

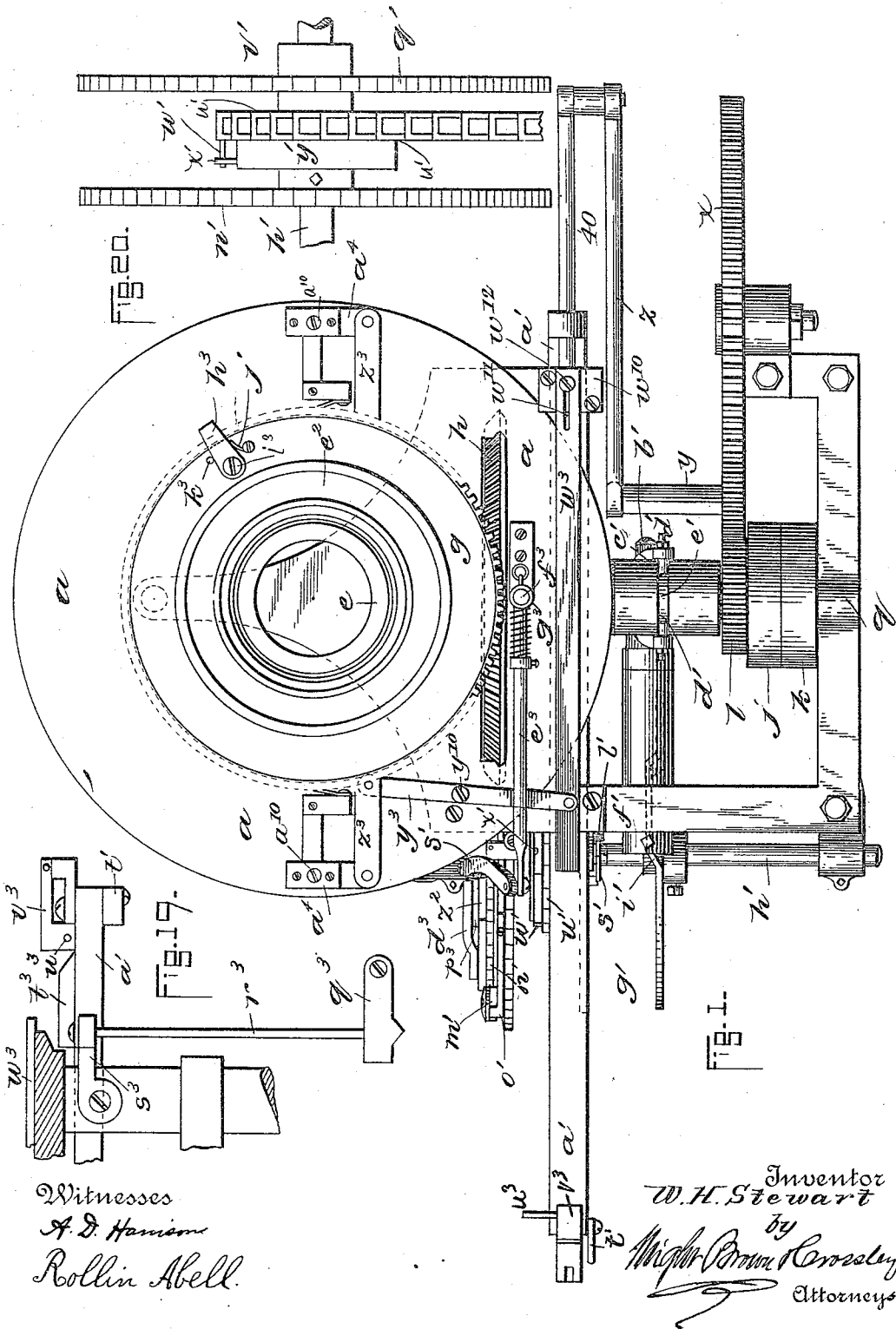
(No Model.)

7 Sheets—Sheet 1.

W. H. STEWART.
AUTOMATIC CIRCULAR KNITTING MACHINE.

No. 529,509.

Patented Nov. 20, 1894.



Witnesses
A. D. Hanson
Rollin Abell.

Inventor
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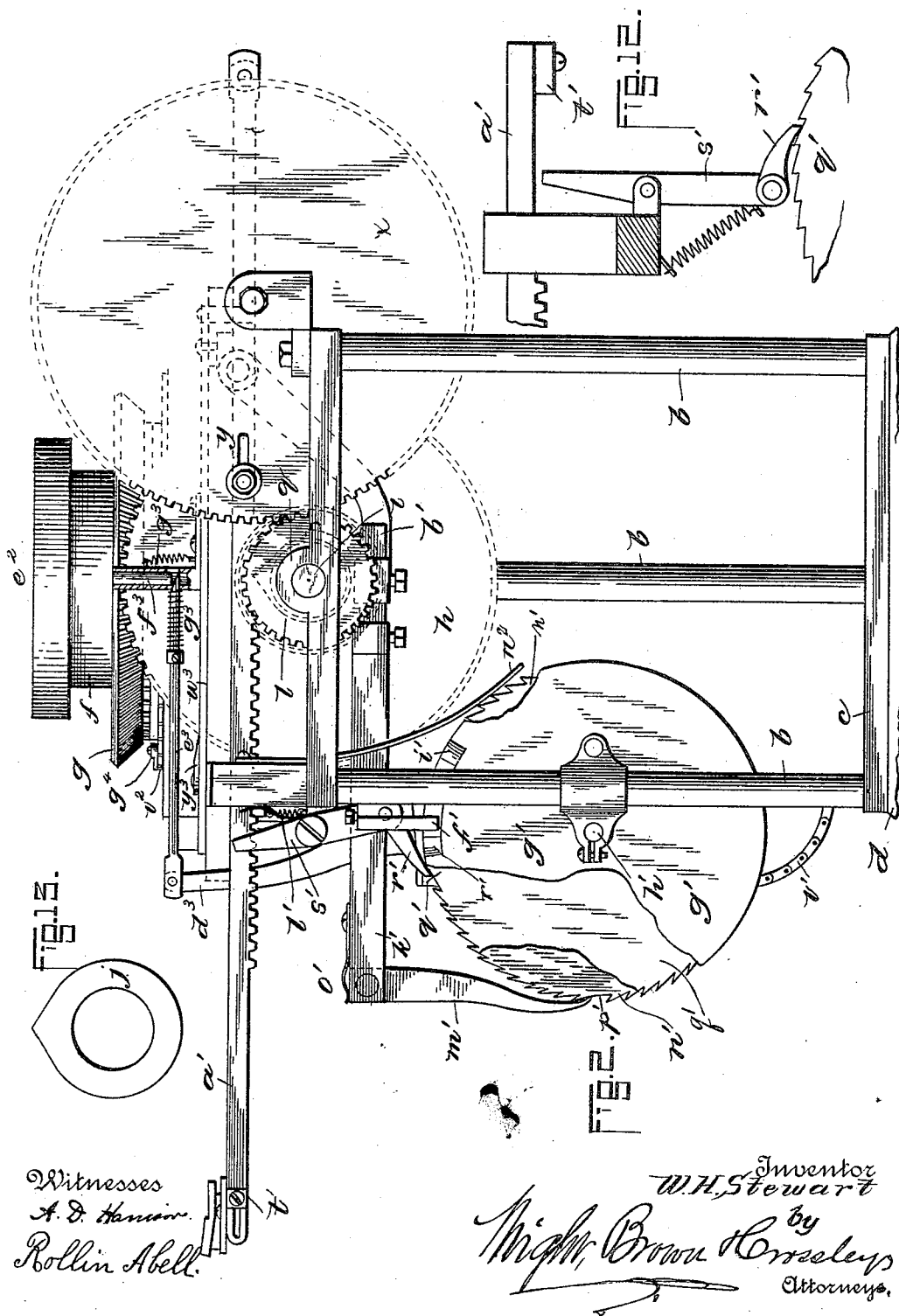
(No Model.)

7 Sheets—Sheet 2.

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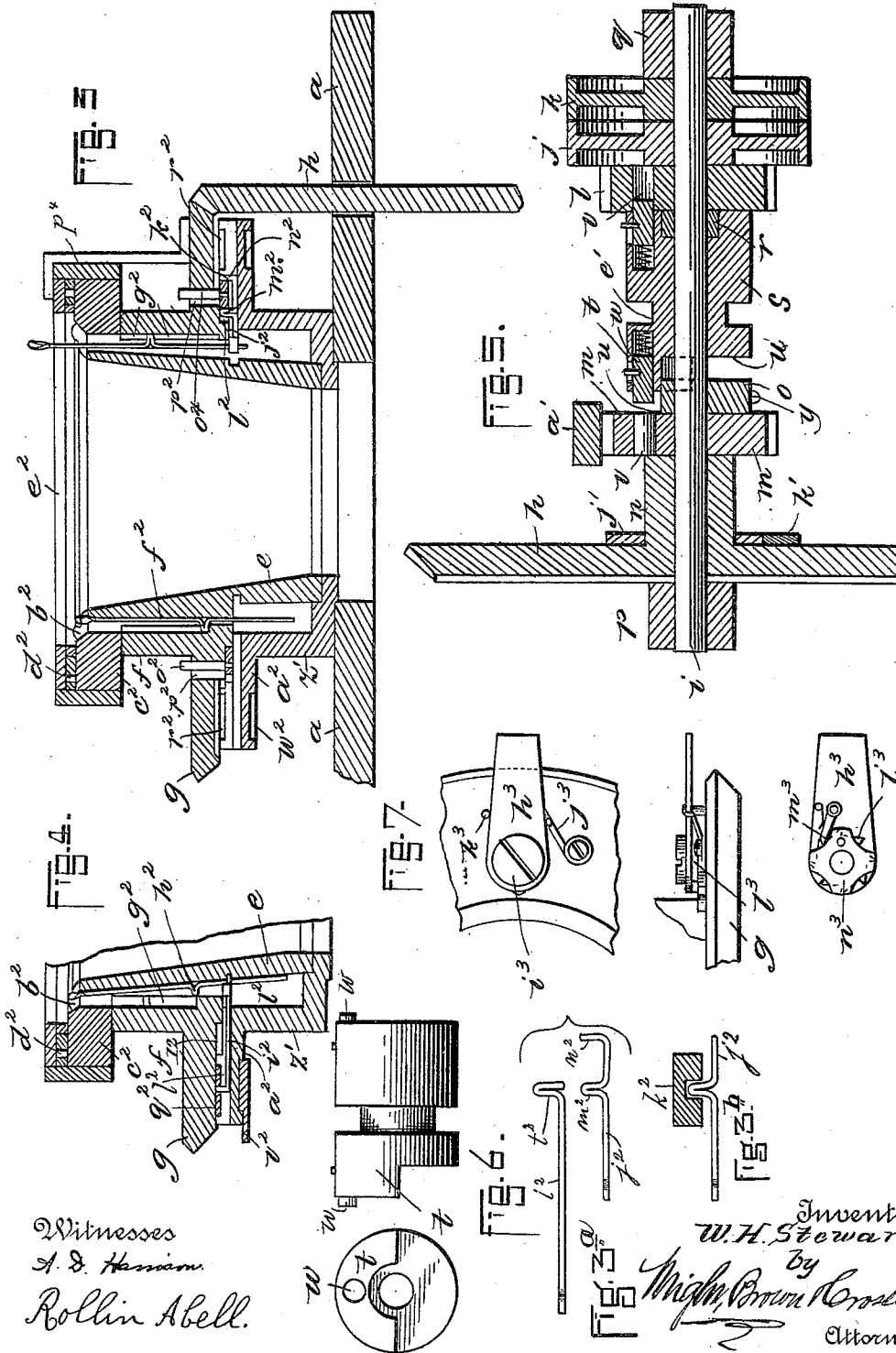
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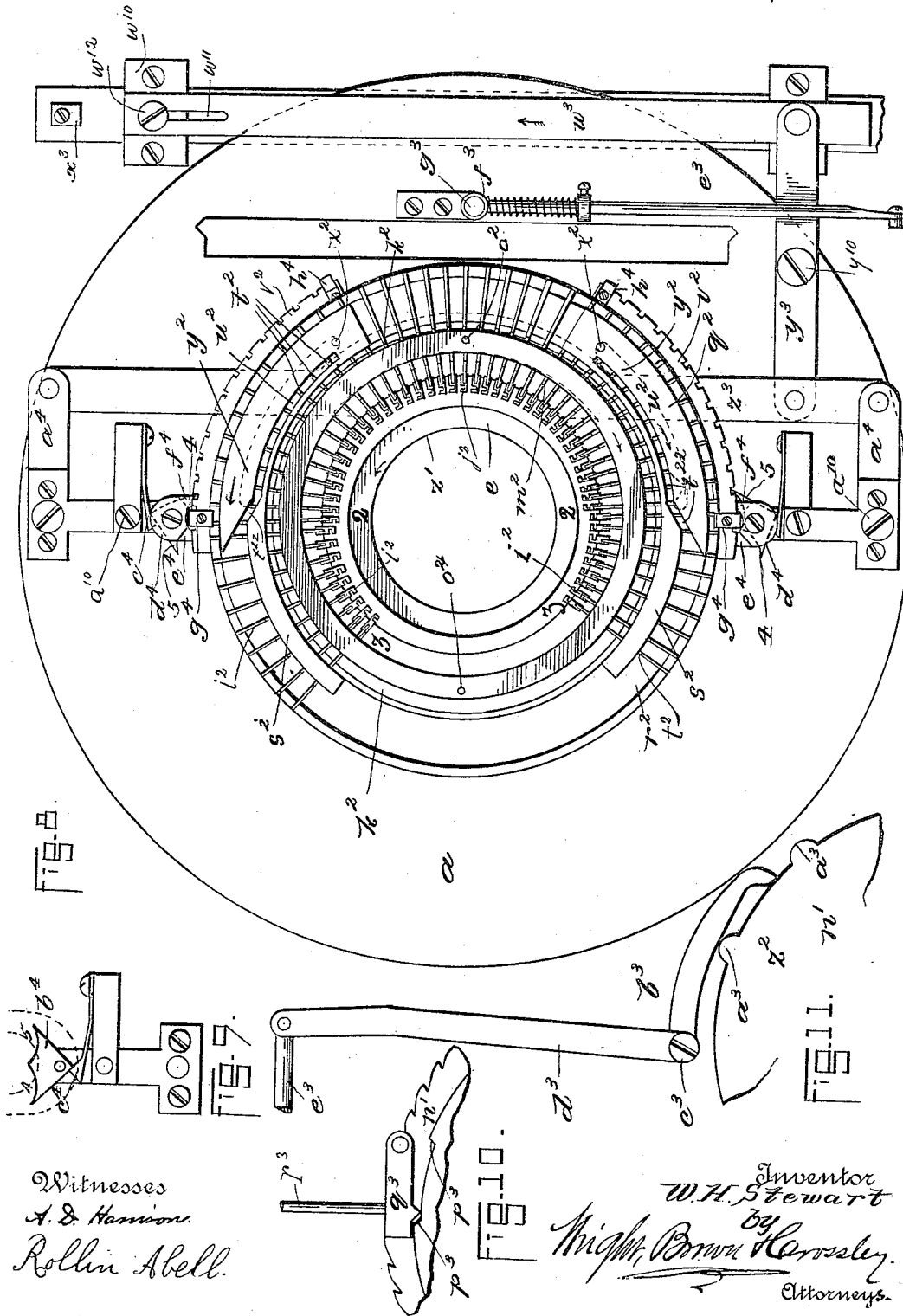
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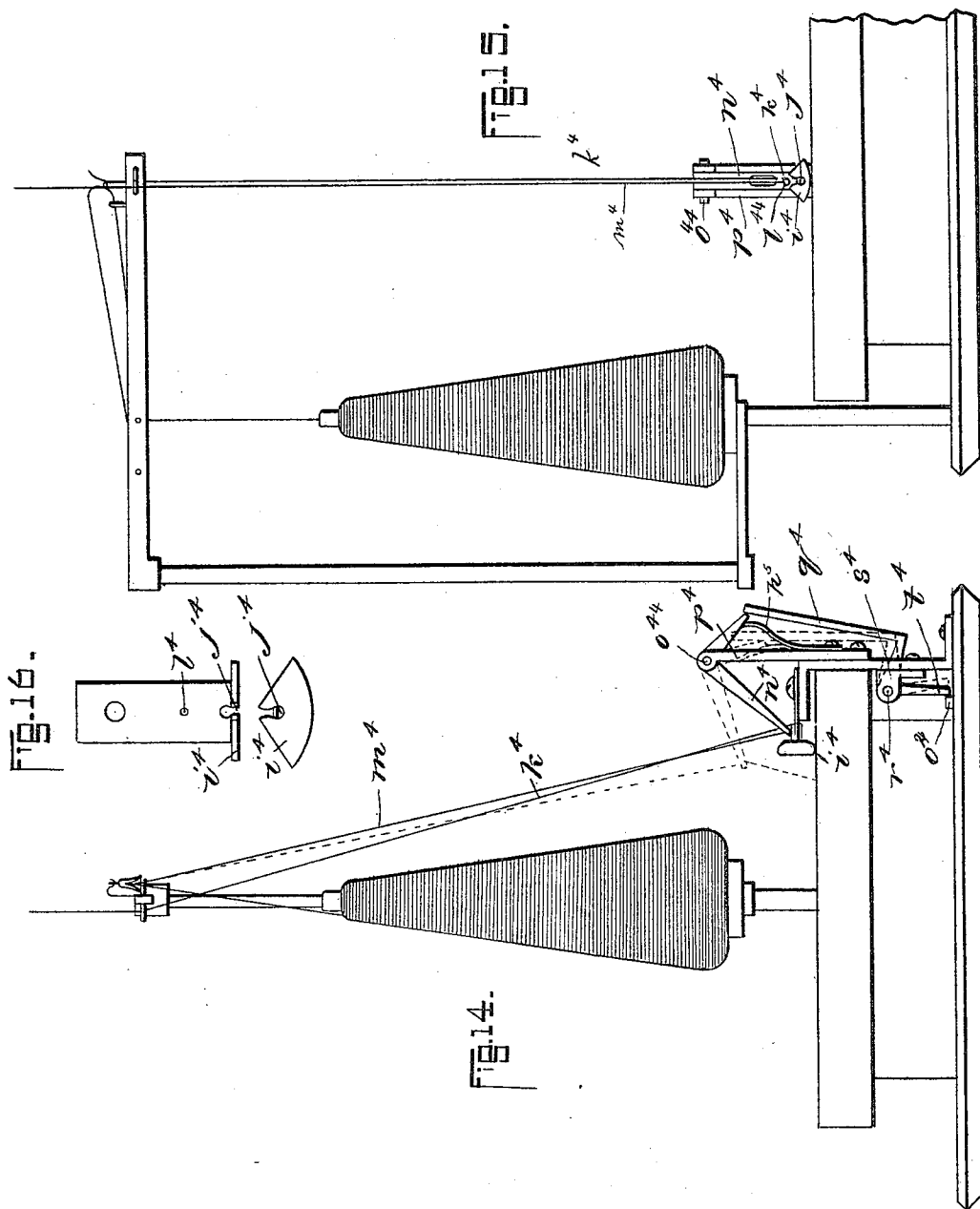
Patented Nov. 20, 1894.



7 Sheets—Sheet 5.

No. 529,509.

Patented Nov. 20, 1894.



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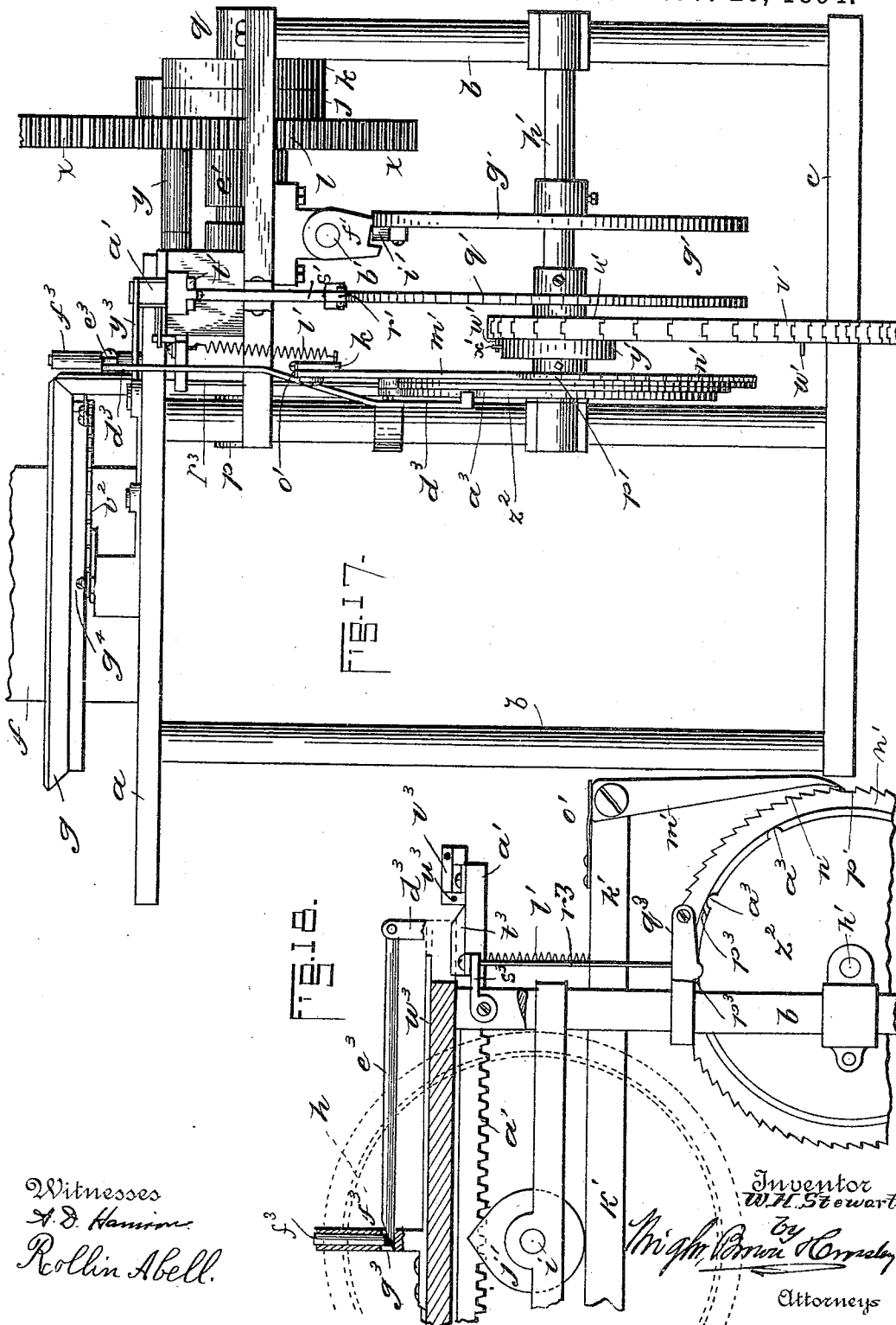
(No Model.)

7 Sheets—Sheet 6.

W. H. STEWART.
AUTOMATIC CIRCULAR KNITTING MACHINE.

No. 529,509.

Patented Nov. 20, 1894.



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(No Model.)

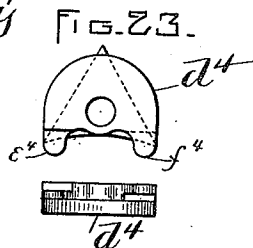
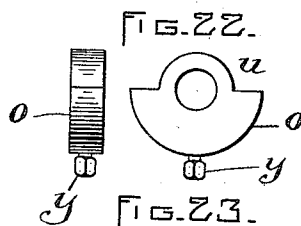
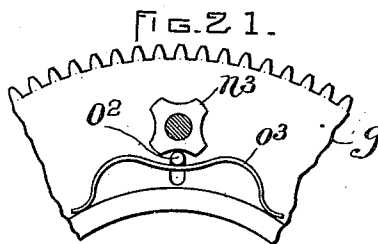
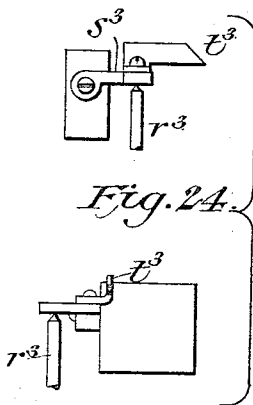
7 Sheets—Sheet 7.

W. H. STEWART.

AUTOMATIC CIRCULAR KNITTING MACHINE.

No. 529,509.

Patented Nov. 20, 1894.



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UNITED STATES PATENT OFFICE.

WALTER H. STEWART, OF FRANKLIN, NEW HAMPSHIRE.

AUTOMATIC CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 529,509, dated November 20, 1894.

Application filed April 25, 1894. Serial No. 508,968. (No model.)

To all whom it may concern:

Be it known that I, WALTER H. STEWART, of Franklin, in the county of Merrimac and State of New Hampshire, have invented certain new and useful Improvements in Automatic Circular-Knitting Machines, of which the following is a specification.

The invention relates to the class or kind of circular knitting machines which are adapted to knit seamless "round-heel-and-toe" stockings, and in which the several operations and changes are automatically accomplished.

It is the object of the invention to provide such improvements in machines of the kind mentioned as will materially simplify and reduce the cost of their construction, and render them entirely certain and rapid in their operation.

The invention consists of the improvements hereinafter fully described and pointed out at the end of the specification proper.

Reference is to be had to the annexed drawings, and to the letters, signs and figures of reference marked thereon, forming a part of this specification.

Of the drawings, Figure 1 is a top plan view of my improved knitting machine. Fig. 2 is a side view of the same, parts being represented as broken away. Fig. 3 is a vertical sectional view through the needle cylinder and its immediate adjuncts. Figs. 3^a and 3^b are detail views hereinafter referred to. Fig. 4 is a sectional detail view of the needle and cam cylinders and connections showing a different position of some of the parts from that in which they are shown in Fig. 3. Fig. 5 is a central sectional view of the parts operating in conjunction with the driving shaft and its supports. Fig. 6 comprises side and end views of the clutch roll. Fig. 7 comprises top plan, side, and bottom plan views of the means for moving the needle throwing out ring. Fig. 8 is a top plan view of the head and portions of its adjuncts, the needles, web-holders and web-holder operator means being removed. Fig. 9 is a detail view of a part of the means for operating the needle shifter slides. Figs. 10, 11, and 12 are detail views hereinafter more particularly referred to. Fig. 13 is a detail view of a portion of the mechanism employed in changing from circular to heel and toe work. Fig. 14 is a side

view of the yarn supplying device. Fig. 15 shows a view of the yarn-carrier looking toward the yarn-delivery portion thereof. Fig. 16 is a detail view of the yarn guide plates. Figs. 17 and 18 comprise front and side views respectively, of the ratchet and cam wheels and the co-operating parts. Figs. 19 and 20 are detail views hereinafter more particularly referred to. Fig. 21 is a view of the pin, *o*³, cam, *n*³, and spring *o*³. Fig. 22 is a front and edge view of the collar, *o*. Fig. 23 is a detail of the block, *d*⁴. Fig. 24 is a detail view showing the block (*t*³), in different positions.

The same letters, signs and figures designate the same parts or features, as the case may be, wherever they occur.

In the drawings—*a* designates the bed of the machine, which, together with other parts of the machine is supported by columns, *b*, resting upon a base, *c*, which base may in turn be supported by legs, *d*, (a fragment only of which is shown in Fig. 2.)

e designates the needle cylinder, and, *f*, the rotary cam ring or cylinder provided on its periphery with bevel teeth, *g*, which are engaged by the teeth of the bevel gear, *h*, on the driving shaft, *i*. On the outer end of the driving shaft are the pulleys, *j* *k* both loose thereon.

l designates a gear wheel secured to pulley, *j*, so as to turn therewith.

m is a gear wheel arranged to turn loosely on the shaft, *i*, and maintained in place thereon between the hub, *n*, of bevel gear, *h*, and a collar, *o*, fast on the driving shaft, the latter turning in the bearings, *p* *q*, at its ends.

r designates a collar keyed or otherwise secured to the driving shaft at the inner side of the gear wheel, *l* to keep the wheel, *j*, from moving toward the wheel, *m*.

s designates a clutch roll arranged so as to move longitudinally on the driving shaft between the collars, *o* *r*, and gear wheels, *l* *m*, but locked with the collar, *o*, by means of the projection, *t*, extending over the reduced part, *u*, of the said collar so as to turn with the driving shaft. See Figs. 5 and 6. The collar, *o*, is fastened upon the shaft by means of the set-screw, *y*.

The gear wheels, *l* *m*, are provided with holes, *v*, into which the spring-pressed pins, *w*, extending from the ends of the clutch roll,

s, are adapted to extend, the construction and arrangement being such that when the clutch roll, *s*, is moved toward the gear, *l*, the pin, *w*, in the adjacent end of the said roll will extend into the hole, *v*, of the said gear, the pin in the opposite end being disengaged from the gear, *m*, all as is clearly shown in Fig. 5; and when the clutch roll is moved in the opposite direction, it will be disengaged from the gear, *l*, and the other pin engaged with the gear, *m*.

x designates a gear wheel supported on a suitable stud or journal and arranged so as to be engaged and driven by the gear wheel, *l*. The gear, *x*, is provided on its inner face with a wrist pin, *y*, upon which is pivoted one end of a crank arm, *z*, the other end of the said crank arm being pivotally connected with the rear end of a rack bar, *a'*, mounted in suitable bearings and arranged so as to engage and operate the gear wheel, *m*, on the driving shaft, *i*.

Without further description it will be seen that if the driving shaft should be rotated continuously in one direction by a belt on the pulley, *j*, and the clutch roll should be moved into engagement with the wheel, *l*, and disengaged from the wheel, *m*, as is shown in Fig. 5, the cam ring would be revolved so as to enable the machine to knit circular work, as, for instance, the leg and foot portion of a stocking; but if the clutch roll should be moved so as to disengage it from the gear wheel, *l*, and become engaged with the gear, *m*, the cam ring, *f*, would, through the medium of gear, *x*, with the reciprocating rack bar, *a'*, be reciprocated, as is necessary when heel and toe work is to be performed on the machine. The change in the movement of the cam ring is accomplished automatically, and this part of the invention will next be explained.

b' is a rock shaft, supported in a suitable bearing, and provided on its inner end with a forked extension, *c'*, having screws, *d'*, the inner ends of which extend into blocks placed in a groove, *e'*, of the clutch roll, *s*. The outer end of the shaft, *b'*, is provided with a downwardly extended lever or projection, *f'*, notched or grooved to receive the periphery of the disk, *g'*, fixed upon a shaft, *h'*, arranged to rotate in suitable bearings, as is best shown in Fig. 1. The disk, *g'*, is provided at a suitable point or points with a cam part, *i'*, which operates in the groove in the lower end of the lever, *f'*, to move the latter to one side and back again and so rock the shaft, *b'*, in its bearings and ship or "shog" the clutch roll, so as to effect a rotation or reciprocation of the cam ring, as may be necessary or desirable.

The wheel, *g'*, remains stationary during the leg and foot portions of the stocking, the lever, *f'*, at such times resting in the cam portion, *i'*. See Figs. 1, 2, and 17. This cam portion is of sufficient length to allow for the necessary motion of the machine in changing from one operation to another. During the leg portion of the stocking the lever, *f'*, rests in said

cam portion, and during the heel and toe portion of the stocking the lever, *f'*, is upon the straight portion of the heel, *g'*, and the clutch has been shifted, the clutch being shifted as the lever *f'*, is thrown into and out of the cam portion, *i'*, of the wheel, *g'*.

j', (Fig. 13,) designates a cam fixed upon the hub, *n*, of gear wheel, *h*; and, *k'*, designates a lever pivoted to the frame at its rear end and held up against the cam, *j'*, by a spring, *l'*.

Pivoted upon the forward end of the lever, *k'*, is a pawl, *m'*, held into engagement with the teeth of a ratchet wheel, *n'*, fast on shaft, *h'*, by means of a spring, *o'*. A spring, *n²*, bears upon the periphery of the wheel, *n'*, to steady the action of said wheel and check its movement beyond the point where it is moved by the action of the pawl, *m'*. As the driving shaft, *i*, is rotated the lever, *k'*, will be oscillated by means of the cam, *j*, and spring, *l'*, and consequently the ratchet wheel, *n'*, will be rotated to the extent of one tooth at each movement of the said lever, *k'*, until the pawl, *m'*, reaches a point, indicated at *p'*, where one tooth of the said ratchet wheel is mutilated or cut away, when the said pawl will cease to operate the said ratchet wheel until the latter is moved by other means to the extent at least of one tooth.

By the construction and arrangement described in other parts of the specification, the wheel, *n'*, remains stationary during the leg portion of the stocking or straight knitting, and only operates during the knitting of the heel and toe portion of the stocking.

q' designates a ratchet wheel arranged to turn loosely on the shaft, *h'*, and engaged by a spring-pressed pawl, *r'*, on the lower end of a lever, *s'*, the upper end of which lever is adapted to be engaged by a block or projection, *t'*, arranged on the lower face of the outer end of the rack bar, *a'*, as shown in Fig. 12, or extending from the side of the outer end of the said rack bar, as is shown in Figs. 1 and 2. The lever, *s'*, would have its upper end arranged opposite the bar, *a'*, in the construction shown in Figs. 1 and 2, and under the end of said bar in the construction shown in Fig. 12.

u' designates a sprocket wheel connected with the ratchet wheel, *q'*, so as to revolve therewith, over which sprocket wheel there is arranged a chain or belt, *v'*. (see Fig. 17,) having laterally projecting pins, *w'*, arranged so as to engage the radially projecting pins, *x'*, on the periphery of a disk, *y'*, connected with the ratchet wheel, *n'*, so as that when the disk, *y'*, is moved it may move the said ratchet wheel, *n'*. With this construction and arrangement of parts it will be seen that the ratchet wheel, *q'*, will be moved intermittently by the pawl, *r'*, but that the shaft, *h'*, will be rotated only when the pawl, *m'*, is permitted to engage the teeth of the ratchet wheel, *n'*, so that when the pawl, *m'*, reaches a point, *p'*, on the ratchet wheel, *n'*, the latter will not be moved until a

projecting pin, w' , on the chain or belt, v' , engages a radially projecting pin, x' , on the periphery of the disk, y' , so as to move the said disk and the ratchet wheel, n' , to enable the pawl, m' , to catch a tooth on the last-mentioned ratchet wheel.

The construction and arrangement of parts last hereinbefore described, it will be understood by those skilled in the art, is devised for the purpose of economizing diameter or extent of the ratchet wheel, n' , which moves the disk, g' , and controls the movement of the clutch roll and consequently the rotary and reciprocating movements of the cam ring f .

As has hereinbefore been indicated the cam ring is revolved to produce circular knitting in the knitting of half hose or stockings, and reciprocated to produce heel and toe work, and in the knitting of the latter work, substantially one half of the needles are first rendered inoperative, and then the remaining operative needles are gradually retired,—one by one holding the stitches formed thereon, to narrow, and then, one by one, brought into operation to widen and form a round or bulge toe or heel, and this part of the invention will next be described.

z' designates a ring provided with a flange, a^2 , the said ring being supported on the bed, a , and the said flange, a^2 , affording a support for the cam ring, f , and other parts of the machine, as will presently appear. In the present instance the web is held down so as to prevent its rising by the upward movement of the needles by means of web holders, b^2 , which also help to draw the stitch and which are supported in radial grooves in a bed, c^2 , suitably fastened to the needle cylinder, and are reciprocated by cams, d^2 , on the under face of the ring, e^2 . The needles, f^2 , are reciprocated in the grooves of the needle cylinder, e , by means of the cams, g^2 . These contrivances may be of common or suitable form and arrangement, and need not be further described. The grooves in the needle cylinder, in which needles which are thrown into and out of action, reciprocate, are constructed so that by moving the lower end or tail of the needle inward, the heel, h^2 , of the needle may be moved out of the path of the cams, g^2 . (See Fig. 4.) Any construction of the grooves in the needle-cylinder which will permit of this function will answer the purposes of my invention.

i^2 , j^2 , designate needle shifters, so called, which are adapted to be reciprocated in grooves formed in the upper face of flange, a^2 , the shifters, i^2 , being provided at their inner ends with notches or sockets in which the tails of the needles employed in widening and narrowing are adapted to move, and the shifters, j^2 , in like manner engaging at their inner ends the tails of the needles thrown out of action before beginning the knitting of heel and toe work.

k^2 designates a ring arranged in a groove, l^2 , formed in the upper face of the flange, a^2 ,

and fitting between a central heel, m^2 , and rear heel, n^2 , of the shifters, j^2 . The groove, l^2 , is sufficiently wide to permit the ring, k^2 , to be moved from side to side to an extent sufficient to move the needle shifters so as to disengage the needles connected therewith from and bring them into engagement with the needle-actuating cams. Pins, o^2 , o^4 extend up from opposite sides of the ring, k^2 , through slots, p^2 , formed in the flange of the cam ring, f . Ring, k^2 , is revolved with the cam ring, f , by means of the pins, o^2 , o^4 , in the slots, p^2 . The pin, o^2 , co-operates with the cams, n^2 , to slide the ring, k^2 , while the pin, o^4 , at the opposite side of the said ring from the pin, o^2 , operates the yarn attachment. Shown in detail in Figs. 14 to 16. Both pins are essential to make the ring travel steady. Attention is especially called to the location of these pins, the pin, o^4 , being at the opposite side of the ring from the pin, o^2 . This pin, o^4 , is adjacent to the knitting cams and yarn device, so that by this simple mechanism, when the ring is shifted the yarn can be changed or thickened.

The ring (k^2) is automatically slid to the left or to the right as the machine is represented in Fig. 8, in order to render operative or inoperative the instep needles which are controlled by the needle shifters between the points 2—2 during round-and-round work or back-and-forth work respectively. At the beginning of round-and-round work the pin (o^4) and its side of the ring (k^2) is moved to the left in Fig. 8, or to the right in Fig. 14; that is, away from the center of the cylinder and retained in such position by one of the raised points on the cam (n^2). See Fig. 7. The outward movement of the pin (o^4) operates the yarn changer to keep the thickening yarn (m^4) away from the needles so that it will not knit, as is shown in dotted lines in Fig. 14. The ring (k^2) being slid outward in the vicinity of the knitting cams (g^2), (the knitting cams (g^2), the yarn thickening device, and the pin (o^4) being substantially in the same radial line,) as the knitting cams (g^2) and the ring (k^2) rotate together the ring (k^2) pulls by means of the shifters the instep needles outward so that the heels (h^2) of these needles are in the path of said knitting cams. In Fig. 3 the cam cylinder and ring k^2 are shown as turned half way round from the position in Fig. 8. At the beginning of back-and-forth work, the cam (n^2) is shifted so that the ring (k^2) can be slid toward the right in Fig. 8 by means of the spring (o^2) forcing the pin (o^2) into one of the depressions in the cam (n^2). This operation moves the pin (o^4) and its portion of the ring inward. The inward movement of the pin (o^4) permits the arm of the yarn changing device to assume the full line position shown in Fig. 14 to permit the extra yarn to be knitted, the ring (k^2) in the vicinity of the knitting cams (g^2) being also forced inward and retained in this position by the spring (o^2). See Fig. 21. During back-

and-forth work, as the knitting cams (g^2) and the ring revolve together, the ring (k^2) forces the needle shifters of the instep needles inward, and hence the heels (h^2) of said needles will be forced inward out of the path of the knitting cams (g^2).

I do not confine myself to the form of needle shifters shown, nor to the precise form of means illustrated for actuating the same, since it is obvious that these things may be greatly varied within the limits of mechanical skill without departing from the nature or spirit of my invention. For example, the shifters may be made in the form shown in Fig. 3^a, and both of the shifters, i^2 , and j^2 , may be made with a single heel instead of forming the shifters, j^2 , with double heels, and instead of operating the shifters j^2 by a ring between two heels as hereinbefore described, the ring, k^2 , may have a groove formed in its lower side into which the heels of the shifters, j^2 , may extend, as shown in Fig. 3^b. When the shifters are thus operated, they may have but a single heel. Again the slides, q^2 , may be made solid, and have what is called an offset formed thereon and work shifters provided with double heels instead of having a groove formed in the slides, and engaging a single heel of the shifters.

q^2 designates slides arranged in the grooves, r^2 , formed in the upper surface of the flange, a^2 , and at substantially opposite sides of the machine. The said slides are provided with tails, s^2 , against which the butts, t^2 , of the shifters, i^2 , rest when the needles controlled by the said shifters are in action. The slides are also provided with the inclined and concentric slot, u^2 , so constructed and arranged as that when the slides are moved in the direction of the arrow marked thereon, the heels of the shifters, i^2 , will move down the inclined part into the concentric part of the groove, u^2 , and move the said shifters inward, and the needles controlled thereby also inward out of the path of the needle operating cams, and consequently out of action.

v^2 designates segmental slides provided with notches on their edges and arranged in a groove, w^2 , formed in the lower face of the flange, a^2 . The said segmental slides v^2 are placed below the slides, q^2 , and are connected therewith by screws, x^2 , extending up through slots, y^2 . (See dotted lines Fig. 8.)

The shifters, i^2 , engage and control the needles between the points, 2 3 (Fig. 8).

z^2 (Fig. 11) designates a cam disk or flange connected with the ratchet wheel, n' , and provided with two cams or swells, a^3 ; and, b^3 , designates one arm of an angular lever fulcrumed at c^3 , the free end of the said arm, b^3 , resting upon the disk or flange, z^2 , and in the path of travel of the cams, a^3 . The other arm, d^3 , of the said angular lever extends up almost vertically and is pivoted at its upper end to a spring-pressed rod e^3 , the free end of which is beveled and arranged so that it may be thrust under a pin, f^3 , arranged in

a bearing, g^3 , and raise the said pin. The free end of the lever, b^3 , rests between these cams, a^3 , while the shaft, h' , is stationary; that is, during the leg portion of the stocking. The first one of these cams operates to throw the lever, h^3 , through the medium of the lever, d^3 , to shift the ring, k^2 , at the beginning of the reciprocatory motion of the machine, while the other cam, a^3 , moves the said parts to turn the cam, n^3 , so that the pin, o^2 , is engaged by one of the raised portions on said cam, n^3 , to turn the cam (n^3) at the beginning of back-and-forth work so that the spring (o^3), see Fig. 21, can force the pin (o^2) into one of the depressions in said cam (n^3), while the other cam (a^3) moves the said parts to turn the cam (n^3) so that one of its raised points shall strike the pin (o^2) and force the ring (k^2) against the tension of the spring (o^3) into position for round-and-round work.

The pin, f^3 , extends upward, and when raised is in position to strike (when the cam ring is revolved) the outer end of a lever, h^3 , pivoted upon a stud, i^3 , on cam ring g ; and move the said lever to one side against the stress of the spring, j^3 , which, after the pin f^3 , has passed, returns the said lever to its normal position against the stop pin, k^3 . Upon the stud, i^3 , beneath the lever, h^3 , is pivoted a ratchet wheel, l^3 , provided on its periphery with eight teeth which are engaged by a pawl, m^3 , pivoted upon the under side of the lever, h^3 , the construction and arrangement being such as that when the said lever is moved to one side by the pin, f^3 , the ratchet wheel will be moved to the extent of one tooth.

n^3 designates a cam connected to the ratchet wheel, l^3 , and provided upon its periphery with four raised points or surfaces and four depressed points, as is clearly shown in the bottom plan detail, Fig. 7. The pin (o^2) extends up through the slot (p^2) of the cam ring in substantially the same radial line as that in which the cam (n^3) is located, and in operative proximity to said cam, and the position of the parts is such that the raised part of said cam is adapted to engage the said pin and move it and the ring (k^2) at this point inward or to the left in Fig. 8, and when the cam (n^3) is again moved through the medium of ratchet-wheel (l^3), pawl (m^3) and lever (h^3), the said pin will be moved outward or to the right in Fig. 8, by a spring (o^3), Fig. 21, into one of the depressed parts of the cam (n^3) and the ring (k^2) will consequently be moved to the right, Fig. 8. In this way the needles controlled by the shifters, j^2 , will be thrown out of, and brought into action, as has been described, as is necessary in the work of knitting heels and toes for stockings.

Upon the side of the ratchet wheel, n' , are arranged the cams, p^3 , one of which is adapted to raise and the other to lower the free end of a lever, q^3 , resting thereon.

A rod, r^3 , (see Fig. 18), extends up from the free end of lever, q^3 , beneath and in contact with a lever, s^3 , which latter lever is held

down upon the rod, r^3 , by a spring l' . To the lever, s^3 , there is connected a block, t^3 , the outer end of which is beveled and adapted when the block is raised to engage a pin, u^3 , projecting laterally from the pivoted block, v^3 , on the end of rack bar, a' , and raise the latter. The spring, l' holds the lever, s^3 , down against the rod, r^3 , and presses the arm, q^3 , down against the action of the cams, p^3 .

The other end of the spring is attached to the lever, k' , and serves to raise the latter after it has been depressed by the cam, j' . See Fig. 18.

w^3 is a bar arranged to have a limited sliding motion on suitable bearings as (w^{10}), see Fig. 1, on the bed of the machine, and over the bar (a'), and is connected to said bearings by a screw (w^{12}) extending through the slot (w^{11}) in the bar (w^3) and into said bearings so that when the block (v^3) is raised and the rack bar is reciprocated, the said block will strike one end of the bar, w^3 , and move it longitudinally in the direction of the arrow marked on the bar in Fig. 8, and the block, x^3 , on the other end of the rack bar, a' , will strike the other end of the bar, w^3 , and move it back in a direction opposite that indicated by the arrow, and in this way reciprocate the last mentioned bar intermittently.

The bar w^3 is pivoted to one end of a lever y^3 pivoted at y^{10} the opposite end of which lever is pivoted at a bar z^3 , pivoted at its ends to angular levers a^4 pivoted at a^{10} . In the present instance the angular levers are shown as composed of two parts, though this form is a convenience and not a necessity.

The inner free ends of the angular levers a^4 are each provided with a double pawl b^4 having inclined faces on its outer side against which one side or the other of a spring pressed angular cam c^4 is adapted to bear to hold one part or the other of the double pawl in contact with the adjacent segmental slide v^3 with the teeth or notches formed in the outer edge of which the pawls are adapted to engage. It will now be seen that if the slides q^2 and v^3 should be in the position in which they are represented in Fig. 8, and the member of each double pawl on the left side of Fig. 8 should be engaged with the segmental slides v^3 , and the angular levers a^4 should be oscillated through the medium of bars z^3 , w^3 and lever y^3 , the slides q^2 would be moved intermittently in the direction of the arrows marked thereon, that is, to the left and the heels of the shifters i^2 would be engaged by the inclined portion t^{22} of the slot and carried into the concentric portion of said slot, throwing the needles controlled by the said shifters out of action, and if the member of each double pawl on the right side of Fig. 8 should be engaged with the segmental slides v^3 , an opposite movement of the slides q^2 would be effected that is to the right bringing the needles controlled by the shifters i^2 back into operation.

The gradual retirement of the needles con-

trolled by the shifters i^2 , and the bringing of the said needles in like manner into operation, after the needles controlled by the shifters j^2 have been thrown out of action, is necessary in the production of heel and toe work, as will be understood by those skilled in the art without further description, and is accomplished by my improvements in the manner explained.

I have provided means for automatically shifting the double pawls at each end of the segmental slides v^3 , the said means consisting of a block d^4 having projections e^4 f^4 extending the one over one of the double pawls and the other one over the other of the said pawls, the said block being secured to the pawls. The prong e^4 is cut away on its upper face, and the prong f^4 is similarly cut away on its under face, so that the two prongs extend in different planes. g^4 h^4 are dogs secured to the ends of the segmental slides, the former extending in a plane coincident with the plane of prong f^4 and the latter in the same plane with the prong e^4 , so that as the slides t^3 v^3 are moved in the direction of the arrow, the dog h^4 will engage the prong e^4 , shift the position of the double pawl, and reverse the movement of the slides, until the dog g^4 engages the prong f^4 when the pawls will be moved back to their first position and the slides will be operated as before.

It will be understood that the various parts are so positioned and timed as to effect the various movements and changes in proper order and time.

My invention also comprehends the introduction of an additional or thickening thread at the heels and toes of stockings, and this is accomplished by moving a yarn carrier carrying the thickening thread into and out of action with the needles at the proper time, and this mechanism is particularly shown in Figs. 14, 15, and 16.

i^4 designates the yarn guide provided with the eye j^4 from which the yarns are directly delivered to the hooks of the needles. k^4 is the regular knitting yarn which passes down through the hole l^4 in the guide i^4 and cut through the eye j^4 to the needles.

l^{44} in Fig. 15 is a hole in the arm, n^4 , for the additional yarn, m^4 . The regular yarn, k^4 , passes through the slot in the arm, n^4 .

m^4 is the thickening yarn which passes down through the hole l^{44} in the end of the carrier n^4 , and when the latter is in the full line position (Fig. 14) out through the eye j^4 to the needles.

The carrier n^4 is constructed as an angular lever pivoted at its angular point, as at o^{44} , upon the upper end of a bracket p^4 secured on the horizontal part of the cam-ring, f . The end of the outer arm of the carrier n^4 is pressed by means of a spring p^5 against the upper end of an angular lever q^5 fulcrumed at r^4 on a bracket s^4 . The pin (o^4) of the ring (k^2) is arranged to be brought to bear against the lower arm (t^4) of lever (q^4) when

said ring is shogged or moved to the left in Fig. 8, to throw the needles controlled by the said ring and its connecting shifters into action; that is, during round-and-round work, and so move the lever (q^5) and the yarn carrier (n^4) to the dotted line position in Fig. 14, pressing the extra or thickening yarn in toward the center of the cylinder and out of action, and when the ring (k^2) is moved back by means of the spring (o^3) to its position for back-and-forth work, the yarn-carrier (n^4) will be actuated by the spring bearing thereon to carry its yarn into position to be knit, as shown in full lines, the regular yarn, of course, continuing in action in back-and-forth as well as in round-and-round work.

In respect to the wheels, n' and g' , mounted upon the shaft, h' and the cams on said wheels, it is to be observed that this shaft is stationary during the straight knitting, and only rotates during the heel and toe work. During the straight knitting, the lever, f' , is in the cam-portion, i' , on the wheel, g' , the lever-arm, b^3 , is between the cam-swells, a^3 , and the lever, q^3 , is between the cams, p^3 , on said wheel, n' . As shown in the drawings, there is a considerable space between the members of each set of cams; that is to say, between the cams, p^3 p^3 , and between the cams, a^3 a^3 , and that the cam-portion, i' , has a similar distance between the two inclines of said cam. During straight knitting the ends of these three several levers lie between their respective cams. At the beginning of the heel and toe work, the shaft, h , rotates by mechanism already described, the wheels, g' and n' , also rotate, the first cam in each one of the three sets strikes its respective lever and raises it in the case of q^3 and p^3 , and in the case of f' , shifts it. The wheels, n' and g' , continue their rotation, the peripheries of said wheels bearing against their respective levers until almost an entire revolution of said wheels has been made, when the other cams, p^3 and a^3 and the second portion of the cam, i' , operate the levers; in the case of i' to shift the clutch; in the case of b^3 to shift the ring; in the case of q^3 to lower the lever s^3 . A sufficient space is provided between the members of each of these several sets of cams to allow for the movement of the machinery in changing from rotary to reciprocatory motion, and vice versa.

Having thus explained the nature of the invention and described a way of constructing and using the same, though without attempting to set forth all of the forms in which it may be made, or all of the modes of its use, it is declared that what is claimed is—

1. A knitting machine embracing in its construction a needle cylinder provided with deepened grooves, needles provided with extended tails in said grooves, a grooved needle-shifter bed, needle shifters arranged to slide in the grooves of the said bed and engaging the tails of certain of the needles to move the latter in their grooves, and the slides engag-

ing the needle shifters to actuate the same, notched segmental plates connected to said slides, the bar w^3 , levers a^4 having double pawls engaging said plates, and connections between the said bar and levers, whereby the needles may be gradually retired and brought into operation to narrow and widen, as set forth.

2. A knitting machine embracing in its construction a needle cylinder, provided with deepened grooves, needles provided with extended tails in the said grooves, a grooved bed, a^2 , needle shifters, j^2 , engaging the tails of certain of the needles and a ring, k^2 , adapted to be moved horizontally engaging the said shifters, whereby a predetermined number of needles may be rendered inoperative in the knitting of heel and toe work, as set forth.

3. A knitting machine embracing in its construction a needle cylinder provided with deepened grooves, needles provided with extended tails in the said grooves, a grooved bed, a^2 , needle shifters, j^2 , engaging the tails of certain of the needles to move the latter in their grooves and the slides, q^2 , engaging the needle shifters to actuate the same, combined with the needle shifters, j^2 , engaging certain other of the needles, and a movable ring, k^2 , engaging the said needle shifters, j^2 , and means for actuating the said ring and said slides, q^2 , whereby a portion of the needles may be rendered inoperative, and the remaining needles gradually retired and brought into operation to narrow and widen, as set forth.

4. A knitting machine comprising in its construction a needle cylinder provided with deepened needle grooves, the needles therein, the ring or cylinder, z' , provided with the slotted and grooved flange bed, a^2 , the needle shifters, j^2 , in the grooves of the flange bed engaging the needles, the slotted slides, q^2 , on the upper face of the flange bed to engage the needle shifters, the segmental slides, v^2 , on the under face of the flange bed, pins, x^2 , extending through slots of the flange bed connecting the slides, q^2 , and v^2 , and means to actuate the slides, v^2 , as set forth.

5. The needle cylinder and needles, and cam ring, combined with the needle shifters, j^2 , and the ring, k^2 , engaging the said shifters, said ring being adapted to be moved laterally so as to be eccentric or concentric with the needle cylinder, as set forth.

6. The needle cylinder and needles, the cam ring, and needle shifters, j^2 , provided with the heels, m^2 n^2 , combined with the laterally movable ring, k^2 , arranged between the said heels, whereby by the movement of the said ring, the needle shifters may be moved, as set forth.

7. The needle cylinder and needles, and the needle shifters, j^2 , combined with the ring, k^2 , engaging the said shifters, the flanged cam ring or bed provided with a slot pin, o^2 , connected with the said ring and extending through the said slot, lever, h^3 , the ratchet wheel, l^3 , a pawl connected with lever, h^3 , to

actuate the ratchet wheel, a cam, n^3 , connected with the ratchet wheel and adapted to act on the pin, o^3 , to move it in one direction, a spring to move it in the opposite direction, and means to actuate the lever, as set forth.

8. The needle cylinder and needles, the cam ring, and the slotted flanged bed, a^2 , combined with the needle shifters, i^2 , the slides, q^2 , provided with the slots, u^2 , to engage the heels of the shifters, the notched segmental slides, v^2 , means extending through the slots of the flanged bed connecting the slides, and means for actuating the slides, v^2 , as set forth.

9. A knitting machine adapted for knitting heel-and-toe work comprising in its construction a needle cylinder and needles and cam ring, slotted slides (q^2) for rendering the narrowing needles operative and inoperative, a rack bar, a' , and connections with the cam ring for reciprocating the latter, and connections between the rack bar and slotted slides (q^2) for rendering the narrowing needles operative and inoperative, whereby the said slotted slides (q^2) may be actuated and controlled by the rack bar in exact time with the reciprocating movements of the cam ring, as set forth.

10. Means for introducing a thickening yarn consisting of the combination, with the cam ring, of the open-eye yarn guide, a pivoted yarn carrier, spring, p^5 , the shifting ring, k^2 , and pin, o^4 , operatively connected with the pivoted yarn carrier as set forth.

11. Means for introducing a thickening yarn consisting of the combination, with the cam ring, of the open-eye yarn guide, a pivoted yarn carrier constructed as an angle-lever, the spring (p^5), a lever for operating upon one arm of the said angle-lever, the shifting ring, k^2 , and pin, o^4 , for acting upon the last-mentioned lever as set forth.

12. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams and complementary stitch-forming mechanism, a laterally sliding ring, connections between the instep needles and said ring, and automatic means connected therewith for sliding said ring to throw the instep needles into and out of operation as set forth.

13. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams and complementary stitch-forming mechanism, a yarn device, a laterally sliding ring, connections between the instep needles and said ring and between the yarn device and said ring, and automatic means connected therewith for sliding said ring to throw the instep needles into and out of operation and to operate said yarn device as set forth.

14. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams, and complementary stitch-forming mechanism, a yarn device, a sliding ring, connections between the instep

needles and said ring automatic means connected with one side of said ring for sliding the latter, and means connected with the opposite side of said ring arranged to operate the yarn device upon the sliding of said ring as set forth.

15. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams and complementary stitch-forming mechanism, a yarn device, a sliding ring to control said yarn device and the instep needles, connections between the instep needles and said ring and between the yarn device and said ring, slotted slides to control the narrowing needles, a reciprocating bar a' , devices between said bar and ring for actuating and controlling said slides and ring as set forth.

16. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams, and complementary stitch-forming mechanism, a yarn device, a sliding ring to control said yarn device and the instep needles, connections between the instep needles and said ring and between the yarn device and said ring, slotted slides to control the narrowing needles, means including a clutch mechanism and the bar a' for changing the motion of the machine from rotary to reciprocatory and vice versa, and devices between said bar and slides and ring and clutch in virtue of which said bar controls and times said slides and ring and clutch.

17. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams, and complementary stitch-forming mechanism, a yarn device, a horizontally sliding ring arranged to throw the instep needles into and out of operation and to operate the yarn device, connections between the instep needles and said ring and between the yarn device and said ring oscillatory slides for throwing the narrowing needles into and out of operation, a main driving shaft, means including a clutch mechanism and the bar a' for changing the motion of the machine from rotary to reciprocatory and vice versa and devices between said bar and ring and between said bar and clutch in virtue of which said ring is shifted before the motion of the knitting cams is changed from rotary to reciprocatory and vice versa.

18. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams, and complementary stitch-forming mechanism, a horizontally sliding ring arranged to throw the instep needles into and out of operation, connections between the instep needles and said ring, oscillatory slides for throwing the narrowing needles into and out of operation, means including a clutch mechanism and the bar a' for changing the motion of the machine from rotary to reciprocatory, and vice versa, and devices between said bar and ring, and between said bar and clutch, and between said bar and slides in virtue of which said ring is shifted

before the motion of the knitting cams is changed from rotary to reciprocatory and vice versa, and before said slides are put into operation.

5 19. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams and complemental stitch-forming mechanism, an automatically operated laterally movable ring arranged to
10 throw the instep needles into and out of operation, and connections between the instep needles and said ring as set forth.

20. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams and complemental
15 stitch-forming mechanism, needle shifters, an automatically operated laterally movable ring, and suitable connections between said shifters and said ring as set forth.

20 21. In an automatic circular knitting machine, in combination, a needle cylinder, knitting needles, knitting cams and complemental stitch-forming mechanism, needle shifters
25 connected to the instep and narrowing needles, an automatically operated laterally movable ring and oscillatory slides arranged to engage the shifters upon the instep and narrowing and widening needles, respectively, a
30 main driving shaft, a reciprocatory bar and devices between said shaft and bar and between said bar and ring and between said bar and slides, in virtue of which said ring and slides are actuated and controlled from said bar.

22. In an automatic circular knitting machine, in combination, an open-eye yarn guide, a pivoted yarn-carrier, a laterally movable ring and automatic means for moving said ring, and connections between said ring and carrier as set forth. 35 40

23. In a knitting machine, in combination, a main driving shaft (*i*), a pulley loose on said shaft, a gear (*l*) also loose on said shaft and connected with the pulley, a gear (*m*) loose on the shaft, a collar (*o*) fast on said shaft
45 adjacent to the gear (*m*), a clutch roll between the gear (*l*) and collar (*o*), a rack-bar (*a'*) engaging the gear (*m*), and gearing intermediate of the gear (*l*) and the rack-bar, substantially as and for the purpose described as
50 set forth.

24. In a knitting machine, in combination, a main driving shaft, a sliding clutch part on said shaft, a rock-shaft (*b'*) having means arranged to engage said clutch part, the cam-
55 wheel (*q'*), the gears (*l*) and (*m*), the rack bar (*a'*), and actuating devices between said bar and gear *l* and between said bar and cam wheel.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 31st day of March, A. D. 1894. 60

WALTER H. STEWART.

Witnesses:

F. N. PARSONS,
MARGARET A. DEVINEY.