed to all the needles, and the machine is rotated so as to produce, by round and round knitting, continuous circular courses of stitches, until the desired length of tubular fabric for the leg has been formed and it becomes necessary to form a heel.

In knitting a sock, the stitches of a short length of ribbed tubular fabric may be applied to the needle of the machine before commencing to knit the leg of the sock, so that when the sock is complete, it will have a rib top; but in knitting a lady's stocking, where no rib top is required, the needles may have a greater draft while knitting the upper or calf portion of the leg than while knitting the lower or ankle portion. After the desired length of tubular fabric has been produced for the leg, the needles A are raised so that their butts or shanks are above and free from the action of all the cams; leaving only needles B and C in action.

An extra thread, or thickening thread, is twisted to the main thread to reinforce or thicken the heel, the machine at the same time changing from rotary to reciprocating motion. The two threads are carried back and forth around that part of the needle cylinder having the needles B and C forming stitches upon them. At the end of each reciprocating motion, one of the needles B, at the end adjacent to the needles, is thrown up and out of action, first on one side and then on the opposite side, so that with each reciprocating movement, the web produced is narrowed to the extent of one needle, first on one side and then on the opposite side. This narrowing operation is continued until all of the needles B B have been thrown out of action, leaving only the needles C in action. As soon as this has been done, the needles B B must again be thrown into action for the purpose of widening. This is done by lowering two needles into action, and after knitting one course of stitches upon them, one is thrown out of action again. This is continued first on one side, then on the opposite side, until all of the needles B B have been lowered into action in the reverse order

from that in which they were thrown out of action. When this is done, the thickening thread is cut out, the needles A are lowered into action again, and the machine changed from reciprocating to rotary motion.

The operation just described is performed to produce a seamless pocket, which constitutes the heel of the stocking or hose. After the heel has been completed, knitting of the tubular fabric is resumed and continued, until it is of the length desired for the foot of the stocking or hose, thereupon, the operation resorted to in order to form the heel is repeated to form the toe.

After the completion of the toe, a few tubular courses are knit,

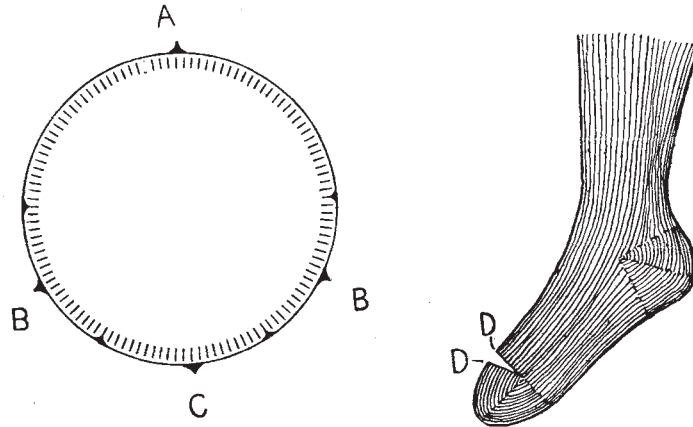
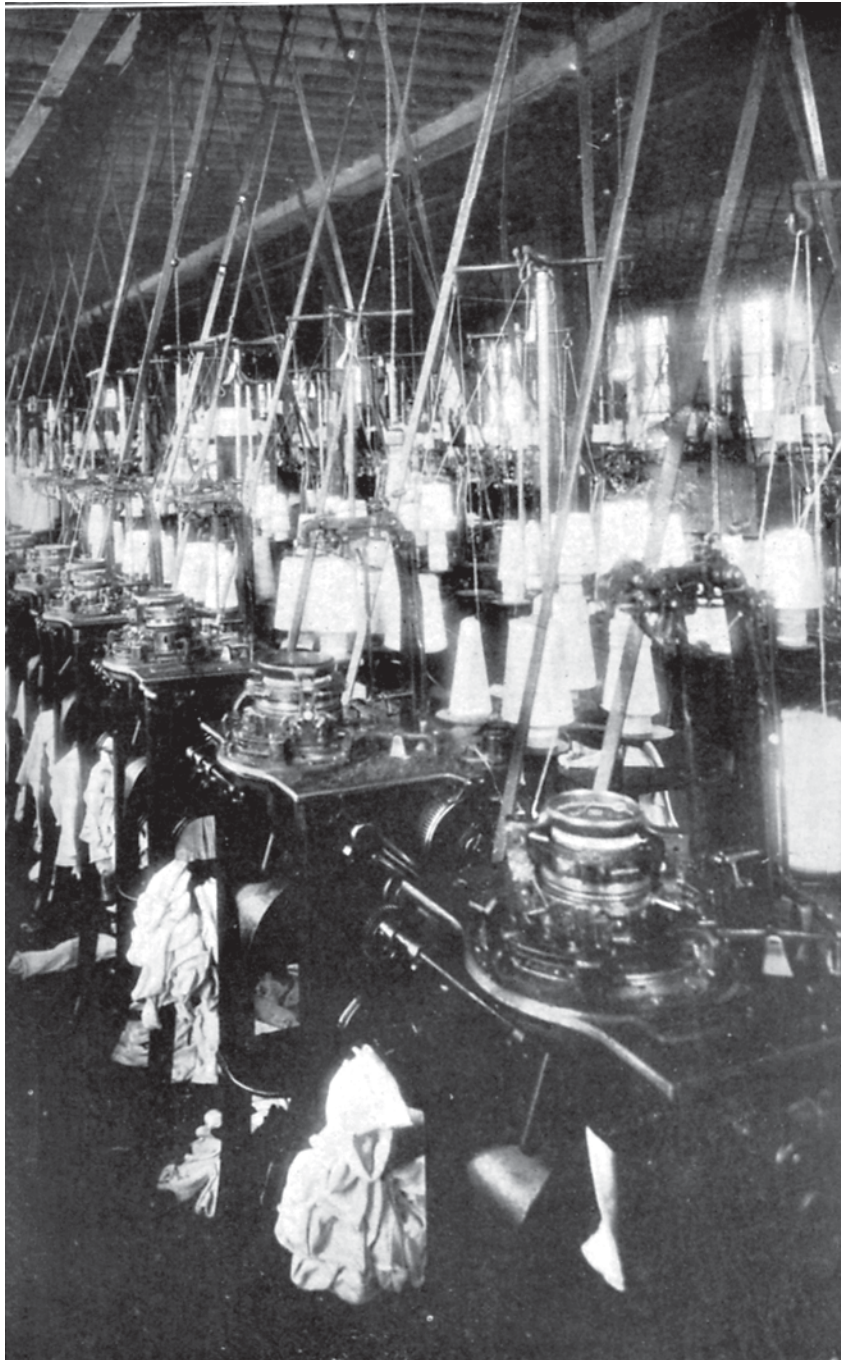


Fig. 145.

then the stocking or sock may be cast off the needles, and a new stocking or sock commenced. But if it is intended to operate the machine, to produce stocking after stocking in succession, the production of the tubular fabric may, after the formation of the toe, be continued to form the leg of the next stocking, and so on, the fabric being cut off near the toe, so that each stocking will present the appearance shown in Fig. 145, the toe being completed by uniting the edges D D in the usual manner.

THE RIBBING MACHINE

Half hose are finished with a rib top, as alluded to several times previously, ribbed fabric being very elastic and better adapted for the purpose than plain knit fabric.



VIEW IN KNITTING DEPT OF DES MOINES HOSIERY MILLS SHOWING
ACME KNITTING MACHINES

The Rib Top Machine, or "Ribbing Machine" as it is more commonly called, is a single feed, full automatic machine with two banks of needles (dial and cylinder) designed especially for making rib tops. It is so constructed that almost any desired length of rib can be made, either very elastic or non-elastic, in a continuous string, having any desired number of welts from one to six, and an extra course of long stitches, for convenience in placing the stitches on points of what is known as a transfer, or direct on the needles of the knitting machine according to the method in use.

The ribs are cut by hand, or by a rib-cutter which the operator operates with the foot, severing the string between the round of long stitches (slack course) and the welts. These must be cut as near the welts and as straight as possible, for this represents the top of the sock. When the rib is cut off we have the rib proper. It is then placed on either transfer points or the needles of the knitting machine. In case of the former, which is in most general use, the rib is then transferred to the needles of the knitting machine by placing the hollow points of the transfer over the eyes of the needles, and lowering them until the hooks of the needles pass the stitches on the points, when the transfer can be removed, leaving the rib stitches on the machine needles.

If the knitting machine is full automatic, it proceeds with its work, making the leg, heel, foot and toe, throwing an extra thread in both heel and toe, thus producing what is termed a reinforced, or spliced heel and toe. After completing the toe, several rounds of stitches are knit on to make room for the looping, or closing of the toe on a looping machine.

The ribbing machine belongs to the Stationary Needle Cylinder class in which the needle cylinder, needle dial, take-up and fabric are stationary; and the cam ring (to which are fixed the vertical needle actuating cams), the cam dial (to which are fixed the cams for actuating the horizontal or radial needles), and crossbar, or yoke, revolve.

The ribbing machine being of smaller diameter is usually fitted with but one feed and one set of cams each for cylinder and dial. One of the sets, usually the dial set, is provided with a movable cam in order to effect the change from the plain stitch to the welt which will not ravel out, for the finish of the cuff. The welt consists of two or three courses of short stitches and is made by allowing the dial needles to project only about half the usual distance so as to hold their loops with-

out knitting; or in other words so that the loop already in the hook is allowed to slip back only far enough to open the latch and let the yarn carrier feed one or more loops into it, thus forming a separate tubular plain fabric for a few courses.

This variation of needle movement is effected by means of a movable cam which is controlled by a pattern wheel arrangement.

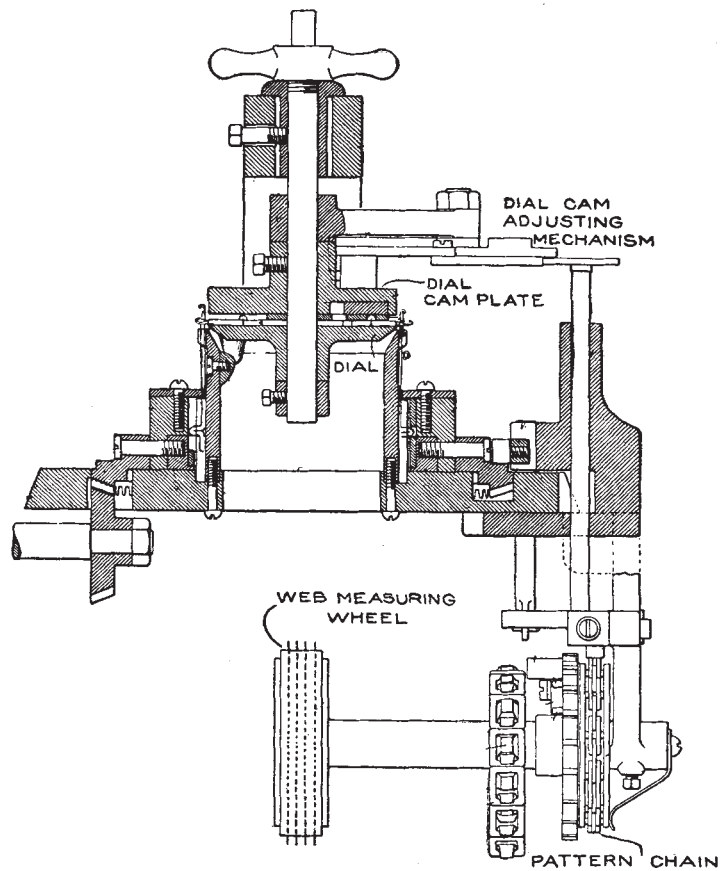


Fig. 146. Type of Rib Top Machine. Sectional View.

It is customary to knit a course of long loose stitches somewhat less than a half an inch from the welt, so that when the continuous string of ribbed tops are cut apart, the loose stitches may be easily transferred on to the needles of the stocking machine. The loose or

slack course is made in the fabric by means of the cylinder needles, actuated by a movable cam in the cam ring, which is controlled by a pattern wheel. Fig. 146 represents a type of this machine.

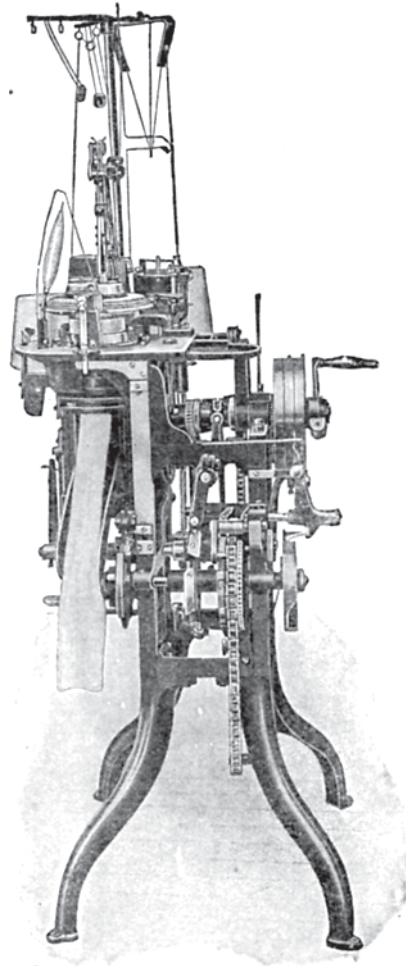


Fig. 147. Hemphill Full Automatic Machine.

HEMPHILL FULL AUTOMATIC

The machine illustrated at Fig. 147 represents another type of circular knitting machine in which web-holders or sinkers are employed with latch-needles to knit seamless stockings with heel and toe of different yarn.

Method of Driving. The bed 1 of the machine is supported by a frame 2, mounted on legs 3, as illustrated in Fig. 148, a cup-shaped bearing 4 being formed below the bed (also shown in Fig. 154).

The main shaft of the machine is represented at 7, and is provided with the large bevel-gear 8 secured thereto at one end, while the other end is mounted in a sleeve 9, to which is secured a driving-pulley 10, having a crank-handle 11 for working the machine by hand. A loose pulley 12 is mounted on an extension of the hub of the driving-pulley. Loosely mounted on the shaft near the bevel-gear 8, is a pinion 13; the inner end of the sleeve 9 is also formed as a pinion 14. Between the pinions 13 and 14 is a clutch-hub 15, with a feather to permit the hub to slide while held from independent rotation. Two projections or teeth 16, in the clutch-hub, engage a groove in one or the other of the pinions 13 and 14; and an angular groove 17 receives pins or rollers 18, carried by a shifting yoke 19, which is secured to one end of rock-shaft 20 (see Figs. 149 and 165) mounted in a bearing 21.

A gear 22 (see Figs. 148 and 149) is mounted in a bearing supported by the frame and meshes with pinion 14, and is constantly driven thereby during the operation of both the round-and-round work and heel-and-toe knitting operation. To crank-pin 23 (see Fig. 148) is connected one end of a pitman 24, the other end being connected with one end of an elbow-lever 25, mounted on a shaft 26, supported in standards 27. The other end of the lever 25 is provided with a segmental gear 29 which meshes with pinion 13 on the main shaft (see Figs. 148, 149, and 154).

When the clutch-hub is in engagement with the pinion which is constantly driven, the gear will move continuously in one direction. During this time the segmental gear is imparting a rotary reciprocating motion to the pinion which is loose on the shaft; but when the clutch-hub is shifted to engage the loose pinion, it is disengaged from the constant pinion, which latter then imparts to the shaft and to the gear 8 a rotary reciprocating motion. The motion of the elbow-lever imparts movement to the pattern-chain and to certain cams, through the medium of pawls.

Pattern Chain. A shaft 30 is mounted in bearings 32 (Fig. 149) supported by the frame. Loosely mounted on this shaft is a ratchet 33, to one side of which is secured the pattern-chain pulley 34 (see also

Fig. 164), the pulley having teeth to engage the links in the pattern-chain, some links having lugs 36. The ratchet and pulley are driven in the direction of the arrow shown in Fig. 162, by means of a pawl 37 connected with one end of an elbow-arm 38 (see Fig. 148) mounted on shaft 26, the other end of the arm being secured to the side of the elbow-lever by means of a bolt. A bracket 41 is secured to the frame of the machine (see particularly Fig. 149); and bolted to this bracket

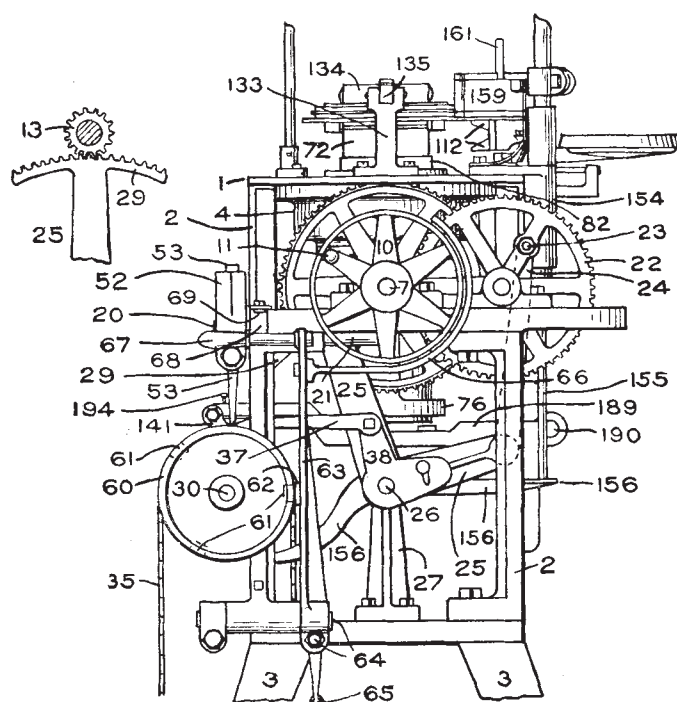


Fig. 148.

is a shield 24, on which the pawl rides during a portion of its stroke. The shield is secured to the bracket with a bolt to adjust the amount of feed imparted to the pattern-chain. A ratchet 43 (see Figs. 163 and 164) is secured to the shaft 30 on the opposite side of the pulley 34; and this cam-driving ratchet is intermittently rotated by means of a pawl 44 when permitted by the lugs of the chain. The pawl 44 is also connected with the elbow-lever 25, and is reciprocated thereby. The shield is pivoted on a pin 46, carried by the bracket and extending

over both ratchets and chain-pulley, and is provided with an arm 47, having a pin 48, which projects into the path of movement of the chain-lugs. A spring 49 is coiled about the pin 46, and tends to hold the arm and shield in position; but when a chain lug raises the pin, the shield is depressed, the pawl engages a tooth of the ratchet, advances the latter, and partially rotates the shaft and the cam-discs.

One complete rotation of the shaft 30 and its cams takes place

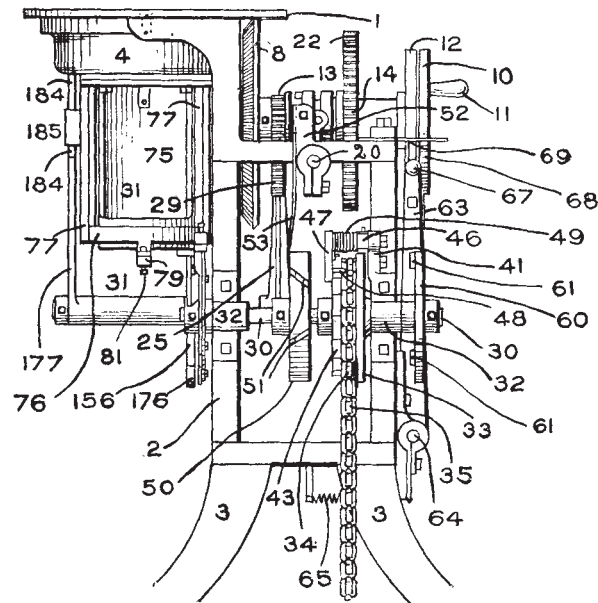


Fig. 149.

during the knitting of one stocking, the length of the article and its shape being controlled by the length of the chain employed and the spacing and number of lugs carried by the chain. The knitting operation itself continues uninterruptedly without regard to the rotation of shaft and cams; but when a stocking is finished, the rotation of the shaft effects the automatic stoppage of the entire knitting operation; and, during the single rotation of the shaft, it also effects two temporary shafts of the driving-belt, to slow down or ease off the machine when the clutch-hub is moved into engagement with the pinion 13. This movement of the hub changes the knitting from circular or round-and-round work to the narrowing or widening at heel or toe, one-half

of the needles being thrown out of action. During the narrowing or widening the knitting-cams have a rotary reciprocating motion through the segment and other gearing; and to change to this motion from the continuous rotary motion, another mechanism is provided.

Changing the Motion. At one end of the shaft 30—the right-hand end (Figs. 148 and 149)—there is secured a disc 60, having three cam-lugs 61 on its side, near the edge. These operate successively against a pin or roller 62, carried by a lever 63, pivoted at 64 to the

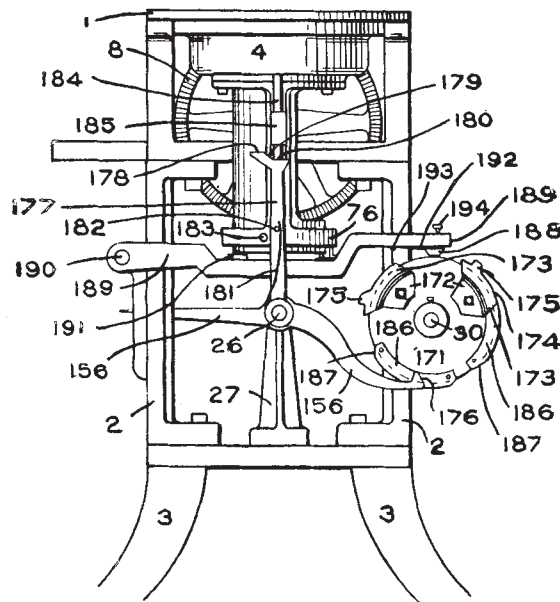


Fig. 150.

frame of the machine, the lower end of the lever being acted on by a spring 65 to keep the pin or roller in engagement with the cam-disc. The upper end of the lever 63 carries a belt-guide 66 for shifting the belt when cam 61 acts on the shipping lever.

The lever is provided with a handle 67, and with the finger 68, which moves under and is held by a spring-latch 69 secured to the frame (see Fig. 149) whenever the lever 63 is moved to its limit of motion for throwing the belt off the fast pulley. One of the cams 61 on the disc 60 is of a height sufficient to throw the lever to this limit of movement, so that the lever is retained by the spring-latch and the

driving-belt held on the loose pulley, thus stopping the machine. To start the machine, lift the spring-latch and permit the spring to cause the belt-shipping lever to restore the belt to the fast pulley; the movement of the disc which caused the lever to be caught by the spring-latch carries the cam-lug just beyond the roller of the lever. The other two cam-lugs cause the lever to shift the belt onto the loose pul-

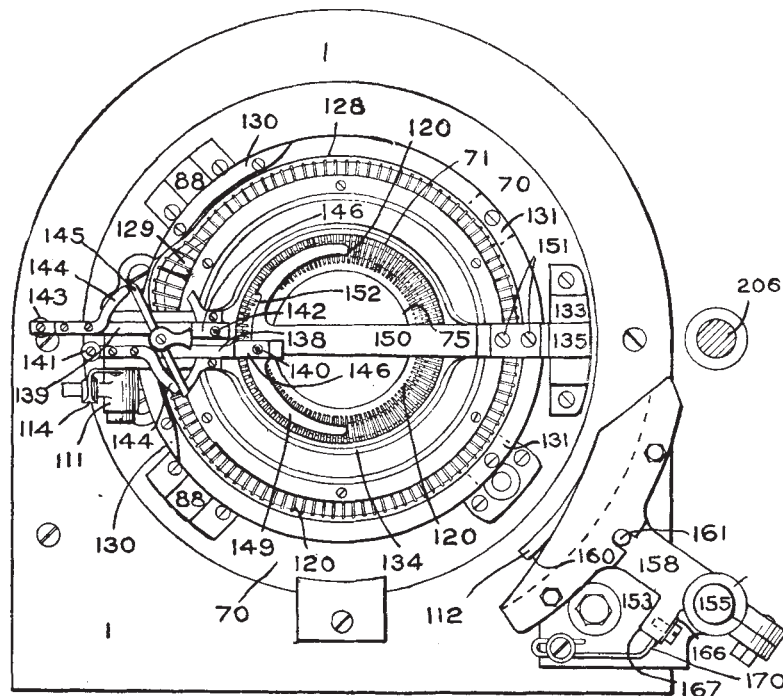


Fig. 151.

ley, but not to be engaged by the spring-latch, so that the power is thrown off the machine momentarily, at the moment when the change in the knitting above described is taking place. The cam-lugs operate the lever and pass beyond it during the time that the pawl is making one stroke to partly turn the shaft and its cams, the belt barely passing off the fast pulley before it is shifted back again.

The Needle-Cylinder. The needle-cylinder 72 extends through a central opening in the cam-ring (see Fig. 154), and rests upon an annular shoulder 74 formed upon web-guide 75. The upper end of the

web-guide extends within the needle-cylinder; and the lower end is steadied within ring 76, supported by two rods or bars 77, which depend from the bottom of the cup-shaped bearing 4. The ring 76 has a projecting lug 78 (see Figs. 149 and 150), to which block 79 is secured by means of a bolt. A stop 81 extends vertically through the inner end of the block and projects above it. The web-guide 75 rests on the stop, except when raised for lengthening the stitch; and it supports the needle-cylinder by means of the shoulder 74. The stop being adjustable in the block 79, the needle-cylinder may be adjusted to alter the length of stitch.

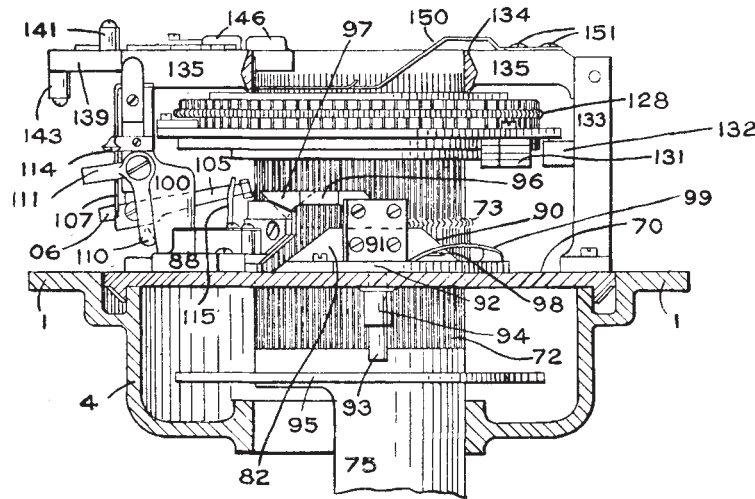


Fig. 152.

The Knitting Cams. A cam-web 82 which forms about three-fourths of a circle (see Figs. 152, 153, 154, 157, and 158), is formed at each end with an incline or cam 83, and is secured to the ring 70. The cams 83 act on the heels of the needles to raise them during the knitting operation, the heels riding on the top of the web after being raised until acted on by one of the draw-cams. During straight or round-and-round knitting, but one of the cams 83 acts; but on heel-and-toe work, when the cams are all given a rotary reciprocating movement, the two inclines or cams 83 act alternately to raise the needles. The two draw-cams 84, to lower the needles and draw the loops of yarn, face in opposite directions, toward each other. Each cam 84 is formed on the

end of a block 85, which is secured to a plate 86 on the inner end of a slide 87, fitted to reciprocate in a direction radial to the needle-cylinder in a guide-block 88, secured to the ring 70. A spring 89, is confined between the outer, closed end of the block 88 and the slide. The upper, as well as the lower, surfaces of the cams are inclined, the function of the upper inclines being to complete the raising of the needles after they have been acted upon by the picking-finger in heel-and-toe work. The faces of the blocks are flat; and when one of the cams is traveling backward around the needle-cylinder, it rides over the outer

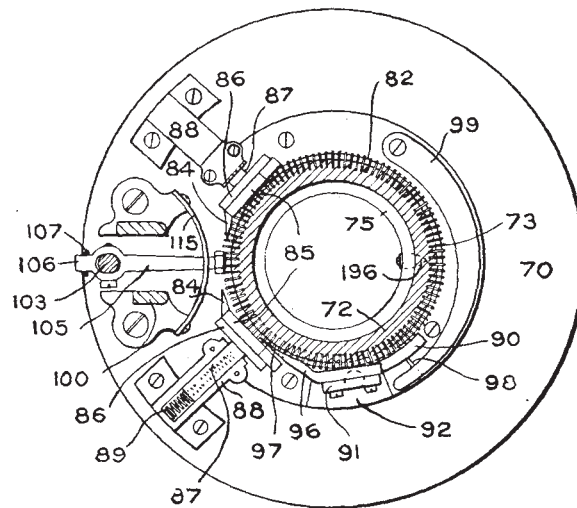


Fig. 153.

ends of the heels of needles, the spring permitting the entire block and cam to be moved outward. During heel-and-toe work the rotary reciprocating motion of the cam-ring causes first one cam to operate, the other being pushed away; and *vice versa* on the reverse movement.

Heel and Toe. Practically one-half of the needles have heels longer than those of the other needles. The long-heel needles are thrown out of action and remain so during the heel-and-toe work. Cam 90 (see Figs. 152 and 153 in connection with Fig. 154) travels in a plane entirely below the needle-heels during circular or round-and-round knitting, but is raised when the change to heel-and-toe work begins. It is secured to a block 91, rising from a segmental plate 92, which fits in the flange of the cam-web 82, and is provided with a pin 93, extending down through the cam-ring 70 and through a long tubu-

lar bearing 94, depending from ring 70. The lower end of the pin 93 is acted upon in a vertical direction by a circular plate 95 within the cup-shaped bearing 4.

The block and cam are prevented from rotating on the axis of the pin by the inner edge of the segmental plate. When cam 90 is elevated it will elevate the long-heel needles, thus carrying them out of position to be operated by the draw-cams. The block has also secured to it an arm 96, having a throw-in cam at the end. This cam,

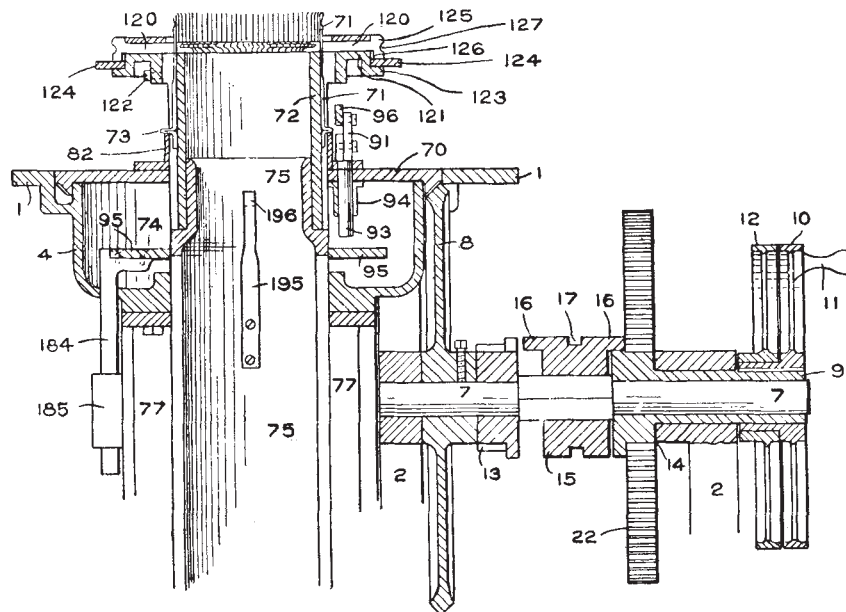


Fig. 154.

when lowered, engages the tops of the long heels and one short heel; and when the block is lowered at the end of the heel-and-toe work, it sweeps over the long heels and the single short heel, and lowers the needles to position for circular work. A pin 98 projects from the cam 90, and is engaged by the outer end of a spring 99, the other end of which is secured to the flange of the cam-web 82. The spring acts to depress the block and cams when permitted by the descent of plate 95.

Picking. The cup-shaped bearing 4 supports the cam-ring 70, which meshes with the teeth of the bevel-gear 8. This cam-ring is revolved continuously to produce circular or round-and-round work,

or is given a rotary reciprocating motion to produce heel-and-toe work. While doing the latter, practically one-half of the needles are first thrown out of action; and a portion of the remaining needles are then thrown out of action one by one to narrow, being restored in the reverse order to widen.

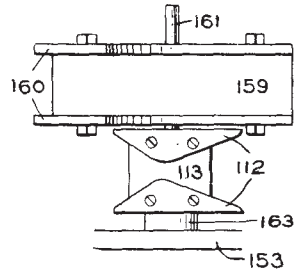


Fig. 155.

The Picker. Mounted on the cam ring, and rotating therewith, is an arched standard 100, provided with an offset 101, in which is a vertical bore or recess 102 closed at the top (Fig. 158). A plunger 103 is fitted to slide and oscillate on its axis within the recess, and is pressed downward by a spring 104, confined between the plunger and the top of the

recess. To the lower end of this plunger, the picking-finger 105 is pivoted, the plunger affording a support for the picking-finger and yielding vertically against the pressure of the spring 104; and the outer, short end or heel 106 of the finger is held between two springs 107 secured to the standard or offset (see Fig. 160). These springs have a tendency to hold the picking-finger and the plunger in such position that the finger is radial to the needle-cylinder, but permit these parts to swing to either side of that position. The acting end of the picking-finger is shaped somewhat in the form of an equal-armed cross (see Fig. 167), with two vertical lugs 108 and two horizontal lugs 109. Fulcrum 110 consists of a horizontal arm, having a sharp upper edge projecting from an elbow-lever 111 pivoted to the side of the standard-offset 101. The cams 112 have no movement other than a vertical one.

As the outer end of lever 111 sweeps around between them, it comes in contact with one or the other, according to the elevation of the block 113 and the cams, and causes the fulcrum-arm to shift its position. The movement of the fulcrum in one direction is limited by its coming in contact with the outer side of the standard 100, and

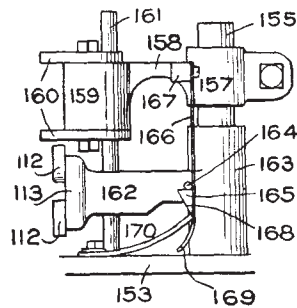


Fig. 156

in the other direction by a stop 114 secured to one side of the offset 101, as shown in Figs. 152 and 160. To the feet of the standard 100 is secured a curved plate 115 (see Figs. 153, 157, 158, and 159) having an opening through which the picker extends. When narrowing is to be commenced at the heel or toe, and after the cam 90 has raised all of the long-heel needles out of action, the block 113 is raised, and the lower cam 112 throws the picking-finger 105, into the position shown in Fig. 157. At the same time, the motion of the cam-ring is changed from a continuous rotary to a rotary reciprocating movement, during which movement neither cam 90 nor cam 97 performs any function. As one side of the upper lug 108 of the picker comes in contact with the side of the butt of the first needle of the remaining series of needles, the end of the picker is stopped; but since the cam-ring continues to

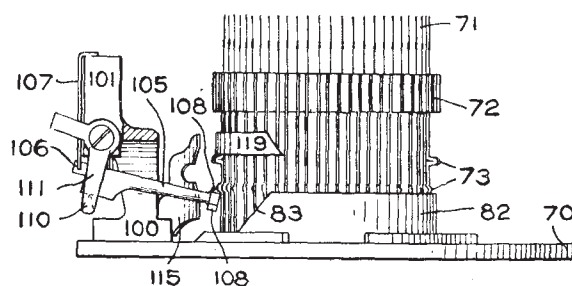


Fig. 157.

move, and with it the standard and cam-plate, one of the lower cams 117 of the plate rides under the finger and elevates it, thus causing the upper surface of one of the lugs 109 of the picker to throw that needle up out of action. As the finger finally rides into the slot 118 of the plate 115, the swinging of the finger causes the lugs of the finger to leave the butt of that needle. As soon as the finger leaves the needle, the springs 104 and 107 cause it to assume the position indicated in Fig. 157, ready to engage and elevate a needle at the other end of the series.

When the needles are to be brought back again into action one by one for widening, the block 113 is lowered, and the upper cam reverses the position of the elbow-lever 111, moving the picker to the position shown in Figs. 151 and 152. Then the lower lug 108 of the picker, and the under surfaces of the lugs 109, act on the butts of the needles

one by one to depress them under the influence of the upper cams 116 of the plate 115. When all of the short-heel needles except one at each end of the series have been rendered active the block 91 is lowered and the first complete rotation of ring 70 causes the cam 97 to throw in all of the elevated needles, which are the long-heel needles, and the two remaining short-heel needles; round-and-round work is automatically resumed. The reason for throwing in the last two fashioning needles simultaneously with the long-heel needles, is to avoid leaving a small hole in the fabric each side of the heel. When all of the needles are down, the picking finger engages none of the heels, for it is then in the position shown in Fig. 152, the block 113 and the cams 112 being lowered.

Sinkers. The web-holders or "sinkers" which co-operate with the needles and prevent the lifting of the web by the upward movement

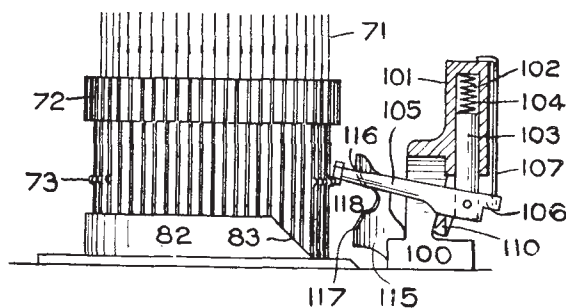


Fig. 158.

of the needles, and which also help to draw the stitch, are indicated at 120 (see Figs. 154 and 166 in connection with Figs. 148, 151, and 152). They are supported in radial grooves in a bed 121, which is secured to the needle-cylinder by screws 122, the bed having a horizontal flange 123, which forms the bearing for a ring 124 carrying the cams for reciprocating the web-holders. Each web-holder has an upper shoulder 125, to limit the inward movement, and a lower shoulder 126, which permits the cams carried by the ring 124 to withdraw the holder. The outer ends of the web-holders are notched, as at 127, to receive an elastic band 128, consisting of an endless coil of fine steel wire, which acts on all the web-holders to hold them inward and prevent their being thrown out by centrifugal force.

The cams carried by the ring 124 are shown in Fig. 151, in which

129 represents the double-ended cam for engaging the inner sides of the shoulders 126 for moving the web-holders outward during either direction of movement of the ring, and 130 represents the two cams also carried by the ring 124 for engaging the outer ends of the web-

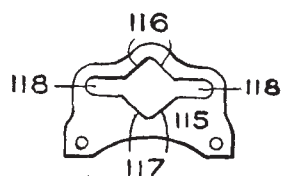


Fig. 159.

holders to retract them, aided by the action of the endless spring 128. Secured to the underside of the ring 124 are two blocks 131, the positions of which are indicated by dotted lines in Fig. 151, and between which a striker 132 extends, the striker projecting from a standard 13 (see Fig. 152) which rises from and rotates or oscillates with cam-ring 70. When cam-ring 70 is revolving continuously, the striker engages but one of the blocks 131; but when oscillating, the striker engages the two blocks alternately and reciprocates the ring. The space between the two blocks 131 corresponds somewhat with the space between the knitting-cams, and permits of the web-holders and needles remaining at rest while the picking-finger is changing its position. By pulling away the spring-band 128, either entirely or for portions at a time, the web-holders can be easily withdrawn and replaced by others, if desired; or those which are used most continuously may replace those which are less worn on the other side of the machine, and *vice versa*.

The *latch-guard ring* 134 (see Figs. 151 and 152) can be swung up out of the way whenever desired, as when placing a new cuff on the needles or to enable the needles to be more readily examined, without removing it from its support by the cam-ring 70.

The *yarn-changing devices* are carried by the arm 135. The upper surface of the outer end of the arm 135 is formed with guideways (Fig. 151) for two slides 138 and 139, one having a yarn-guide eye 140 at its inner end and a pin having a roller 141 at its outer end, and the other slide having a yarn-guide eye 142 at its inner end and a downwardly projecting pin having a roller 143 at its outer end. Each slide is provided with a projecting arm 144, against which bear the ends of a lever 145.

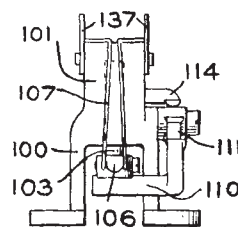


Fig. 160.

Lever 145 is pivoted to the guard-ring arm between the two slides; and when one slide is pushed in, its arm pushes the other slide out. The inner ends of the slides each have a stop 146, to limit their outward movement.

The curved web-guide 149 (see Fig. 151) is formed at the outer end of a spring-arm 150, secured to the arm 135 back of the latch-ring, as indicated at 151 in Fig. 152. A recess 152 is formed in the edge of the web-guide, having hooked ends to retain the yarn which is not being knitted in position for use again when the next change is made.

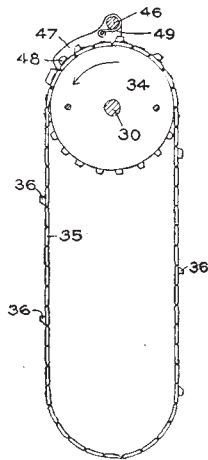


Fig. 161.

Changing Yarn. A plate 153 is secured to the bed 1 of the machine, and has a vertical sleeve-bearing 154 extending over and below the bed (see Fig. 148). This bearing is for a lift-rod 155, the lower end of which bears upon and is operated by a lever 156. To the upper end of the lift-rod is secured a sleeve 157, having an arm 158, carrying a block 159, to the upper and lower surfaces of which are secured plates having cam-shaped edges 160. Cams 160 are so spaced that one or the

other of the rollers of the yarn-changing slides will sweep between them when no change in the yarn is to be effected; when the yarn-guide slides are to be shifted, the lift-rod is acted upon by the lever to raise the block and bring the lower cam into the path of movement of the roller, which, moving over the edge of the cam, reverses the positions of the guide-eyes. When the yarn-guides are to be shifted back again, the rod is lowered to position and changes the yarn.

Changing Operation of the Picking-Finger. The block 113 (Fig. 156) carrying the cams 112, is supported by an arm 162 projecting from a sleeve 163 loosely mounted on the lift-rod. The guide-pin 161 passes through the arm 162 to steady it, as well as the block 159. A pin 164 projecting from the arm 162, is engaged by a lug 165 carried by a spring 166, the upper end of which is secured to a lug 167 projecting from the arm 158. The side of lug 165 is inclined, as 168; and below this incline the lower end of spring 166 is curved or inclined, as at 169, under the end of a finger 170 fixed to the plate 153. The cams which act on the lift-rod impart two elevations to it for each narrowing

and widening operation, during which time the yarn is changed. The first lift of the rod elevates the block and cams and changes the yarn as above described. At the same time, block 113 is elevated, and this brings the picking-finger into operation for narrowing. The timing

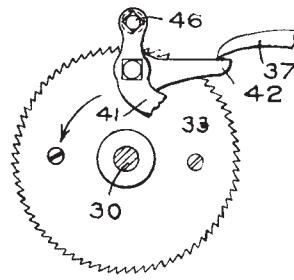


Fig. 162.

of the operation of other parts is such that simultaneously the needles having the long heels are thrown out of action, and the rotary reciprocating motion of the knitting cams takes the place of the continuous motion. When the narrowing is completed, the lift-rod is given a short elevation above the plane of the first, giving to the arm what may be termed a "hitch." This is but momentary; but it serves to draw the curved lower end of the spring upward, over but not entirely above the end of the fixed finger, which pushes the spring outward sufficiently to carry the lug out from under the pin of the arm. The arm and its block and cams immediately drop, and cause the operation of the picking-finger to begin restoring the needles for widening. The second elevation or hitch of the lift-rod is for this purpose only, and the position of the cams is not so changed as to shift the yarn-guides, for the same yarn is used in widening as in narrowing. Simultaneously, however, with the resumption of continuous rotary motion of the knitting cams, and the restoration of all the needles to positions of activity, the lift-rod descends to its normal position, and the upper cam effects the change of the yarn to the color and quality preferred for the round-and-round work; and the inclined lower side of the lug rides down over the pin, the lug then snapping under it, ready for the next operation. The picking-finger is left turned upward; but, there being no needles with their heels in a plane to be engaged by the finger, the latter remains out of operation until the next change.

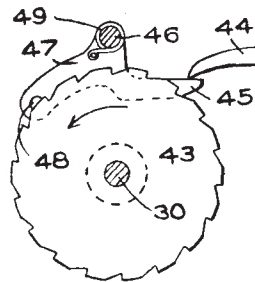
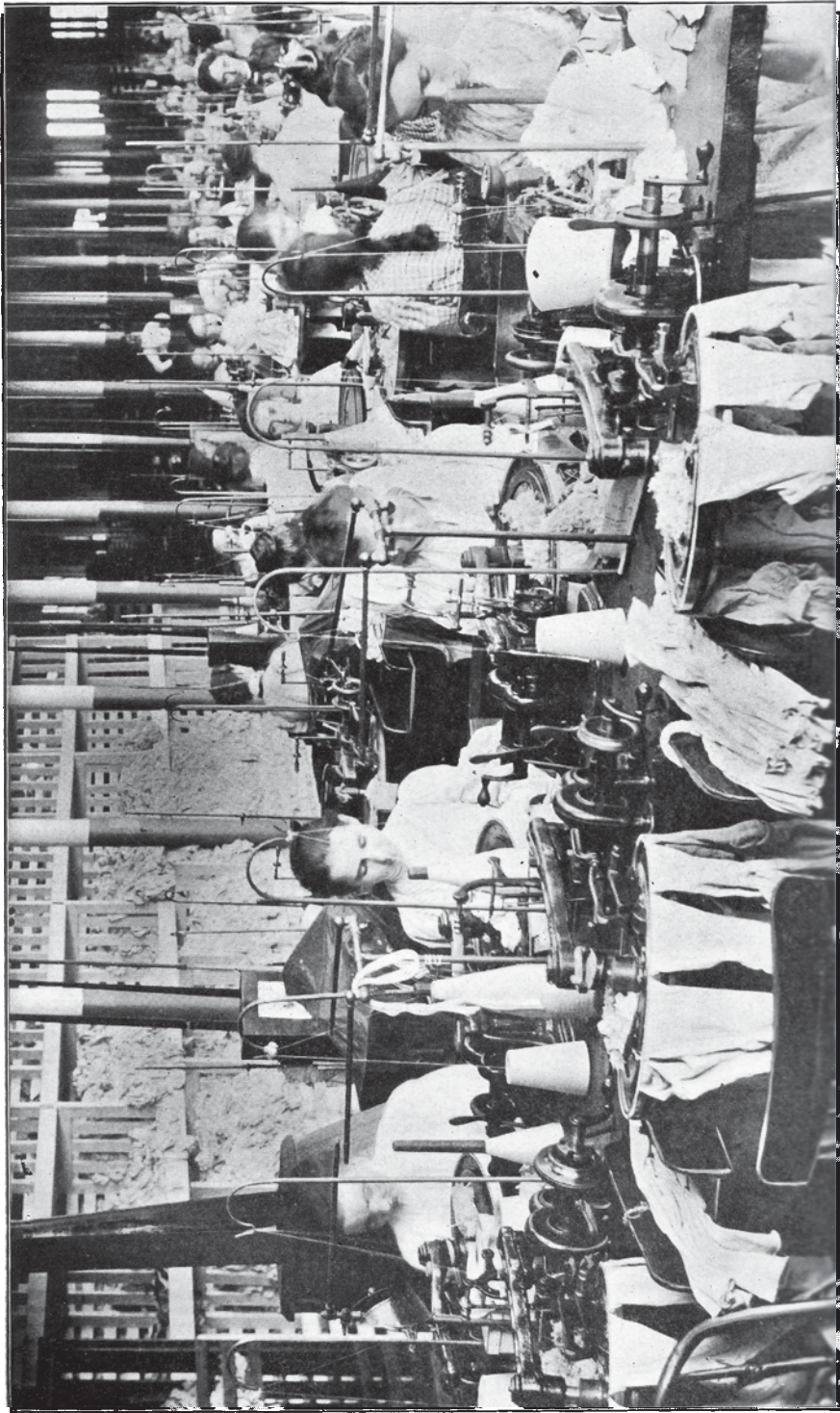


Fig. 163.

The lift rod is secured to shaft 30 at the opposite end from belt-
shipping disc 171, to which two sets of cams are attached (see Figs.



VIEW IN LOOPING ROOM OF SHAW STOCKING CO., SHOWING OPERATIVES CLOSING TOES ON BEATTIE LOOPERS

149, 150, and 164). To this disc are attached two similar ears 172, the operative surfaces of which are offset.

The lever 156, which operates the lift-rod, is pivoted on shaft 26, and has its front beveled end 176 in the path of movement of cams 173 and 175. Cam 173 imparts the first elevation to the lift-rod, while cam 175 gives it the second elevation or hitch before referred to, after which the end 176 of the lever passes to the short section of plate 172 behind cam 175, and at the next advance of the disc it passes off the plate and to the position shown in Fig. 150.

Connected with the lever, so as to oscillate therewith, is an arm 177, having its end formed with two steps 178, 180, connected by an incline or cam 179 (see Fig. 150). A spring 181 secured to the bearing

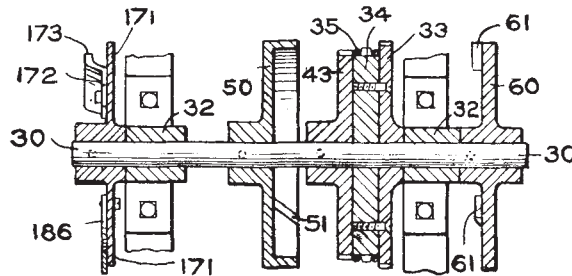


Fig. 164. Cam Shaft.

for lever 156 and arm 177, bears against a pin 182 projecting from the arm, and tends to hold the arm and lever in the position shown in Fig. 150, a stop 183, projecting from ring 76, serving to limit the movement of this lever and arm toward the left.

The circular plate 95, which rises and falls to control the action of cams 90 and 97, is secured to a rod 184, which slides vertically through an opening in the cup-shaped bearing 4 (Fig. 154), and in a guide 185 carried by one of the bars 77. The lower end of slide-rod 184 rests on upper end of arm 177, and, as the latter oscillates, passes from step 178 to step 180 over the incline 179 (Fig. 150) or *vice versa*. The action of these parts is so timed that the circular plate is elevated to render inactive the needles having the long heels simultaneously with the first elevation of the lift-rod by cam 173, which causes the change of yarn and the commencement of operation of the picker-finger; but when the lift-rod is given its second elevation or hitch by

means of cam-lug 175, the step 178 simply moves slightly across the lower end of the slide-rod without affecting the elevation of the circular plate. The disc carries also two segments 186, each having a cam-surface 187 at one end to act upon a block 188 carried by a lever

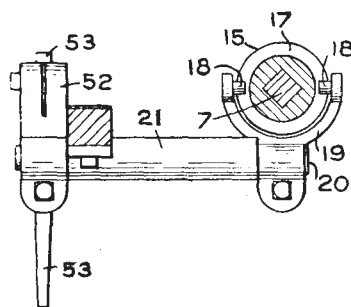


Fig. 165.

189 pivoted at 190 to the frame of the machine and having a lug 191 adapted to bear against the lower edge of the web-guide 75 when the latter is to be lifted to elevate the needle-cylinder. In order to adjust the amount of elevation that may be imparted to the web-holder and needle-cylinder by the cams, the block 188 is adjustably connected with the lever 189.

The needle-cylinder rests upon the shoulder 74 of the web-guide 75 (see Fig. 154). The upper end of the latter is surrounded by the needle-cylinder, and the cylinder can be rotated upon its seat if not locked. A yielding lock for securing the needle-cylinder to the upper end of the web-guide is shown in Fig. 154, consisting of a spring-bar 195, secured to the inner wall of the web-guide and having a wedge-shaped lug 196 at its upper end, which lug extends through an opening in the web-guide and into a tapered recess in the inner wall of the needle-cylinder. The upper end of the bar rests in a vertical groove in the inner wall of the web-guide, and the bar and its lug form a lock to prevent rotation of the needle-cylinder on the web-guide. Should a needle offer an obstruction to the passage of a cam, or if for that or any other reason such an obstruction is caused as might break a cam or break away the ribs of the cylinder between the needles, the inclined side of the recess will act on the side of the lug and force it inward, thus unlocking the cylinder from its support and permitting it to rotate.

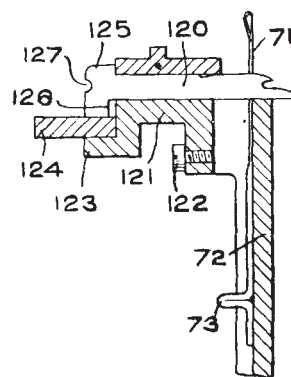


Fig. 166.

By loosening one screw and turning in the other, the bar is rocked on its lug as a fulcrum, and thus forces the other lug more or less into the recess of the needle-cylinder.

The Process. The cuff *a* is placed on the needles by means of a transferrer, and circular knitting at *b* (Fig. 168) proceeds to the point *c*. Then narrowing begins, and continues to the point *d*; and from there the knitting widens to the point *e*, when circular knitting is resumed to form the foot portion *f*. At *g*, narrowing again begins, and continues to the point *h*, whence

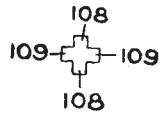


Fig. 167.

it again widens to the point *i*, when, after knitting a few courses, the machine automatically stops. The operator then breaks off the yarn, and, by means of the crank 11, turns cam-ring 70 one revolution forward, which disengages the needles from the stocking, so that it may be removed. He then moves the crank backward slightly, which, through the engagement of the

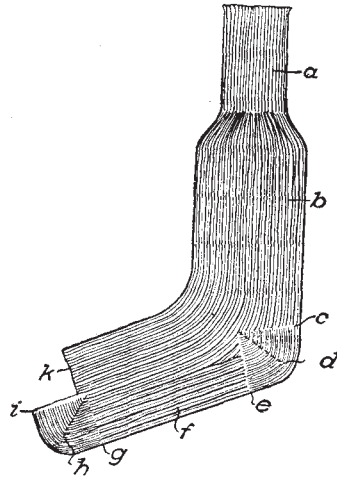


Fig. 168.

heels of the needles with the inner face of the block 85 last in operation, forces the block out of operative position and permits the cam 83 to raise the needles so that their upper ends will be on a level, in position to receive another cuff. In other words, the needles are leveled in the upper knitting-path. After the stocking has been removed from the machine, the edges *i* and *k* are united in the usual manner.

FANCY HOSIERY

When it is desirable to reinforce stockings, particularly children's stockings, at several points—such as the heel, the toe and the knee—a second or thickening thread is introduced with the main thread, the two being fed to the needles as one. If the same length of stitch be maintained in the thickened part as in the other part, the fabric is made closer, harder and less elastic. It is therefore desirable to lengthen the stitch at the points where the thickening occurs. A desirable method of introducing a reinforce just above the heel, is to throw out of operation about one-fourth of the needles at the rear at this point; knit reciprocatingly on the remainder, raising a needle at each reciprocation until one-half the needles are out of operation; and then introduce a reinforcing thread and knit reciprocatingly on the needles originally out of operation, adding a needle at each reciprocation until about one-half are in operation. By this method, the junction line between the ordinary and the thickened portion extends diagonally upward.

The *well-known split-foot hosiery* was originally produced upon a circular, independent-needle machine, the peculiarity of which lay in the fact that instead of forming the leg portion by rotary knitting, the cam cylinder was reciprocated throughout, being supplied on opposite sides with yarn-guides and knitting cams, each yarn-guide feeding yarns to, and each set of knitting cams acting upon, one-half the needles only. The result is that each yarn forms a course of stitches extending half-way around the stocking. Where these half-courses meet, at opposite sides, the stitches are interlooped. In this manner the back of the stocking may be of one color and the front of another, or the foot only may be of contrasting colors. In hosiery to be worn with low shoes, it is customary to make the lower part of the foot and the lower portion of the heel of one color, say white, and the upper part of the foot and the entire leg portion of a contrasting color. It is obvious that the half-courses of different colors may be interlooped in the same vertical wale, or that they may be interlooped in different wales according to a predetermined pattern, as shown in the accompanying illustration (Fig. 169).

A split-foot stocking may be formed upon a circular machine, by feeding one of the threads to the needles in the usual manner, a little more than half-way around the needle-cylinder, and then drawing it inward while passing the remainder of the needles. At a point a

little in advance of that where the first thread is withdrawn, the second thread is introduced and is fed to those needles from which the first is withdrawn, and is itself withdrawn after being fed to one-half the needles. After the stocking is finished, it is necessary to clip out the

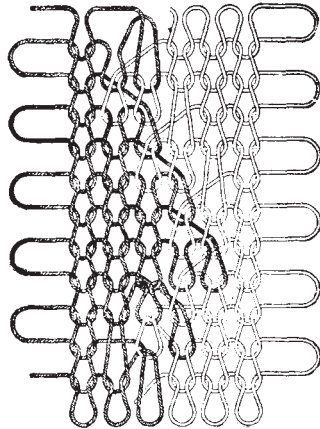


Fig. 169. Pattern Effect with Contrasting Colors.

float threads. A stocking knitted after this fashion may be produced more rapidly than by the method first described.

In still another plan, by circular knitting, each course is knit as follows:

One of the threads—say the black thread—is fed first to the needles; and knitting therewith proceeds until a half-circle or thereabout has been completed and the point is reached where it is desired that a suture shall begin. The white thread is then introduced; and for a few needles—say two—both threads are knit simultaneously. Then

the black thread is thrown out, and knitting proceeds with the white thread alone until the opposite suture begins. Then the black thread is again thrown in; and for two needles both threads are knit with simultaneously, as on the opposite side. The white thread is then thrown out, and knitting with the black thread alone proceeds, at which point the operation begins to repeat itself. The throwing in and throwing out of the threads must be accurately timed, so as to occur for each course between the same needles. In this way a suture is formed at each side by the interlapping threads, always on the same needles. When the thread is thrown out of the needles, it is allowed to float across the tube to the point where it is again thrown in. The number of needles forming the suture by simultaneous knitting with both threads may vary according to fancy. After the completion of the knitting of the stocking the float-threads are removed by being cut from the interior of the tube. The foot thus produced has its upper portion entirely knit from one thread, its lower portion entirely knit from another thread, and sutures at both sides knit with both threads, the courses thus formed in regular alternation being continuous, as in round-and-round knitting. Although the two portions thus formed

are not actually interknit, yet the suture formed by loops interlapping for the space of two loops is equally strong, and cannot be opened except by breaking the threads.

An imitation split-foot stocking has been produced by knitting the stocking from yarns of one color, preferably white or undyed, then enclosing that portion of the foot that is to retain its original color, in a clamp that will exclude moisture, and finally subjecting the stocking so protected, to a dye, the result being that the leg portion and upper portion of the foot are given a color contrasting with that of the sole of the foot. In a stocking carefully treated in this manner, the line of the dye will follow the edge of the clamp very exactly, and an excellent imitation of the real split foot stocking is produced.

A very pleasing color effect for hosiery is shown in the accompanying illustrations (Fig. 170). The first of these shows a piece of ordinary knitting, all except two of the horizontal courses of which are knit with white threads. Two courses (lettered *a* and *b*) are knit with black thread. Between these two black courses are four white courses *c c c c*. If the entire piece of fabric had been plain knitting, it would therefore exhibit nothing but two black horizontal stripes on a white ground. Instead of this, at two points, loops *d d*, belonging to course *a*, have been drawn forward, so as to project longitudinally ahead of their fellow loops of the same course and into the territory of the succeeding white courses *c c*. Furthermore, the interknit loops *f f* of the course *b*, by which this forward projection of the loops *d d* is effected, are themselves drawn back behind their fellow loops by the tension of the loops *d d*, so that there is produced along the same longitudinal series of loops a forward projection of the black stripe, *a* and a backward projection of the black stripe *b*; and by the meeting of these two projections, the effect produced to the eye is that of a longitudinal line or stripe joining the two horizontal stripes.

The projected loops *d d* are ten stitches apart. To effect this, every tenth needle of the machine must be so operated that, after receiving the loops of the black course *a*, it shall be prevented from knitting during the knitting of the four succeeding courses *c c c c*. This may be accomplished by preventing these needles, during the knitting of these four courses, from rising far enough to throw the loops of the black course below their latches, and returning them into line with the rest of the needles at a point either above or below the

feeding-level. This fabric has been made by throwing them in at a point *above* the feeding-level. Consequently the threads *c c c c* of the four succeeding courses have all been laid in the hooks of the inactive needles without being interknit with each other. When the work has progressed as far as the course *b*, these needles are again thrown into ordinary action, and, having taken within their hooks the

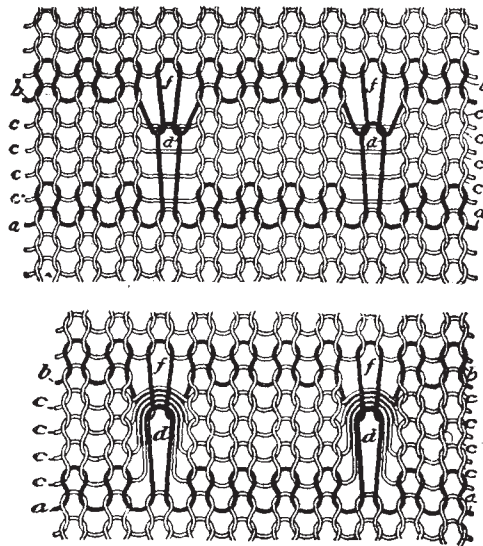


Fig. 170. Interknit Loops for Color Effect.

loops *f f* from thread *b* when drawn down by the knitting-cams, shed simultaneously loops *d d* and the four unknit white threads over their backs, thus interlooping all five threads with the loops *f f*. Thereafter these needles continue to knit, as do their fellows, and plain knitting is produced, until it is desired to again reproduce the pattern, when the operation repeats itself.

If, instead of throwing these needles in at a point *above* the feeding-level, they had been thrown in at a point *below* the feeding-level, the action and resulting fabric would have been the same, except that threads *c c c c* would not have taken within the hooks of these needles, and consequently, instead of being interlooped with loops *f f*, these four threads would pass across straight behind loops *f f* and *b b*. The resulting fabric is shown in the lower illustration. Fig 170.

STOCKINGS WITH OPEN OR LACE WORK

In the accompanying illustration (Fig. 171) is shown a seamless hose or stocking knitted in one continuous operation, upon a circular knitting machine, and having its front ornamented with one or more sections of lace work extending from the upper part of the leg, over the instep and onto the foot. The rear portion of the leg, the entire heel portion, the back or sole portion of the foot, and the entire toe portion, are all made of plain, regularly-knit fabric. The front of the stocking, extending along the leg and over the instep, is formed of sections of plain, regularly-knit fabric interposed between other sections of open or lace work united to the plain sections and knit therewith. In the operation of knitting, the thread, as it leaves the plainly-knitted portion of the stocking, crosses a space of from three to five plain stitches or loops in a crossing-thread or loop, when it is again knitted in the regular manner for a single stitch. Then again it is made to form another crossing-loop or thread; and so on until a lace section is completed. A plain intervening section is then knitted in the usual manner; then another series of open-work spaces; and so on until the entire number of lace and plain sections are completed. This method is followed for three courses, when the thread, instead of being formed into the cross-thread, is midway of its length made to form the long, loose loop in each of the open-work spaces. This operation is carried on throughout the entire portion of the leg, instep, and foot, which it is desired to provide with the lace-work.

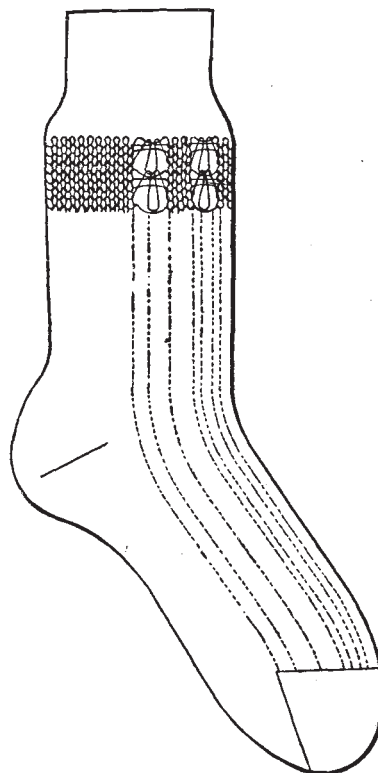


Fig. 171 Seamless Open Mesh Work Stocking.

The entire stocking is thus formed of plain, seamless, knitted, tubular fabric, in which the leg, instep, and foot portions are provided with alternate sections of plain and open or lace work knitted together.

An ordinary plain portion is formed at the back or rear of the leg, and is continued in the heel, the bottom of the foot, and in the toe portions of the stocking.

A stocking having sections of lace work alternating with sections of plain knitting around the entire leg, such as here shown (Fig. 172), may be made as follows:

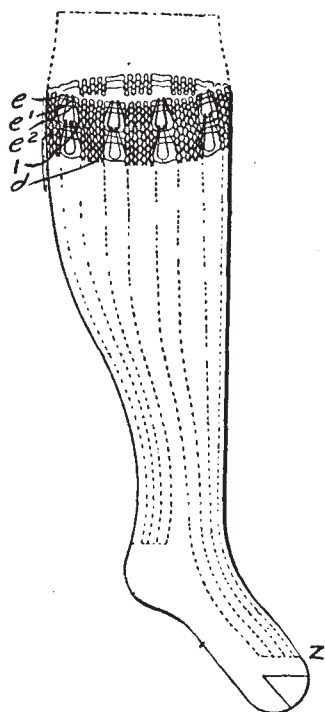


Fig. 172. Making a Lace Work Stocking.

Starting at the plain section, the thread forms a straight cross-thread e to the next plain section, crossing the space of one or more plain loops. A given number of plain loops are then made. The thread then makes a further cross-thread to the next section of plain knitting; and so on entirely around the leg of the stocking. On the next round, the cross-thread e' is made in like manner. On the third round, the cross-thread e'' is made in the same manner. On the fourth round, the cross-thread is drawn down over the three cross-threads $e e' e''$, forming the elongated loop d , as is well understood in the knitting of tuck fabrics. This is continued to the point where the heel is knitted of plain loops.

After the formation of the heel the knitting is continued, forming the bottom of plain loops and the top of the ornamental courses and plain sections, until the point z is reached, at which point a number of plain-knitted courses are formed entirely around the stocking. The toe is then completed with plain loops.

This stocking may be made of one continuous thread, or it may be made by knitting the heel and toe of one thread and the remaining portions of the stocking from another thread, or it may be made by

forming the heel and toe of one thread and the other portions of the stocking knitted from two, three, or four other threads, as the operator may prefer. The stocking may be knitted upon a machine constructed in the well-known manner to produce tuck-knitting, provision being made for causing the needles of the front and back portions of the stocking to be thrown separately into operation to knit tuck or plain knitting, as desired.

Another method of ornamenting a stocking upon both front and back, is as follows: The lace-work upon the front is produced in such manner that where a lace-work stripe is to be made, a needle is omitted

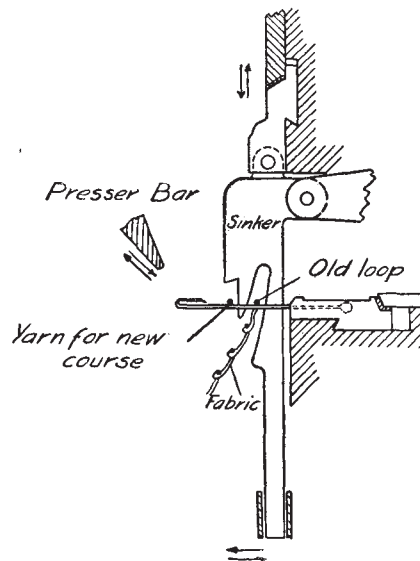


Fig. 173. Position of Loops, Needles, Jack-Sinkers, and Presser Bar Taking the Thread.

from either side of an intermediate needle, which needle is operated to tuck or retain its loops for several courses. Two needles may even be omitted from either side of the intermediate needle. It is apparent that the actual omission of needles from that portion of the machine which forms the back of the leg would prevent the proper formation of the heel and toe pockets, and the sole of the foot.

In producing this effect, the following disposition of needles is made—an omitted needle, a tuck-needle, an omitted needle, a plain needle, an omitted needle, a tuck-needle, and an omitted needle. Here the tuck-needles knit two and tuck two. The ornamentation

down the back of the leg is not so open as the real lace work upon the front of the stocking, and may be described as "imitation lacework." It is produced by two tuck-needles separated by a single plain needle and without any omitted needles.

In forming this stocking, all of these tuck-needles throughout the knitting of the tubular portion of the leg, knit for two courses and then tuck for two courses; and so on in regular alternation, so that the mechanism for specially operating the tuck-needles is in continuous operation during the entire knitting of this portion of the stocking. Upon reaching that point in the operation of the knitting of the stocking when the formation of the heel upon the rear fashioning set begins, the mechanism

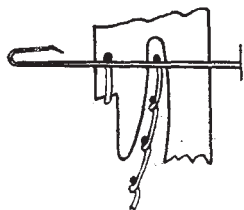


Fig. 174. Sinker Measuring off New Loops.

for specially operating the tuck-needles is thrown entirely out of operation; so that, throughout the process of narrowing and widening, the tuck-needles operate as do all the others, thus producing a heel of ordinary plain knitting. Upon reaching the point of operation at which the formation of the foot begins, the mechanism for specially operating the tuck-needles is in operation during that half of each course of round-and-round knitting which corresponds to the upper half of the instep; but it is out of operation during the remainder of each course. Thus the sole of the foot is knit of plain knitting, all of the tuck-needles that occupy the portion of the needle-cylinder with which this part of the stocking is made being operated as ordinary needles; while, on the other hand, the top of the instep is knit with longitudinal stripes—corresponding to the front of the leg. Upon reaching the point of operation at which the knitting of the toe-pocket begins, the tuck mechanism is again thrown altogether out of operation, and the toe-pocket knit, as usual, upon the rear fashioning set, all the needles knitting in the ordinary way.

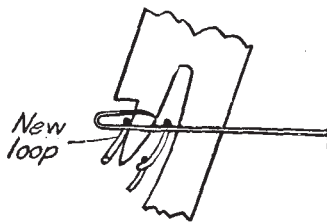


Fig. 175. Sinking into Hooks of Needles.

It is obvious that the limitations which are imposed upon the ornamentation by lace-work of stockings produced upon circular machines by a continuous operation, do not exist in the formation of

stockings upon the straight-bar machine or stocking frame, for in such machine a transfer point may be provided for any needle, and the loops may be transferred to produce the greatest variety of ornamental or lace work.

STRAIGHT HOSIERY FRAMES

In the old, straight machines, the thread, guided by a tubular carrier, was traversed along the needles, after which a row of jack-sinkers, one acting on the thread (see Figs. 173, 174, 175, 176 and 177) in each interstice between the needles, was caused to move down to draw the thread into loops, the last row of loops knit meanwhile hanging from the shanks of the needles behind the new course of thread. The new loops were then carried into the needle-hooks by the motion of the jack-sinkers or of the needle-bar; the old loops were held from moving with the needle, or moved on toward the needle-head, by the jack-sinkers contracting with the previous fabric; while the presser-bar, acting on the needle-barb, closed it so that it passed through the old loop, carrying the new loop with it. Thus the new loop remained on the shank of the needle, and the same cycle of movement was repeated.

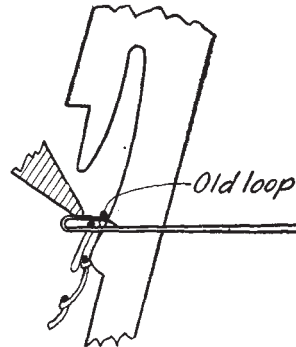


Fig. 176. Barbs Pressed: Sinker Landing Old Loop on Barbs.

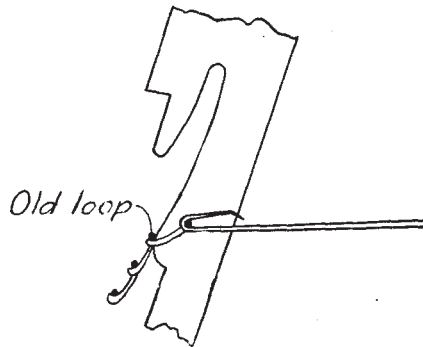


Fig. 177. Presser Bar Retired: Old Loop Knocked Over Head of Needle. Sinker Returns to Position 173.

requiring all four to operate. The seat was a part of the framework of the machine. When the rotary shafts were applied, the seat part of the framework was done away with. The rotary crank-shaft was connected by means of wheels or belts with the main shaft, on which were

cams and levers connected to the slur-cocks, sinkers, pressers, etc., whereby they were actuated in the proper time and order to perform their functions. This rotary shaft had its bearings so located that it was in convenient position for the operator to turn as he stood in front of the frame, the shaft being made with two (sometimes more) cranks, similar to the rotary crank-shaft of the present flat-rib machine. When the change was made, they were called *rotary* frames, probably to distinguish them from the old *hand* frames; possibly the hand frames were simply called *knitting* frames up to that time. After development of the rotary shaft frame, it seems but an easy step to extend the shaft and secure a pulley on it to be driven by a belt transmitting horse- or water-power. This straight rotary spring needle frame has been improved upon at different periods, by various parties, until what is known to-day (1906) as "Cotton's" system has developed.

The first circular machine on record seems to have been the one described in the British patent in 1816 granted to the celebrated engineer, Mark Brunel, which invention he obtained from some unknown source in France. In this machine the needles were placed radially on a circular plate, with mechanism to feed the thread arranged to rotate about the circle. This arrangement made a continuous seamless tube of fabric at a greatly increased speed. This was the first *circular* machine. The spring needles were soon placed in a belt around an open cylinder, in a more convenient arrangement.

Thus the term *circular* has been used to designate this type of machine whether the needles were spring or latch, radiating inward or outward or both, or whether they were positioned vertically, with needle cylinder or cam cylinder revolving with or without dial needles. So, too, has the term *rotary* been used to designate that type of straight machine which includes rotary shafts. The term *frame* or *machine* is, to-day, simply a matter of choice, in either case.

THE "COTTON" TYPE

Fine hosiery—that is, fine in the smallness of mesh and of yarn and in perfection of shaping of the flat blanks—is knit almost exclusively upon flat-bed machines of the "Cotton" type.

These machines are fully automatic in their operation, a single controlling and pattern mechanism serving to operate simultaneously as many as twenty-four like knitting-beds, each of which makes the

shaped web for a stocking. The needle-beds move in these machines in a path having two dimensions; the presser-bar may be fixed, and the sinkers have only a vertical motion. This is ingeniously given by a cam traversing with the thread-guide and a lever attached to or integral with the sinker, which so multiplies the slope of the "wave" of depressed sinkers as to carry each one to the limit of its motion before its neighbor has started to move, avoiding abrasion and strain on the yarn.

The motions of the machine for knitting, and while transferring the group of end stitches, are very different; they are controlled respectively by two distinct sets of cams on the main shaft of the machine, which shaft is moved endwise at the proper time to accomplish the change.

Fashioning, narrowing and widening the knit web is done on these machines by transferring the loops from several of the edge needles in use on to a separate instrument, moving them one or two needle-spaces in or out, and then replacing these loops on the needles.

In knitting a so-called "full-fashioned" stocking it is customary to commence the knitting at the widest portion of the leg, the knitting being performed on flat machines having spring-beard needles, and the strip being knitted of a uniform width until the calf portion is reached, whereupon the strip is narrowed by the transferring of stitches from the end needles on both sides of the machine toward the center of the fabric, until the fabric has been sufficiently narrowed for the ankle portion of the stocking, the latter being then knitted of uniform width until the formation of the heel is necessary.

At this juncture two yarn-guides are thrown into action, one employed for knitting a projecting heel-piece at one side of the ankle-web, and the other for knitting a corresponding heel-piece at the opposite side of the ankle web, the intervening needles of the machine having the stitches cast from them. The heel-strips are knitted of uniform width down to the point where the rounding of the heel is to be effected, whereupon each of the strips is narrowed to the desired extent by transferring stitches from needle to needle in the same manner as when narrowing for the calf portion of the stocking.

When the knitting of the heel-strips has been completed, they are cast from the needles; and the selvaged inner edges of the heel-strips are run upon the outermost needles of a separate machine known as

a *footing machine*, the intermediate needles of this machine receiving the loops around the instep portion of the leg-web which were thrown from the needles of the leg-machine when the formation of the heel-strips was begun.

The foot-web is then knitted upon the needles of the second

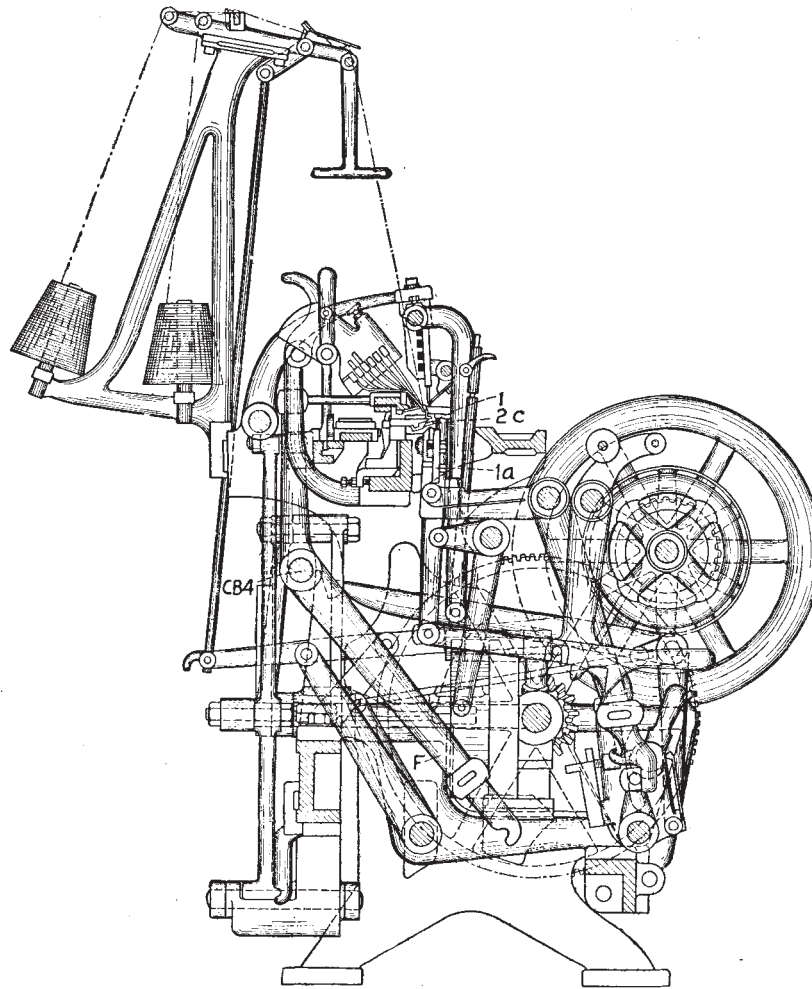
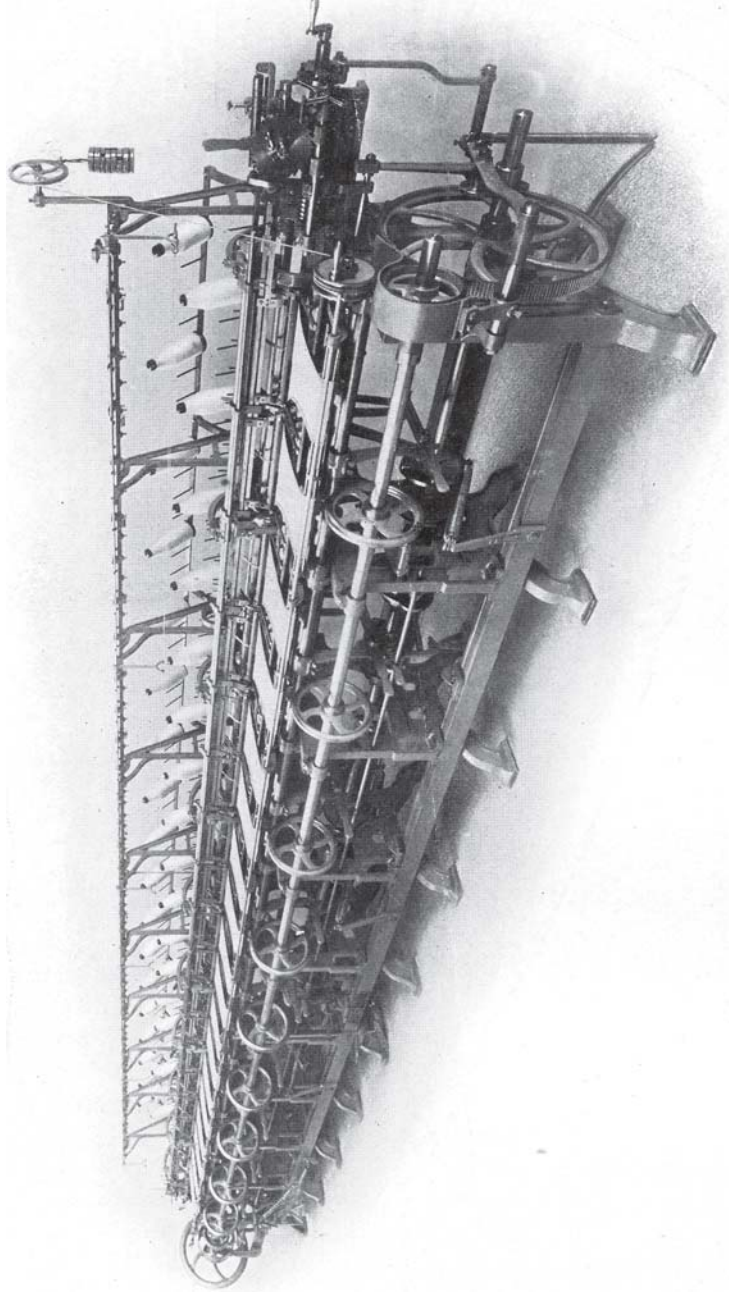


Fig. 178. Diagrammatic View of Textile Machine Work's Footer.

machine, the web being narrowed at each side to form the desired instep-gussets, and being also narrowed at the toe, so as to properly round the same.



FULL FASHIONED HOSIERY KNITTING MACHINE OF 18 SECTIONS, WITH SPRING BEARD
NEEDLES—BUILT ON COTTON SYSTEM

Otto Walthert

This method of manufacture necessitates sewing or seaming operations to complete the stocking, because, as the stocking-blank is knitted in the form of a flat web, it is necessary to unite the edges of this web by a seam extending down the back of the leg, calf, ankle, and heel, and by another seam extending under the bottom of the toe, foot, and heel.

Generally speaking, the advantages of a full-fashioned stocking over the product of a circular machine, consist in the fact that the former is shaped or "fashioned" in such a way that the fabric is narrowed by the dropping of stitches to suit the contours of the leg and foot, and to insure a perfectly fitting stocking. Another advantage of a full-fashioned stocking is that it is made with spring needles, which leave the yarn its full amount of elasticity, as it is subjected to very little strain during the operation of knitting. This results in a fabric of great elasticity, such as is not produced on a seamless machine using latch-needles, even though the same number of needles per inch be employed.

In addition to these points of superiority of the full-fashioned stockings resulting from the method of making, the construction of the machine and the accessibility of the co-operating elements permit of producing effects of design or ornamentation which it is impossible to produce by circular knitting.

The underlying principles of machines of this system are pointed out in detail with reference to the illustrations of the machine built by the Textile Machine Works at Reading, Pa. The formation of the loops is produced in the following manner:

The needles shown at 1 (Figs. 178 and 179) are clamped in the needle bars shown at 1A, and stand in a vertical position. Instead of the former method of casting needles into leads, they are securely held in position by slots being milled in brass bars and holes drilled through these bars, whereby the end of the needle shank is held, this end being bent at right angles to the length of the needle. These brass bars are securely fastened against steel needle-bars. The steel needle-bars form independent sections, generally of a length to make two stockings. Clamping plates three inches in length are used to hold these needles securely in place; and in the latest construction these plates are so arranged that they can be loosened by unscrewing a bolt from the front of the machine whenever it becomes necessary

to replace a broken needle. This is found to be a great convenience, as the replacing of a needle can be done very quickly.

The loops are formed by sinkers, of which there are as many as there are needles. Each sinker is placed in the center between two needles. Two kinds of sinkers are used, termed *jack-sinkers* and *dividers*. The jack-sinker is reinforced at the rectangular rear end by steel plates, to provide a better and more durable surface for the "jacks" to strike against. There is always one jack-sinker alternating with a divider. The jack-sinkers form a loop over every two needles and the dividers divide the same, to give an equal loop to each needle. Sinkers and dividers have projections at their front end, which are termed, *nib* and *nose*. The nib is used for forming the loop, while the nose separates the new loop from the old one during its formation and until it has been drawn through the old loop.

The sinkers have an independent motion, which is given them by the jacks, of which there is one to each sinker. The dividers are moved forward by the catch-bar, which is so shaped as to control also the backward movement of the sinkers. The catch-bar extends across the whole width of the machine, and is supported by the catch-bar arms, which, at their opposite ends, are connected to other arms attached to the rocking shaft C B4 (Fig. 178), which shaft receives its rocking motion by levers F extending to the main shaft and carrying a roller at their lower end, which is acted upon by the catch-bar cam.

The movements of these various parts to form a row or course of knitted loops, are as follows: The needles stand with their beards above the tops of the sinkers, while the nose of sinkers and divider protrude between them. The thread-carrier lays a thread in front of the nib of the sinker, and behind the needle shanks. The sinkers, having an individual movement, as explained, are each brought forward, one after the other, by the jacks, which are pressed against the back of them by the "slur-cock" as it travels across each division of needles. By this movement, each sinker forms a loop between alternate needles. When these are completed, the dividers are brought forward all together by means of the catch-bar to form a loop between those needles that had no loops formed for them by the sinkers. In order to provide thread for the dividers, the needles all move back nearer the sinker-nib, freeing part of these loops to be taken by the dividers, and so forming a series of loops around each needle-shank,

all of which should be of uniform size. The needles then descend to such a distance that the new loop passes under the needle-beards; and the needles are moved toward a fixed presser-bar to close the beards; so that, as the needle-bar descends still farther, the point of each beard shall enter the old loops, being landed on top of the needle-beards, and, finally, in a further descent of the needles, being knocked over the head of the needles by the knocking-over bits, the sinkers and dividers in the meantime retiring to give a free passage to the old loop

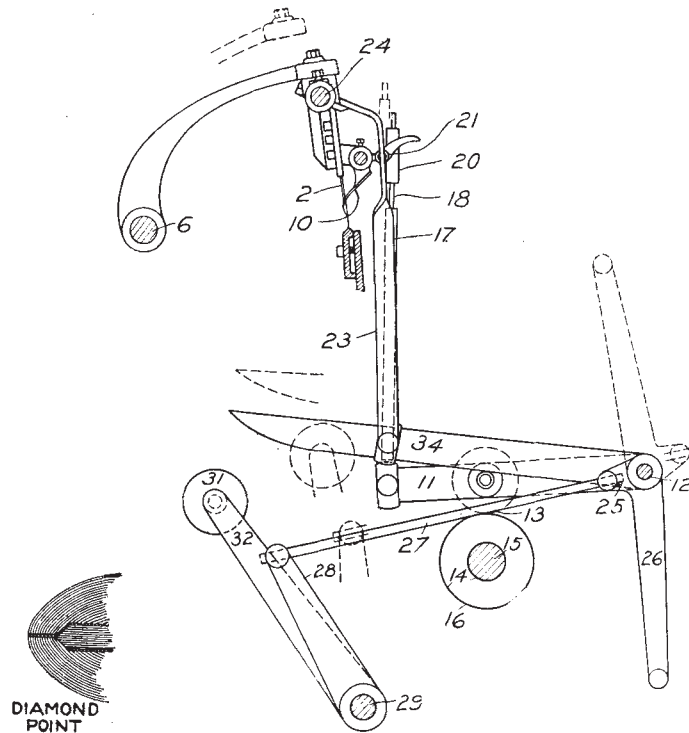


Fig. 179. Narrowing Mechanism, Raising Device, and "Diamond Point" Mechanism.

as it goes over the new one. The whole row of old loops being over, the needles commence to rise, the sinkers and dividers coming forward above the loops to hold them down in position, ready for the making of the next row of new loops, which are commenced as soon as the needles have reached their normal position again.

Fig. 178 shows a diagrammatic sectional view of a *Footer*; and while it shows plainly the well-designed, mechanical construction

and the strong proportions of the machine, some of the new details of improved construction are shown in the other illustrations.

Fig. 179 illustrates a very convenient improvement for raising the narrowing mechanism; also an improved mechanism for producing the *diamond point* at the toe of the foot of a full-fashioned stocking.

The raising and lowering of the whole narrowing mechanism is conveniently effected, and the narrowing machine is rigidly held in the raised position by employing a lever 34, fixed to the shaft 12, and pivotally connected to a rod 23, which in turn is pivotally attached at its upper end to the shaft 24 of the narrowing mechanism, in con-

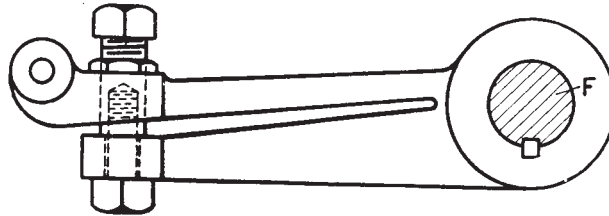


Fig. 180. Needle Bar Micrometer Adjustment.

nection with a hand mechanism for operating lever 21, comprising a bell-crank 25, 26, loosely mounted on the shaft 12, and having its short arm connected by a pivoted rod 27 to an arm 28 on shaft 29. The turning of the latter by the swinging of the bell-crank arm 26 upward to its dotted position against the stop 30, causes the end 31 of arm 32 on shaft 29 to swing forward to its dotted position indicated, thereby raising and holding rigidly in place the entire narrowing machine.

This is very convenient for straightening the needles or putting new ones in the machine in place of broken ones. In order to produce the "diamond-points," the guard-blades 10 are employed, which are swung toward the fashioning points 2, and press against some of these points, preventing them from engaging with the corresponding needles and the picking of the loops from such needles in the operation of *footing*. The movement of the guards 10 into and out of contact position with the fashioning points 2, is effected automatically during the operation of the machine by means of levers 11 and connected mechanism as follows:

The lever 11 is pivoted at one end to a shaft 12, and is provided

intermediate of its length with a roller 13, which bears normally upon the concentric periphery 14 of a disc fixed to the rotary shaft 15, upon which the lever is thus supported without movement; but when the shaft 15 is moved longitudinally during the narrowing operation, the bearing of roller 13 is transferred from the concentric disc to an eccentric periphery 16, which raises the pivoted lever 11. Pivotaly con-

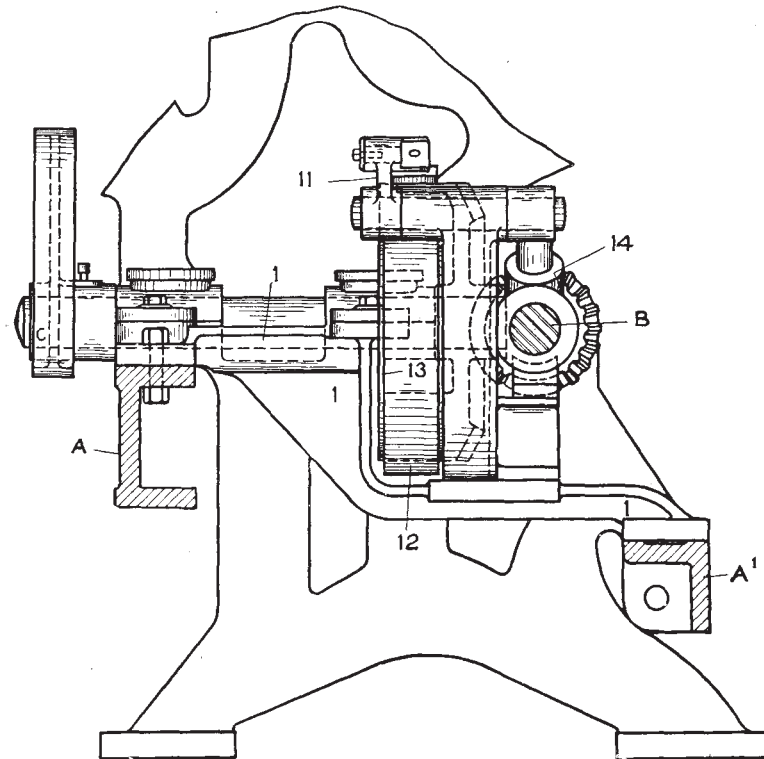


Fig. 181. Draw-Cam Shaft, Bearing, and Brake.

nected to the free end of the lever 11, is a rod 17, the upper end 18 of which is engaged so as to slide in a sleeve 20, which in turn is pivotally connected at 21 to an arm 22 fixed to the shaft 8. The free movement of the rod-end 18 in said sleeve is limited by a shoulder or stop 19, which comes in contact with said sleeve before the lever 11 is fully raised, and raises it, so as to turn the shaft 6 and swing the guards 10 outward, as indicated by the dotted lines.

Fig. 180 illustrates a very important improvement, which allows

of a micrometer adjustment of the needle-bars. It is very important that the needles should always be in exact co-operating position with the sinkers; and it will readily be understood by referring to the illustration, that the double bolt and jam-nut of this double-armed needle-bar crank furnish accurate means for doing this.

Figs. 181 and 182 show an improved bearing for the draw-cam shaft, and an improved brake for arresting the movement of the draw-cam shaft as soon as the longitudinal movement of the main cam-

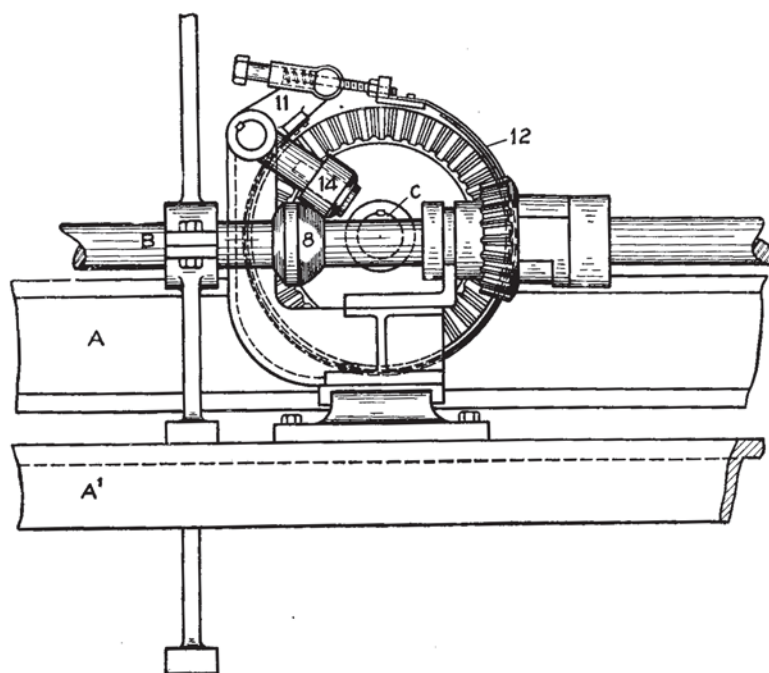


Fig. 182. Draw-Cam Shaft Brake.

shaft takes place—in other words, as soon as the machine commences to narrow. In nearly all other machines this stopping of the draw-cam shaft is done by a key pushing in between the teeth of the bevel gear on the cam-shaft. This improved brake works with a steel band, leather lined, adjustably secured, and tightens as soon as shaft B is longitudinally moved (see 8, 14, 11, 12, and 13). The construction of bearing 1 not only forms a substantial one-piece bearing for the draw-cam, but at the same time bridges and braces transversely the entire machine, by being bolted to beam A in the rear and beam A' in the front part of the machine.

LACE EFFECTS AND OPEN MESH WORK

The high perfection of the Cotton type of flat-bed knitting machine, has enabled these machines to compete successfully in the manufacture of ornamental high-grade open-work products—stockings, of course, being the chief output in this line. Such machines can be used very successfully for producing fabrics of great variety in design, with any perforated patterning that may be desired, and without changing anything in the machine that would prevent its being easily restored to the making of hosiery. The slowness of operation in these machines is more than compensated for by their ability to turn out simultaneously a number of fashioned blanks suitable for the finest grades of underwear, while at the same time making any pattern of open-mesh work in the fabric that can be formed of tuck-work, transferred stitches, or dropped stitches. The following is a detailed description of such a machine equipped for the production of open-mesh fabric wherein loops are transferred from one needle to the adjacent one by a transfer point (see Fig. 183). Of course the pattern shown in Diagram H may have the open spaces X at much more frequent intervals.

The lace-needles are represented at 1, the stop-needles at 2, and the knitting-needles at 3. The needles 3 are provided in larger numbers than the others, and form a connected row, while the lace-needles 1 and the stop-needles 2 are comparatively few in number, and stand in smaller groups of two or three, according to the nature of the open-work pattern to be produced. The lace-needles 1 are secured in the lace-point bar 4, while the knitting-needles 3 are secured in the needle-bar 15. The lace-point bar 4 is suspended from the shaft 17 through the medium of the arm 16; and these parts 1, 4, 16, and 17 may be called the *open-work attachment*.

The narrowing-needles 6 are secured in the smaller needle-bars 7 and 8. All the needle-bars 7 are rigidly connected to the bar 9, and all needle-bars 8 to the bar 10. These enumerated parts 6, 7, 8, 9, and 10 are mounted upon the shaft 11, through the medium of the lever 5, and may be designated as the *fashioning or narrowing attachment*. The sinkers 12 in their operation are moved to and fro horizontally. The knocking-over bits 18 remain fixedly in their place.

Diagram B shows the positions of the parts at the moment when the knitting-needles 3 have reached the highest point in their move-

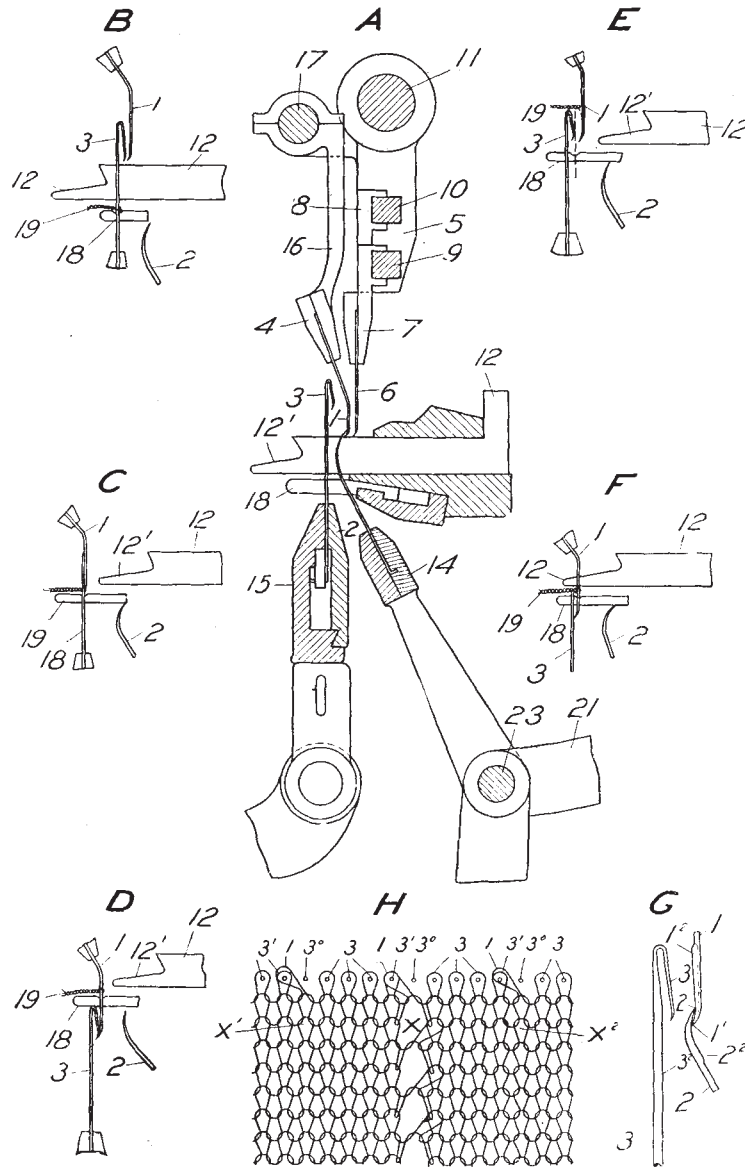
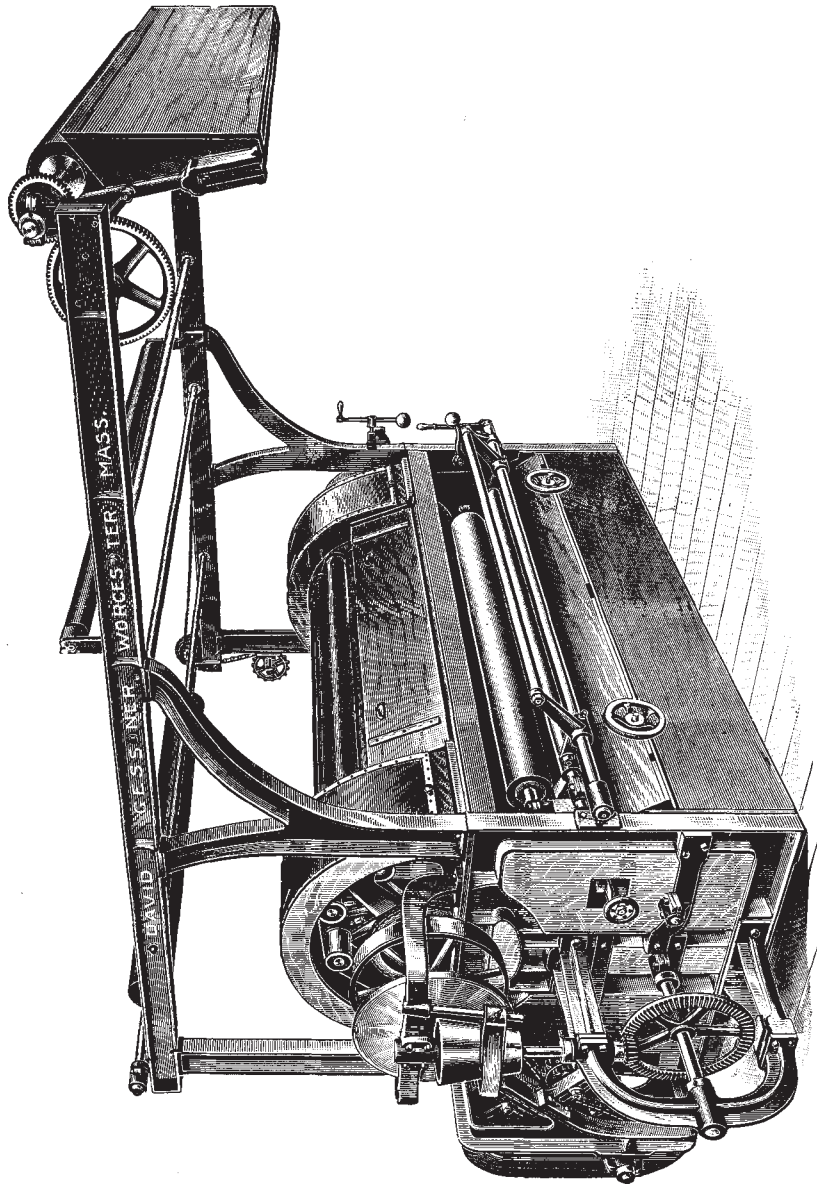


Fig. 183. Transferring Loops, by Transfer Point, to Produce Open-Mesh Fabric.

ment, the web 19 hanging on the knitting-needles, the sinkers 12 being projected, and the lace-needles 1 being about to lay their grooves upon the knitting-needles. In Diagram C the lace-needles have so laid themselves upon the knitting-needles 3 that their points 1¹ have entered the grooves 3¹ (Diagram G), and the beard 3¹ is entirely covered by the groove 1² (Diagram G). Thus tightly closed together, the two needles move downward through the loops. The loops resting upon the jack 18 are stripped from the knitting-needles 3 and shoved upon the lace-needles 1. This series of steps in the formation of the loops takes place only where the lace-needles 1 are located in the lace-point bar 4. Those knitting-needles 3 which are not covered by lace-needles 1, retain their loops and produce a smooth web.

Diagram D shows the next succeeding moment of the needle operation. Web 19 no longer hangs upon the knitting-needles 3, but has now been fully pushed upon the lace-needles 1. The lace-needles 1 now begin to elevate themselves from the knitting-needles 3. In Diagram E both needles 1 and 3 have moved upward; the web 19 has been carried upward with them; and while this was taking place, the lace-needle 1 has with them raised itself from the knitting-needle. In this elevated position of the needles, the shaft 17, together with all the parts mounted upon it—being one or two needles, according to the pattern of the goods—is moved to the left or right. Upon shaft 17 is secured the lace-point bar 4, and the needles 1. Since upon each lace-needle 1 a loop hangs (Diagram E), these loops will be taken laterally a distance of one or two needles; and at this point the knitting-needles 3 (Diagram E), move into the dotted position, so that the loop can be transferred from the needles 1 to the needles 3. This may be clearly seen in Diagram H, where a number of knitting-needles 3 are shown from above in horizontal section. The knitting-needles 3 are hung with loops, excepting the needles 3^o, which are cleared in consequence of the lace-needles 1 having taken the loops from them and covered them by the neighboring needles 3¹, as illustrated in Diagram E.

In Diagram F both of the needles 1 and 3 now move again downward. The web 19, which was elevated in Diagram E, has been taken downwardly in Diagram F, and again rests in the position which it assumed in Diagrams B, C, and D upon the knocking-over bits 18. The sinkers 12 now move forward horizontally and secure the web 19



GESSNER KNIT GOODS NAPPING MACHINE
David Gessner

so that it is confined between the knocking-over bits 18 and the beaks 12¹ of the sinkers. If now the needles 1 and 3, covered the one by the

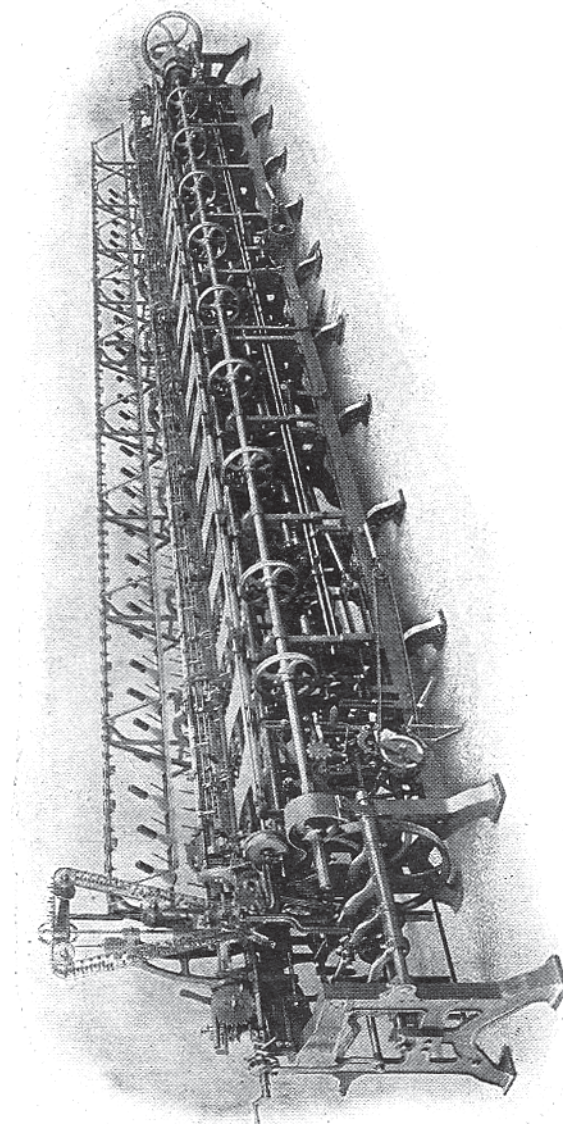


Fig. 184. Schubert and Salzer Full-Fashioned Hosiery Machine.

other, move upward in common, the loops are pushed from the needles 1, and slide among the needles 3 again. The lace-needles 1 are now

free, and again separated from the knitting-needles 3. The parts have now again reached a position similar to that shown in Diagram B.

By the proceedings as outlined with reference to Diagram B to F, beautiful open-work patterns may be produced. Diagram H is not given as a sample of a very artistic production; it is designed simply to show how a progressive series of openings x may be produced. If the three lace-needles 1 in Diagram H are brought into operation, there would be produced not simply the single row of openings x in the middle of the web, but two lateral rows of openings x^1 and x^2 . The ornamentation of the pattern and the variegation thereof can be accomplished to a very much greater extent by interrupting one or more of the lace-needles 1 for the production of openings x at will. It is also practicable to omit openings and introduce plain work, just as often as may be desired, along the lines x^1 and x^2 . If in Diagram

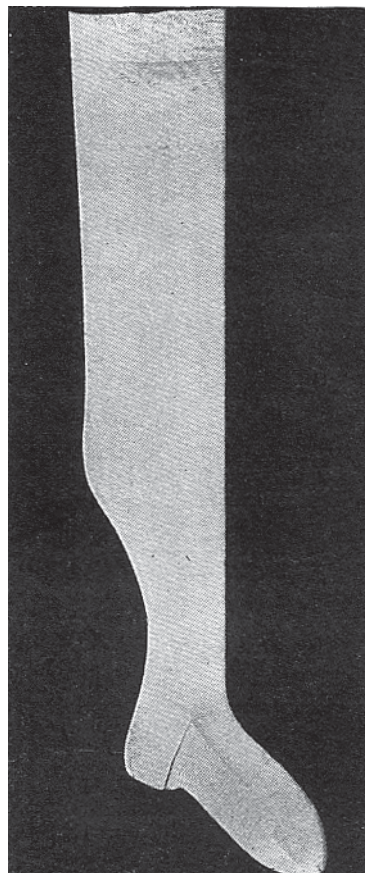
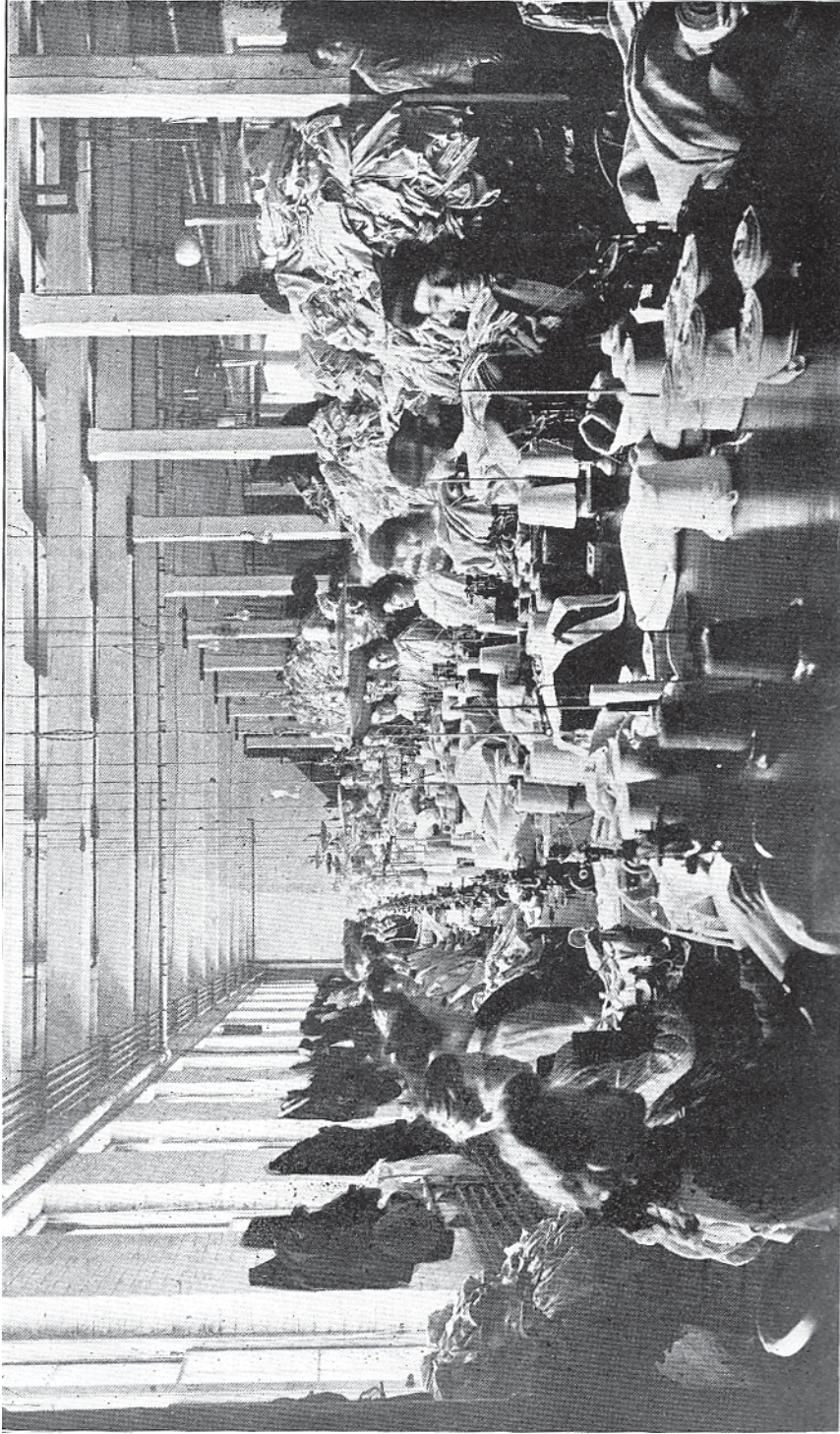


Fig. 185. Ladies' Full-Fashioned Stocking.

H it should be desired to introduce a row of openings at 3° 3° 3° , this can likewise be accomplished by simply omitting all of lace-needles 1 1 1.

Fig. 185 shows a ladies' full-fashioned stocking of mercerized thread made on a 39 gg. (gauge) or 26 needles to the inch Schubert & Salzer machine. It has spliced garter top, heel, sole, and toe, and is narrowed in the leg, heel, instep, and toe.



SECTION OF FINISHING ROOM WHERE 12,000 GARMENTS ARE FINISHED DAILY

KNIT GOODS FINISHING AND FINISHING MACHINES

One of the marked characteristics of the time is the increased demand for ready-made garments. The first demand for this grade of clothing seems to have been by sailors fitting out in New Bedford for long whaling voyages. So many men going out of port at one season of the year influenced an enterprising store-keeper to have a lot of clothing made up ready for the rush. This was before the sewing machine was invented; and the clothing, though far from stylish, was comfortable and durable.

From this small beginning came the enormous clothing industry of today, with its many branches, including men's clothing, ladies' clothing, muslin underwear, children's dresses, skirts, shirtwaists, infant wear, knitted underwear, etc. Before the sewing machine came into use, the clothing industry was being rapidly developed, and this undoubtedly served, in a large degree, to spur on the inventors to produce a sewing machine.

The growth of the industry has been marvelous. It is, and always has been, a great incentive to the sewing machine manufacturers to exert their inventive faculties, and in this large special field, a profitable market is found. Large and profitable concerns have been developed in the ready-made garment industry because the manufacture of garments in large lots makes it possible to offer them at prices that command attention and in better style than those turned out by the average tailor or seamstress.

The knitted underwear branch of the clothing industry early saw the advantage of concentrating its help under one roof and under the skill and guidance of experts, and they, quicker than any other branch, also saw the great advantages of special machines. As a result they have today the best equipped factories in the ready-made garment business. Almost every operation, in fact every operation, has a special machine designed and adapted to perform that part of the work. It is an unusual thing for an operator to make a gar-

ment complete in a knitted underwear factory. After leaving the cutter in bundles of one dozen each, they pass successively through different operators' hands for almost every operation.

KNIT GOODS FINISHING

Since the manufacturer of knit goods has undertaken to promote his sales by direct personal solicitation, the details of finishing have become almost innumerable. When knit goods were marketed chiefly by the commission houses it was customary to sell the goods as the sample was made up, but when the manufacturer, to close his sales, sought to do a little better than his competitor and offered to "cat-stitch", to put on Prussian binding, or four buttons instead of three, or pearl buttons instead of bar, or a ribtail instead of hem, or collarette instead of binding, or stitched with silk, or one quality of golloons here, and another quality of buttons—cloth, bar, ivory, bone, shell or pearl—single stitched, two needle stitched, or three rows of stitches, or some of the innumerable catch features adaptable to the finishing of underwear, he built up for himself and for the entire trade an interminable number of styles to perplex himself as well as his help and retard production; because this or that lot must be marked 88AB21 or Xo 225, or with some other hieroglyphic equally difficult to keep run of, and sort out.

We will take under consideration the more important processes, leaving the more stylish designs to be acquired after due experience.

Between the first attempts to produce factory-made underwear and the many fine examples of the art before us on every hand at the present day, is a goodly journey, and to one who has been a privileged observer of even a part of the necessary changes, both mechanical and artistic, which have followed one after another during this period, the transformation is of vast interest.

From an artistic standpoint, and in a peculiar sense, much of the credit for the excellence of our present-day underwear must be given to the garment designer. This person is never satisfied with a new design or effect if another suggests itself which seems better; and if mechanical difficulties prohibit its adoption, they are but a spur or incentive for the inventor, and are looked upon as things to be overcome. The cares and designs of the garment maker, or originator, however, are of a different nature from the foregoing,

in that there is never any surety that the particular style of finish or cut of a garment, which is finally worked out with such exceeding care, will remain in vogue longer than one season at the most.

Fabric. These most useful and necessary garments are today made in an almost inconceivable number of styles, and in as many different qualities. There also seems to be no end to the different kinds of fiber which may be used one way or another in their fabrication. Silk, wool, cotton, ramie, mohair, camel hair, flax, etc., are all adaptable in some form or other, or in various combinations, so that we are able to select garments that are not only perfectly adapted to meet our requirements of warmth for the winter season, or cool comfort in the warmer months, but every grade shows remarkable taste as to finish and texture of the fabric itself.

Yarn. In making the yarn for this peculiar elastic fabric, we have recourse to all of the various fibers which are used in woven fabrics, but differing from the latter, a knitting yarn must be smoother and more even. If these requirements are complied with, the knitting process is much faster than weaving, and consequently a greater quantity of knitted cloth can be made at the same cost, than of a woven fabric of equal quality. For this reason, and because of the elastic nature of a knitted fabric, it is especially suited for wear next to the body, and has taken the place of all other kinds of material for this purpose.

The finest results are obtained by the use of silk yarn, yet many very satisfactory fabrics are made from lisle thread and mercerized cotton; fibers that are much cheaper than silk. Such fabrics retain their style, shape and brilliancy through much hard usage, and many trips through laundries. Indeed, the problem seems to be that on the medium-priced garments the trimmings, which are necessary to present a sufficiently neat appearance, must be of a somewhat better quality than the fabric itself, in order to wear as well.

Making Up Samples. In making up samples for an approaching season, the designer's field would appear to be somewhat limited, from the fact that the general styles or character of these garments have now become standardized, and are in a measure arbitrary. Thus the vest or shirt of a two-piece suit will allow of but little alteration from the usual shape, except in the length of sleeves or cut of the neck; and with the pants and drawers which complete these