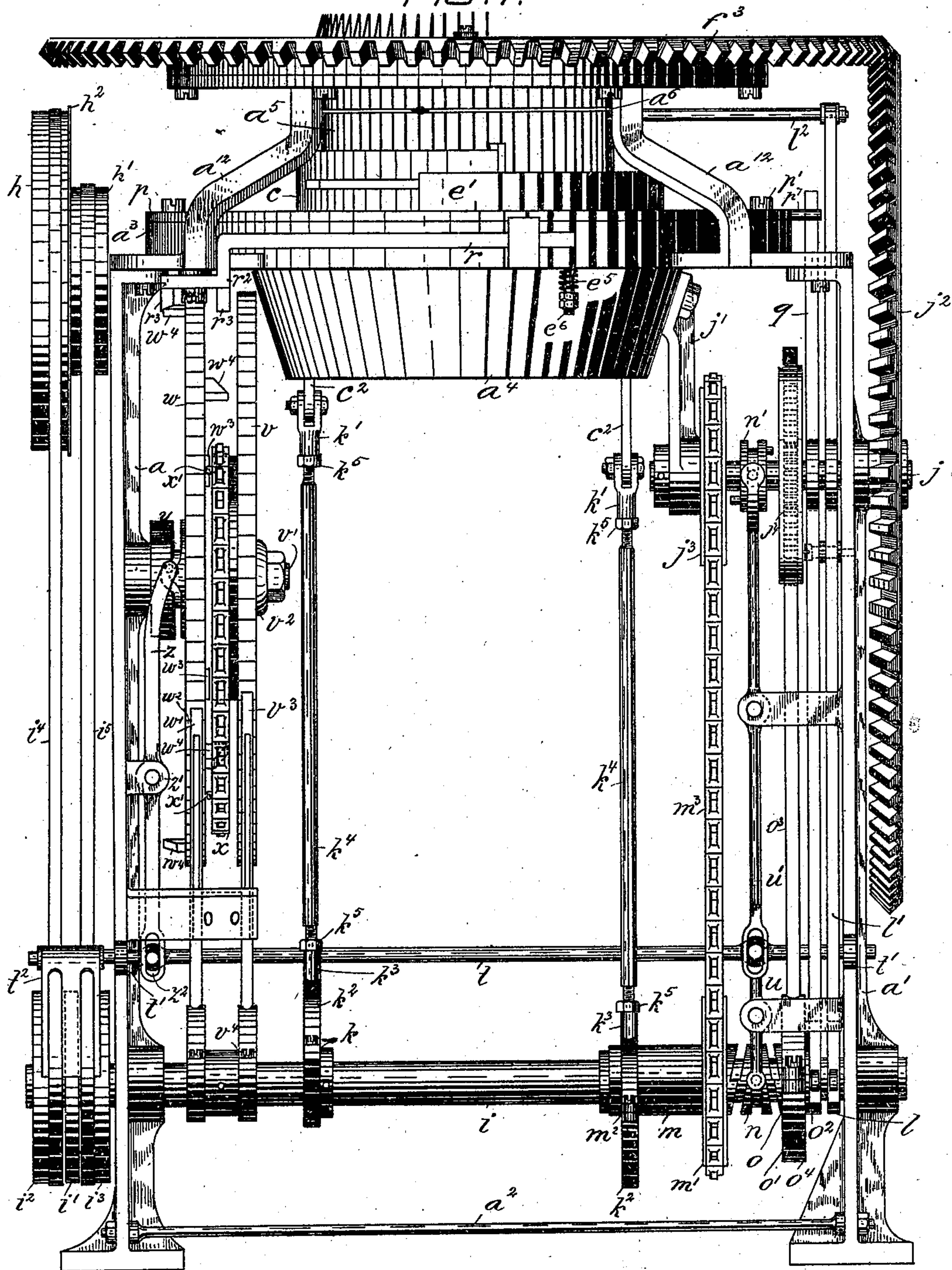


4 Sheets—Sheet 1.

No. 502,292.

Patented Aug. 1, 1893.

FIG. 1.



John H. Acharde
Thomas M. Smith.

Emil J. Franck.

BY J. Walter Douglass.
ATT'Y.

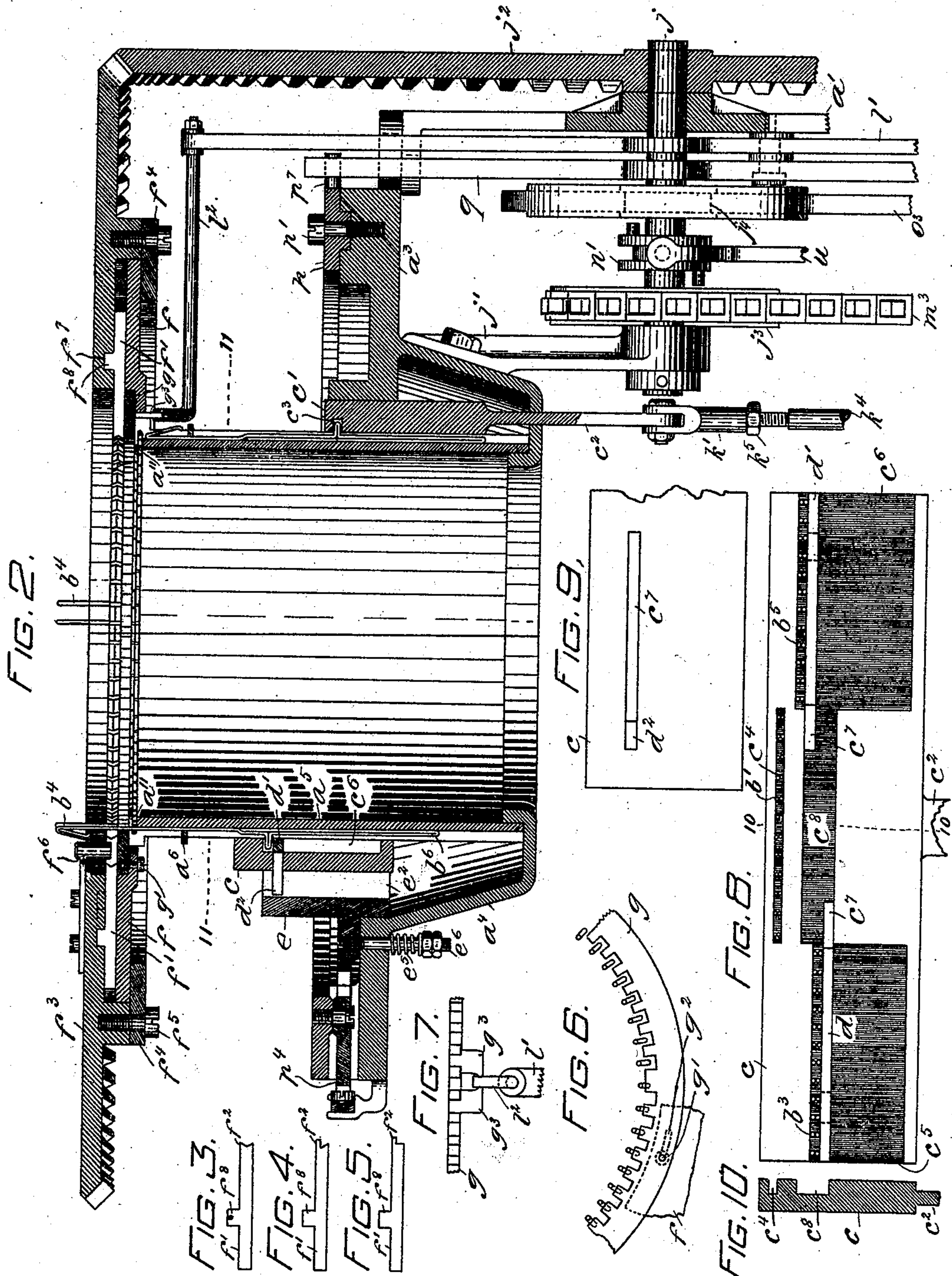
(No Model.)

4 Sheets—Sheet 2.


E. J. FRANCK.
CIRCULAR KNITTING MACHINE.

No. 502,292.

Patented Aug. 1, 1893.



WITNESSES:
John W. Richard
Thomas M. Smith.

INVENTOR:
Emil J. Frauck,
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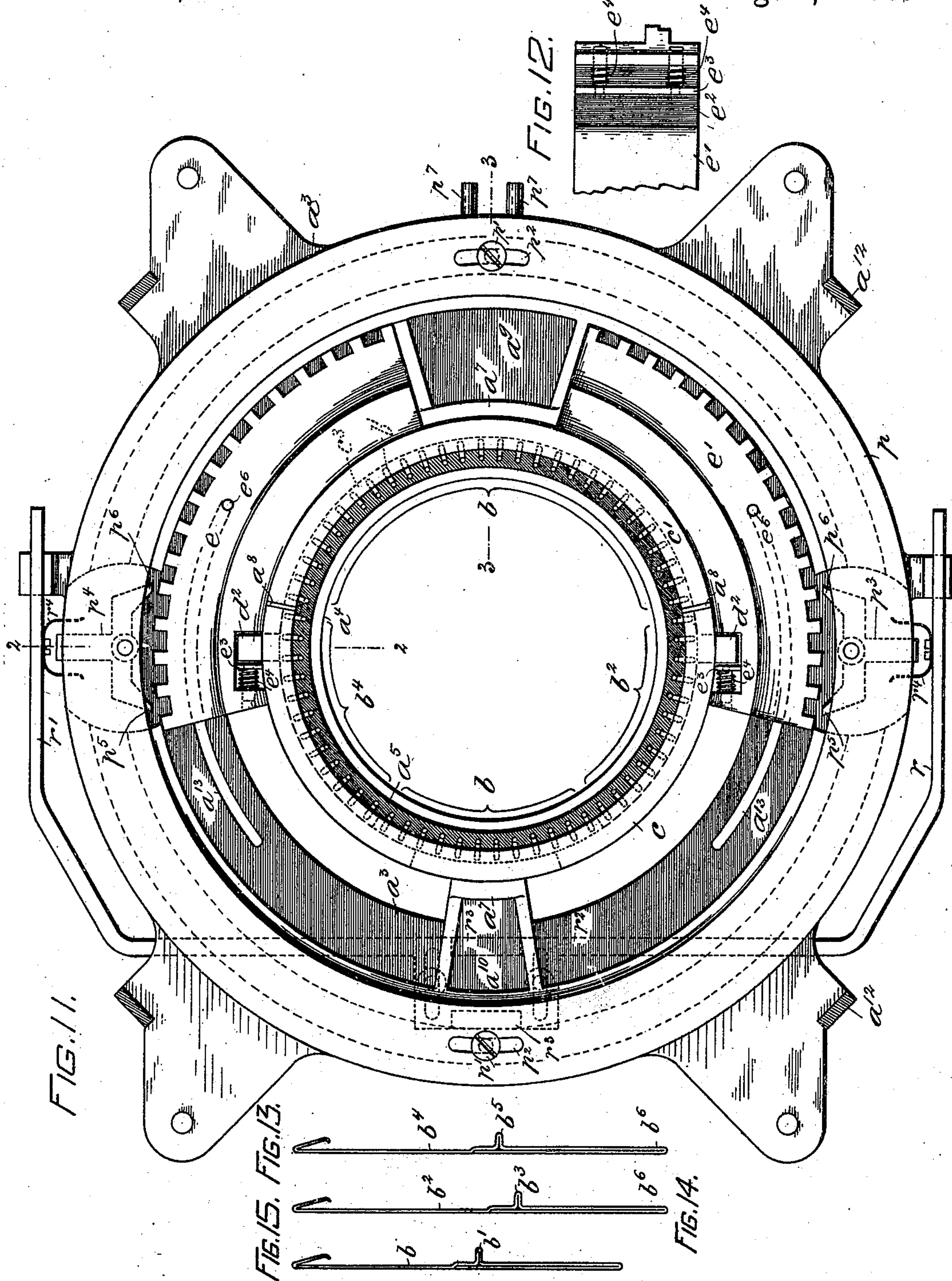
(No Model.)

4 Sheets—Sheet 3.

E. J. FRANCK.
CIRCULAR KNITTING MACHINE.

No. 502,292.

Patented Aug. 1, 1893.



WITNESSES:

John W. Acharo,
Thomas M. Smith.

INVENTOR:

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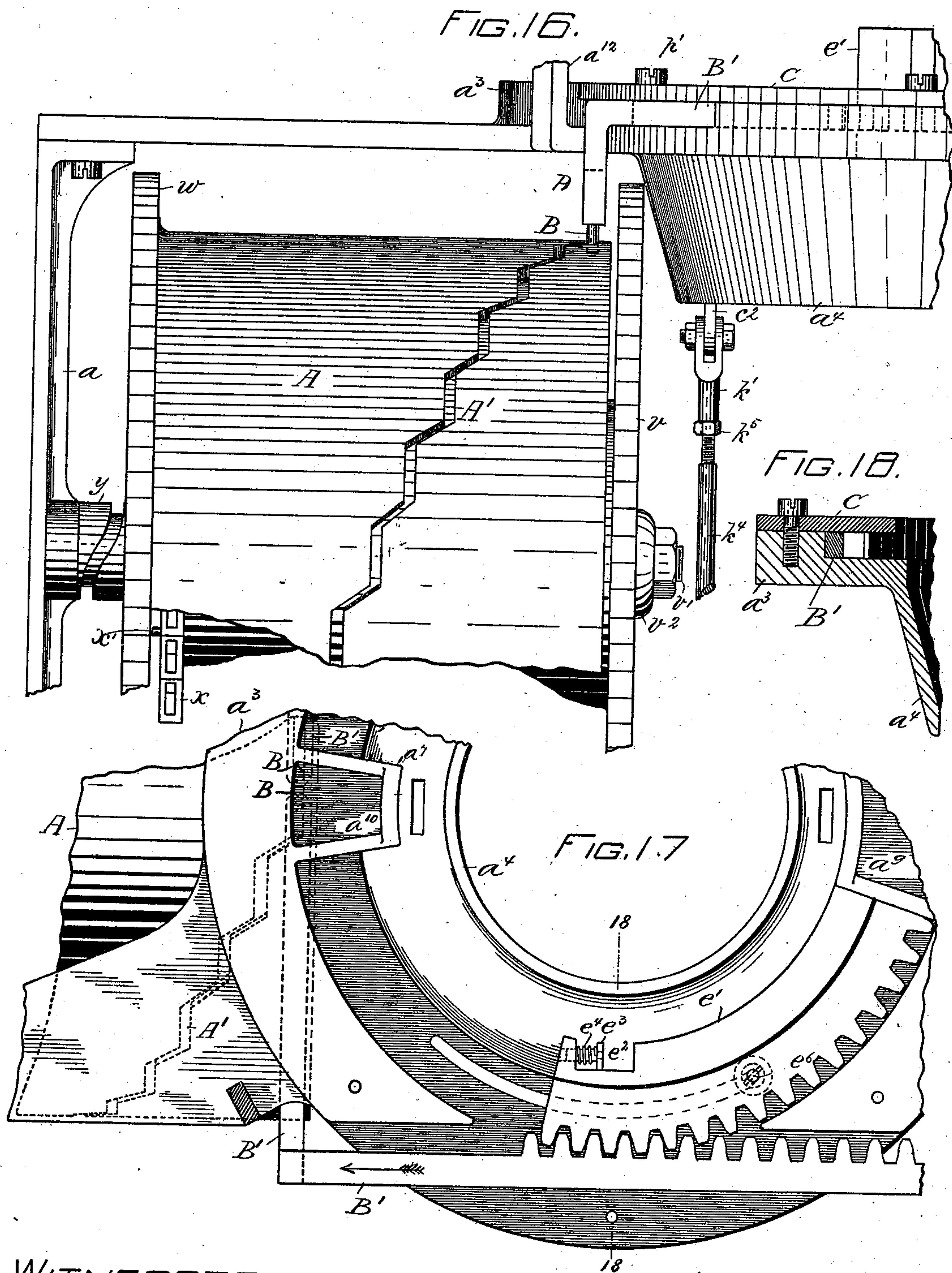
(No Model.)

4 Sheets—Sheet 4

E. J. FRANCK.
CIRCULAR KNITTING MACHINE.

No. 502,292.

Patented Aug. 1, 1893.



WITNESSES:

John W. Achard.
Thomas M. Smith.

INVENTOR:

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BY J. Walter Douglas.

ATTY.

UNITED STATES PATENT OFFICE.

EMIL J. FRANCK, OF PHILADELPHIA, PENNSYLVANIA.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 502,292, dated August 1, 1893.

Application filed November 22, 1892. Serial No. 452,765. (No model.)

To all whom it may concern:

Be it known that I, EMIL J. FRANCK, a citizen of the United States, residing at the city of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Circular-Knitting Machines, of which the following is a specification.

My invention relates to the knitting machine forming the subject matter of an application for Letters Patent of the United States, Serial No. 441,059, filed July 23, 1892.

The principal objects of my present invention are first, to provide a simple, efficient and comparatively inexpensive knitting machine in which groups of needles are alternately elevated and depressed in the grooves of a fixed needle bed by means of plates reciprocated in the direction of the length of the needles; second, to provide means for automatically closing the beards of the needles of each group as they are depressed by the downward stroke of their complemental plate and for permitting the beards of the needles of each group to open as they are elevated by the upward movement of their complemental plate; third, to provide efficient sinker bars for slackening the thread or yarn between each two of the needles of a group as they are elevated and for holding the yarn in such position against accidental displacement until it is positively drawn off the sinker-bars by the descent of the group of needles; fourth, to provide efficient devices for connecting and disconnecting certain of the needles, to-wit:—the fashioning needles, to and from their complemental reciprocating plate in order to effect the required narrowing or widening of the fabric; and fifth, to provide, simple, effective and comparatively inexpensive mechanism for feeding or operating the devices that throw the fashioning needles out of and into action.

My invention comprises a knitting machine provided with needles movable in respect to their support and with reciprocating plates alternately movable for operating said needles.

My invention further comprises a knitting machine provided with needles, members reciprocated in the direction of the length of the needles and elevating and depressing

groups thereof, and an oscillating ring provided with teeth for closing the beards of each group of needles as they descend and with spaces for accommodating the beards of each group of needles as they ascend.

My invention further comprises a knitting machine provided with needles, members reciprocated in the direction of the length of said needles and operating the same in groups, a thread or yarn carrier for laying the thread or yarn onto each group of needles as they approach and recede from their highest positions, sinker bars provided with notched extremities for holding bights of the thread or yarn between the needles of each group until the bights are positively drawn down by the descent of the group of needles and means for operating the sinker bars.

My invention further comprises a knitting machine provided with needles movable in respect to their support, a reciprocating plate for operating a group of said needles and devices for disconnecting and connecting certain of the needles of the group from and to the oscillating plate to permit of the narrowing and widening of the fabric.

My invention further comprises a knitting machine provided with needles, a plate reciprocated in the direction of the length of the needles and adapted to operate a group thereof, devices for disconnecting and connecting certain of the needles of the group from and to the plate, a rod provided with teeth meshing with teeth on said devices, and means for operating said rod in opposite directions; and my invention further comprises the improvements in knitting machines hereinafter fully described and more particularly designated in the claims.

The nature, characteristic features and scope of my invention will be more fully understood from the following description taken in connection with the accompanying drawings forming part hereof; and in which—

Figure 1, is a side view of a knitting machine embodying features of my invention and illustrating the parts thereof about to be shifted into position for fabricating round or tubular work. Fig. 2, is a sectional view showing at the left hand side thereof a section on the line 2—2 of Fig. 11, and showing at the right hand side thereof a section on

the line 3—3 of Fig. 11, said sections being turned into the plane of the paper for the purpose of illustration. Figs. 3, 4 and 5, are views of sinker-bars provided at one of the respective extremities thereof with notches for holding bights or loops of thread or yarn against accidental displacement between the needles. Fig. 6, is a plan view illustrating a fragment of an oscillating ring provided with teeth for closing the beards of a descending group of needles as shown at the left hand side of said figure and with spaces for permitting the beards of an ascending group of needles to open as shown at the right hand side of said figure. Fig. 7, is an inside elevation illustrating a portion of a bar provided with an arm for oscillating the ring shown in Fig. 6. Fig. 8, is a development of the interior of the reciprocating plate illustrated at the left hand side of Fig. 11, showing recesses for the accommodation of two sets of fashioning needles, the heel needles, and also of movable keys for detachably connecting the fashioning needles and reciprocating plate. Fig. 9, is a similar view of the exterior of the right hand portion of the plate illustrated in Fig. 8, showing a slot through which the shank of the key projects. Fig. 10, is a sectional view taken on the line 10—10 of Fig. 8. Fig. 11, is a sectional plan view taken on the line 11—11 of Fig. 2. Fig. 12, is a view of a portion of one of the toothed travelers showing an elevation of a yielding plate for engaging the shank of one of the keys. Fig. 13, is a side view of one of the needles comprising one set of fashioning needles and adapted to engage the recess or cavity in the plate shown at the right hand side of Fig. 8. Fig. 14, is a side view of one of the needles comprising the other set of fashioning needles, adapted to engage the recess or cavity in the plate shown at the left hand side of Fig. 8. Fig. 15, is a side view of one of the instep and heel needles. Fig. 16, is a side view of portions of a knitting machine and illustrating feed mechanism embodying features of my invention and adapted to operate the devices that serve to throw the fashioning needles out of and into action. Fig. 17, is a top or plan view of portions of the feed mechanism illustrated in Fig. 16; and Fig. 18, is a sectional view taken on the line 18—18 of Fig. 17.

In the drawings, the standards a and a' , tie-rods a^2 , and bed plate a^3 , constitute the main frame of the machine. The bed-plate a^3 , is provided with a circular depending flange or rim a^4 , to which is attached a needle cylinder or support a^5 , provided with axial grooves in which the needles are afforded freedom of endwise play or movement. The needles may be provided with spring beards as shown or with latches. The heel and instep needles b , Fig. 15, are provided with bits or hubs b' , located comparatively near the beards thereof. One set of fashioning needles b^2 , Fig. 14, is provided with bits b^3 , located comparatively far from the beards thereof, and the other set

of fashioning needles b^4 , Fig. 13, is provided with bits b^5 , located intermediate of the bits or hubs of the heel and instep needles b , and of the bits of the first set of fashioning needles b^2 , so that when the tops of the needles are in alignment the bits of the instep and heel needles b , are in the highest plane, the bits of one set of fashioning needles b^2 , are in the lowest plane, and the bits of the other set of fashioning needles b^4 , are in a plane intermediate of the other two planes. All of these needles are prevented from falling out of the grooves of the needle cylinder a^5 , by means of a sectional ring a^6 , fitted into a peripheral notch in the needle cylinder or support a^5 , and the fashioning needles b^2 and b^4 , are provided with long shanks b^6 , adapted to rest upon the flange a^4 , when the fashioning needles have been thrown out of action in a manner to be presently described.

c and c' , are plates held up against the face of the needle cylinder or support a^5 , by means of projections a^7 , and constrained to move in the direction of the length of the needles *i. e.* upward and downward, by means of feathers a^8 , projecting radially from the needle cylinder or support a^5 . These plates c and c' , are provided each with a lug c^2 , working in suitable apertures in the flange a^4 , and are alternately moved up and down through the instrumentality of suitable mechanism of which one type is hereinafter described. One of these plates c' , is shorter than the other, Fig. 11, to permit of the employment of a less number of instep than of heel and fashioning needles, whereby a comparatively large full heel is obtained, and this short plate c' , is provided at the upper portion of its inner face, Fig. 2, with a recess c^3 , into which the bits b' , of the instep needles are fitted. The other *i. e.* the longer plate c , Fig. 8, is provided at the center portion of its inner face with a recess c^4 , Fig. 10, disposed in alignment with the recess c^3 , of the plate c' , and adapted for the reception of the heel needles. The plate c , is provided upon opposite sides of the recess c^4 , with cavities c^5 and c^6 , adapted to accommodate the bits of the fashioning needles in such manner that the plate c , may be reciprocated up and down without moving the fashioning needles.

d and d' , are keys adapted to be passed under the bits of the fashioning needles in order to lock them to place in contact with the upper walls of the chambers c^5 and c^6 , whereby the fashioning needles are caused to move with the plate c . These keys d and d' , are provided respectively with shanks d^2 , that work in and extend through slots c^7 , in the plate c . These keys d and d' , are located in different planes and may be shifted by means of their shanks d^2 , into engagement with the bits b^3 and b^5 , of the two sets of fashioning needles b^2 and b^4 , as shown in Fig. 8, or out of engagement with said bit and into a recess c^8 , located at the central portion of the plate c , and beneath the heel needle bits.

When the keys d and d' , are in the recess c^8 , they overlies each other, and when they are shifted out of this recess they are in different planes, so that the top wall of the recess c^6 , is higher than the top wall of the recess c^5 , and the recess c^4 , is higher than the recesses c^5 and c^6 . However, the bits of the set of fashioning needles b^2 , that appertain to the recess c^5 , are farther from the tops of the needles than the bits of the set of fashioning needles b^4 , that appertain to the recess c^6 , and the bits of the heel needles b , appertaining to the recess c^4 , are nearer their tops than any of the fashioning needles, so that the tops of all the fashioning and heel needles are in alignment, when the bits or hubs thereof are in their highest positions in respect to the plate c .

e and e' , are carriages adapted to slide in the arc of a circle upon the bed-plate a^3 , and provided with transversely ranging slots e^2 , engaging the shanks d^2 , of the keys d and d' , in such manner that the same are free to rise and fall therein, but are moved around the circumference of the needle cylinder a^5 , when the carriages e and e' , are shifted.

a^9 , is a back stop projecting upward from the bed-plate a^3 , and adapted to limit the range of travel of the carriages e and e' , in one direction. When the carriages e and e' , are in contact with the back stop a^9 , as shown in Fig. 11, the keys d and d' , occupy positions as shown in Fig. 8, and serve to lock all the fashioning needles b^2 and b^4 , to the reciprocating plate c . The periphery of each of the carriages e and e' , is provided with teeth by means of which they are fed or shifted toward and away from the front stop a^{10} , through the instrumentality of mechanism hereinafter described. As the carriages e and e' , are shifted toward the front stop a^{10} , they carry the corresponding keys d and d' , into the recess c^8 , Fig. 8, and out of range of the bits of the fashioning needles, so that the latter are unlocked from the plate c , one after another and remain by reason of their weight, in engagement with the flange a^4 , and out of action. When the carriages e and e' , are shifted in a reverse direction toward the back stop a^9 , the corresponding keys are gradually inserted beneath the hubs or bits of the fashioning needles, so that the latter are locked to the plate c , and are thus brought one after another into action. The shanks b^6 , of the fashioning needles that are out of action rest upon the flange a^4 , as has been already explained and thus maintain the bits or hubs b^3 and b^5 , in such position that the keys d and d' , may readily pass under them when the carriages e and e' , are shifted toward the back stop a^9 , it being understood that the keys d and d' , are shifted only when the plate c , is in its lowest position. However, in practice it sometimes happens that the end of the key collides with the bit or hub of a fashioning needle and would thus tend to bend or break it. To obviate such accidental injury to the fashioning needle, bits or hubs use may be

made of plates e^3 , attached by means of spring connections e^4 , Fig. 12, to the faces of the slots e^2 , of the carriages e and e' , that drive the keys d and d' , toward the back stop a^9 , so that if one of the keys should collide with a needle bit the spring connection would yield and thus permit the corresponding carriage to be advanced independently thereof, it being understood that the subsequent rise and fall of the plate c , serves to clear the fashioning needle and thus permits the key to resume its normal operation.

a^{11} , are fingers projecting radially from the upper portion of the needle cylinder or support a^5 , toward the center thereof and between each two of the needles into position for holding down the web.

f , is a sinker bed or frame carried above the bed plate a^3 , by means of curved posts a^{12} , and provided with radial slots in which sinker-bars f' work. Each of these sinker-bars is provided at its forward extremity with a notch of which three forms are shown in Figs. 3, 4 and 5. The notches shown in Figs. 3 and 4, are adapted to hold the thread from accidental movement either upward or downward, while the notch shown in Fig. 5, is only capable of holding the thread from accidental movement in an upward direction, it being understood that the upper portion of each of these sinker-bars f' , adjacent to the notches therein constitute a projection f^2 , that serves to hold the thread against accidental upward displacement and that either type of sinker-bar may be advantageously employed.

f^3 , is a sinker gear mounted upon the sinker bed f , and revolubly connected therewith by means of a ring f^4 , engaging the under side of the sinker bed and detachably connected with the sinker gear by means of screws f^5 . The sinker gear f^3 , carries a thread or yarn carrier f^6 , and is provided upon its under side with a cam groove f^7 , that engages projections f^8 , on each of the sinker-bars f' , and thus causes the notched extremities thereof to be drawn backward away from the center of the needle cylinder in advance of the thread or yarn carrier and to be again projected between the needles in rear of the thread or yarn carrier.

g , is a ring movably attached to the sinker bed f , by means of screws g' , working in slots g^2 , in the sinker-bed, Figs. 2 and 6. This ring g , is provided upon its inner edge with two sets of teeth, whereof one set appertains to the needles operated by the plate c , and the other set appertains to the needles operated by the plate c' . The tooth intermediate of the two sets of teeth on one side is made wider than the other teeth as shown in Fig. 6, and at the opposite side of the ring there is a corresponding wide space in order to insure the engagement and disengagement of all the teeth of each set with the beards of all the needles appertaining to the corresponding plate.

g^3 , Fig. 7, are lugs depending from the ring

g, into range of mechanism hereinafter described, for oscillating the ring *g*. The oscillations of the ring *g*, are timed in respect to the movements of the plates *c* and *c'*, in such manner that when the needles of each plate are rising as shown at the right hand side of Fig. 6, the beards of the rising needles work in the spaces between the corresponding set of teeth and are thus permitted to open in order to free the stitches previously drawn down, and when the needles of a plate are descending, as shown at the left hand side of Fig. 6, the beards of the descending needles collide respectively with the corresponding teeth and are thus closed.

In fabricating a circular web or tube the keys *d* and *d'*, are shifted into range of the fashioning needles, the plates *c* and *c'*, are alternately lifted and depressed, as shown in Fig. 1, the thread or yarn carrier *f*⁶, and sinker-cam *f*⁷, are revolved continuously in one direction, and the ring *g*, is oscillated through the intervention of suitable mechanism hereinafter fully described. These movements are timed in such manner that as the thread or yarn carrier *f*⁶, approaches the outside needle appertaining to the plate *c*, the latter is elevated into position for permitting the yarn or thread to be laid under the beard of said needle, it being understood that the set of teeth of the ring *g*, that appertains to the plate *c*, are in position for permitting the beards to open. The sinker bar *f*⁷, corresponding to said needle is drawn outward from the center of the needle cylinder during the insertion of the thread or yarn beneath the beard thereof, and is subsequently thrust forward toward the center of the cylinder and thus engages the yarn or thread and pushes a loop or bight of the same inward past the needle, it being understood that the projection *f*², on the end of the sinker bar holds the bight or loop in such position and against accidental upward displacement while the thread is being laid onto the rest of the needles that are actuated by the plate *c*. As the thread carrier *f*⁶, approaches the center needles of the plate *c*, the latter is constantly rising, the thread is being inserted beneath the beards of the needles, and the sinker bars appertaining to the needles are being projected forward toward the center of the needle cylinder one after another and as soon as the thread has been laid onto the needles to which they appertain. After the thread or yarn carrier *f*⁶, passes the center of the plate *c*, and while it is approaching the opposite extremity thereof, the plate *c*, is descending. During the descent of the plate *c*, the thread is laid onto the remaining needles and loops or bights of the thread are pushed inward toward the center of the needle cylinder and held in such position by the projections *f*², of the sinker bars, it being understood that the sinker bars are for this purpose operated successively in the manner hereinabove described. The thread or yarn

carrier *f*⁶, and sinker bars *f*⁷, then lay the thread or yarn onto the needles operated by the plate *c'*, in precisely the manner above described with reference to the needles of the plate *c*. While the thread or yarn is being laid onto the needles operated by the plate *c'*, the plate *c*, is descending with the result that the beards of the needles operated thereby are closed by contacting with the teeth of the ring *g*, so that the thread is drawn by means of the closed beards off the notched ends of the sinker-bars over the fingers *a*¹¹, and through the stitches of the previously formed course of stitches of the web; and these latter stitches escape over the closed beards of the needles. The repetition of the above described operations results in the production of a knitted tube, which is held down by means of the fingers *a*¹¹, and which is fed away from the machine through the interior of the needle-cylinder.

In knitting a flat web one plate *c*, is permitted to rise and fall and the other plate *c'*, is thrown out of action. The ring *g*, is oscillated to close the beards of the needles as they descend and to open them as they ascend, and the sinker-gear *f*³, is caused to turn first in one direction and then in the other, in order to cause the thread-carrier *f*⁶, to lay the thread backward and forward across the needles that are operated by the plate *c*, and also to cause the sinker bars *f*⁷, to properly press the thread between the needles and toward the center of the needle cylinder in the manner above described. The flat web may be narrowed by shifting the keys *d* and *d'*, toward the recess *c*⁸, of the plate *c*, into position for passing from beneath the bits or hubs of the fashioning needles *b*² and *b*⁴, so that when the plate *c*, rises such needles rest upon the rim or flange *a*⁴, and consequently are out of action. The keys *d* and *d'*, may be gradually shifted toward the recess *c*⁸, with an intermittent motion, in which case the web is gradually narrowed. The web may be widened out again to its full or normal width by shifting the keys *d* and *d'*, away from the recess *c*⁸, i. e. in a reverse direction, thus locking the bits of the fashioning needles *b*² and *b*⁴, to the plate *c*, in such manner that they rise and fall therewith. The plates *c* and *c'*, the sinker gear *f*³, and carriages *e* and *e'*, may be automatically operated and controlled in substantially the manner above pointed out by means of various types of mechanism. However, a description will now be given of mechanism resembling that set forth in my said application, Serial No. 441,059, and which has been found practically efficient for such purposes.

h and *h'*, are pulleys whereof one *h*, is of larger diameter than the other *h'*, in order to impart two different rates of speed to the machine. The pulley *h*, serves to drive the machine at a comparatively high rate of speed during the formation of a tubular web and the pulley *h'*, serves to drive the ma-

chine at a comparatively slow rate of speed during the operations of widening and narrowing a flat web. The pulleys h and h' , are connected to each other and are mounted loosely upon a positively driven shaft to which they may be connected and disconnected by the operator in order to start and stop the machine.

i , is the main-driving shaft of the machine and is revolubly supported in bearings carried by the standards a and a' . This shaft i , is provided with one tight pulley i' , and with two loose pulleys i^2 and i^3 .

i^4 , is a belt appertaining to the pulley h , and adapted normally to ride on the loose pulley i^2 . This belt i^4 , may be shifted onto the tight pulley i' , and in such case serves to drive the main shaft i , at a comparatively high rate of speed. It may be remarked that the pulley h , is provided with a flange h^2 , that serves to prevent the belt from running off the same when it is in engagement with the tight pulley i' .

i^5 , is a belt appertaining to the pulley h' , and adapted normally to ride on the loose pulley i^3 . This belt i^5 , may be shifted onto the tight pulley i' , and in such case serves to drive the main shaft i , at a comparatively low rate of speed.

j , is a counter-shaft revolubly supported in bearings carried by the standard a' , and by a bracket j' , depending from the rim or flange a^4 , of the bed plate a^3 . This counter shaft j , carries a gear wheel j^2 , that meshes with and drives the sinker-gear f^3 . It has been stated that when both the plates c and c' , are in operation, the sinker-gear f^3 , makes complete revolutions and that when the plate c , is in operation the sinker-gear f^3 , is turned backward and forward. These results are accomplished by means of the following parts: k , is an eccentric keyed or otherwise secured to the main shaft i .

k' , is a socket pivotally attached to the lug c^2 , connected with the plate c , and adapted to work in a suitable slot cut or otherwise formed in the flange a^4 .

k^2 , is an eccentric strap provided with a socket k^3 .

k^4 , is a link having its extremities provided with threads of opposite pitch adapted to engage corresponding threads in the sockets k' and k^3 , so that the plate c , may be adjusted upward or downward by the simple operation of turning the link k^4 , in one direction or the other as may be required.

k^5 , are jam-nuts for locking the link k^4 , to place in its sockets.

l , is a tappet arm keyed to the shaft i , and adapted to vibrate one extremity of a rod l' , pivotally attached to the standard a' , and having its other extremity provided with a rigid arm l^2 , engaging the lugs g^3 , that depend from the ring g . The tappet arm l , continuously oscillates the ring g , and the eccentric k , continuously lifts and depresses the plate c . This is advantageous because the ring g , is vibrated

and the heel and some of the fashioning needles are in operation during the formation of a tube and also of a flat shaped web.

m , is a sleeve loosely mounted upon the main shaft i , and provided with a sprocket wheel m' , and an eccentric m^2 . The eccentric m^2 , actuates the plate c' , through the instrumentality of an adjustable link and its accessories which are exactly similar to the link and accessories of the eccentric k , and which are consequently designated by the same reference letters.

j^3 , is a sprocket wheel loosely mounted on the counter shaft j .

m^3 , is a sprocket chain engaging the sprocket wheels m' and j^3 .

n and n' , are clutch-members respectively splined to the shafts i and j , and adapted to engage the sleeve m , and sprocket wheel j^3 , in order to cause the rotary motion of the shaft i , to impart a reciprocating movement to the plates c and c' , and a rotary motion to the counter shaft j . The rotation of the counter shaft j , causes the gear j^2 , to drive the sinker gear f^3 , and with it the thread carrier f^6 , around the needles of the machine with the result that a knitted tube is produced in the manner hereinabove indicated.

o , is a sleeve loosely mounted upon the shaft i , and provided with an eccentric o' , and a tappet arm o^2 .

j^4 , is a pinion loosely mounted upon the shaft j .

o^3 , is an arm connected at one extremity thereof by means of a strap o^4 , with the eccentric o' , and provided at the other extremity with a slot having a rack cut or otherwise formed upon one of its interior walls and adapted to mesh with the pinion j^4 .

p , Figs. 1, 2 and 11, is a pawl ring afforded a range of reciprocating motion in suitable ways cut or otherwise formed upon the upper surface of the bed plate a^3 .

p' , are screws connected with the bed plate a^3 , and working in slots p^2 , in the pawl ring p , in order to prevent the same from being accidentally lifted upward.

p^3 and p^4 , are pawls pivotally connected with the under side of the pawl ring p , and adapted to work in slots cut or otherwise formed for their reception in the bed plate a^3 . The pawls p^3 and p^4 , are provided respectively with two teeth adapted to mesh with the peripheral teeth of the carriages e and e' , so that when the pawl ring p , is reciprocated the teeth p^5 , may serve to shift the carriages e and e' , toward the front stop a^{10} , in Fig. 11, and the teeth p^6 , may serve to shift the carriages e and e' , toward the back stop a^9 , in said figure.

q , is a tappet rod centrally pivoted to the standard a' , and having one extremity thereof bifurcated and provided with rollers disposed in range of the tappet-arm o^2 , and having the other extremity thereof located between pins p^7 , projecting radially from the periphery of the pawl ring p . When the

clutch-members n and n' , are shifted into engagement with the sleeve o , and pinion j^4 , the sleeve m , and sprocket wheel j^3 , are thrown out of action and the rotary motion of the shaft i , causes the countershaft j , to be turned first in one direction and then in the other through the intervention of the arm o^3 , and its accessories, and also causes the pawl ring p , to be turned backward and forward through the intervention of the tappet rod q , it being understood that the plate c' , is thrown out of action by the release of the sleeve m . Under these circumstances the plate c , is impelled upward and downward, the sinker gear f^3 , thread carrier f^6 and ring g , are turned backward and forward, and the pawl ring p , and pawls p^3 and p^4 , are also turned backward and forward, and the movements of the above mentioned parts are adapted to effect the production of a flat knitted web. This web may be narrowed by turning the pawls p^3 and p^4 , into position for permitting the teeth p^5 , to drive the carriages e and e' , toward the front stop a^{10} , Fig. 11, whereby the keys d and d' , are caused to release the bits or hubs of the fashioning needles b^2 and b^4 , and thus throw the latter out of action. These fashioning needles b^2 and b^4 , may be again thrown into action in order to permit of the widening of the web by shifting the pawls p^3 and p^4 , into position for permitting the teeth p^6 , to drive the keys d and d' and carriages e and e' , in a reverse direction, i. e. toward the back stop a^9 , in Fig. 11. The position of the pawls p^3 and p^4 , is controlled by means of arms r and r' , carried by a frame r^2 , afforded a range of sliding movement in suitable bearings and carried by the under surface and edges of the bed plate a^3 . The position of the clutch-members n and n' , frame r^2 , and belts i^4 and i^5 , and consequently the speed of the machine and character of the resultant product are automatically controlled through the instrumentality of suitable mechanism of which the type shown in Figs. 1 and 11, will now be described.

t , is a rod afforded a range of end play in suitable bearings t' , formed in the standards a and a' .

u and u' , are levers centrally pivoted to suitable brackets carried by the standard a' , Fig. 1, and each having one of their extremities connected with the rod t , by means of slotted connections, and having the other one of their extremities adapted respectively to simultaneously shift the clutch-members n and n' , in the same direction.

t^2 , is a belt shipper carried by the other end of the rod t , and adapted to bring the belts i^4 and i^5 , successively into engagement with the tight pulley i' . When the rod t , is shifted toward the right in Fig. 1, the belt i^4 , drives the shaft i , at a comparatively high rate of speed and the shaft i , operates the plates c and c' , and the sinker gear f^3 , in such manner that a tube is rapidly knit. When the rod t , is shifted toward the left, the belt i^5 , drives the

shaft i , at a comparatively low rate of speed and the shaft i , operates the plate c , reciprocates the sinker gear f^3 and its accessories, and causes the keys d and d' , to throw fashioning needles into or out of operation, with the result that a flat web is fabricated and shaped. It may be remarked that the belts i^4 and i^5 , are both brought onto the loose pulleys before either of them can be brought into engagement with the tight pulley i' , whereby undue shocks and jars that might arise from a sudden reversal of the direction of motion of the counter shaft j , and parts connected therewith are avoided.

v , is a pattern chain feed wheel loosely mounted upon a stud v' , carried by the standard a , Fig. 1.

v^2 , is a dish shaped spring washer for preventing retrograde motion of the pattern chain feed wheel v .

v^3 , is a spring controlled pawl actuated by an eccentric v^4 , keyed to the shaft i , and adapted to rotate the pattern chain feed wheel with a positive continuous motion.

w , is a ratchet-wheel loosely mounted upon the stud v' .

w' , is a spring controlled pawl adapted to mesh with the teeth of the ratchet-wheel w , and to work in two peripheral recesses w^2 , therein, so that the ratchet-wheel w , is driven forward by the pawl w' , until the latter falls into one of the recesses w^2 , whereupon the ratchet-wheel comes to rest.

x , is a pattern chain carried by a suitable drum connected with the feed wheel v , and provided with sidewise projecting pins x' , adapted to contact with suitable projections w^3 , on the inner face of the ratchet-wheel in order to rotate the latter, and thus bring the pawl w' , out of the recesses w^2 , into engagement with the ratchet-wheel, so that the ratchet-wheel w , is advanced for a certain distance again.

w^4 , are wedge shaped pieces projecting from the faces of the ratchet-wheel w , into range of pins r^3 , depending from the frame r^2 . These wedge shaped pieces w^4 , by contacting with one or the other of the pins r^3 , serve to shift the frame r^2 , and with it the arms r and r' , in one direction or the other, thus causing the pawls p^3 and p^4 , to drive the carriages e and e' , and keys d and d' , toward the front stop a^{10} or back stop a^9 , in Fig. 11, as may be required. Accidental retrograde movement of the carriages e and e' , may be prevented by means of springs e^5 , interposed between the bed-plate a^3 , and the heads of bolts e^6 , attached to the carriages and working in slots a^{13} , in the bed-plate Figs. 2 and 11.

y , is a cam carried by the ratchet-wheel w , and adapted to shift the rod t , toward the right or left in Fig. 1, through the instrumentality of a cam lever z , pivotally connected with a bracket z' , carried by the standard a , of the machine and connected with the rod t , by a slotted connection z^2 . It may be remarked that the groove upon the cam y , is

provided at diametrically opposite points with somewhat V-shaped off-sets disposed in line with the recesses w^2 , and adapted to shift the upper end of the lever z first, to the left after each half revolution of the cam y and then to the right at the beginning of each half revolution, the jog or off-set being made abrupt for this purpose, it being understood that the recesses w^2 , permit the cam to remain at rest after the upper end of the lever z , has been shifted toward the left and until the pattern chain again sets the cam and wheel w , in motion.

Having thus explained with reference to Figs. 2 and 11, that the carriages e and e' , of the machine shown in the drawings may be actuated by means of pawls, I will now proceed to describe simple mechanism that may be used in lieu of pawls for driving the carriages.

Referring now to Figs. 16, 17 and 18, A, is a drum attached to the inner face of the ratchet wheel w , and provided upon its periphery with a step by step cam groove A' that extends around it on the side opposite to that shown in a reverse direction, so as to form a continuous groove. This cam groove engages projections B, depending from two angular bars B', afforded a range of reciprocating movement in the direction indicated by the arrow in Fig. 17 and in the opposite direction, between the bed-plate a^3 and plates C, secured thereto. Each of these bars B', is provided with a rack meshing with the peripheral teeth of the carriages e and e' , so that one revolution of the drum A, and cam groove A', causes the bars B', to be shifted first to the left in Fig. 17, and then back again, and this motion of the bars acting through the intervention of the racks causes the carriages to be shifted in a similar direction. These racks not only serve to shift the carriages but also to hold them against retrograde movement, so that when the racks are employed the springs e^5 , may be dispensed with and the bolts e^6 , employed solely for preventing upward displacement of the carriages. Moreover, when the racks and their complementary drum A, are employed the tappet arm o^2 , rod q , pawl ring p , pawls p^3 and p^4 , frame r , and its accessories, and the cam w^4 , of Figs. 1 and 11, may be dispensed with, whereby the machine is simplified and its cost reduced.

For the sake of a further explanation of my invention a description will now be given of the mode of operation of the hereinabove described machine in the production of hosiery, but it must be borne in mind that a machine embodying features of my invention may be advantageously employed in the production of other articles.

To start the machine, the pulleys h and h' are thrown manually into gear by the attendant in charge. In this connection it may be remarked that the cam y , as shown in Fig. 1, would have to be turned manually in order to cause it to bring belt i^4 onto the tight pul-

ley i' . However, when the machine is in operation the shifting of the belt i^4 , and also of the belt i^5 , is controlled by the groove of the cam y .

The leg or tubular portion of the stocking is produced by the alternate elevation and depression of the plates c and c' , in connection with the revolution of the sinker gear f^3 , and its accessories. During this operation the machine is driven at a comparatively high rate of speed by means of the belt i^4 , and its complementary pulleys, it being understood that the pawl w' works in one of the recesses w^2 , and that the ratchet-wheel w , and carriages e and e' , are at rest and that the pattern chain feed wheel v , is in motion. Near the completion of the leg portion of the stocking the pattern chain x , advances the ratchet-wheel w , into gear with the pawl w' , whereby the ratchet-wheel w , is continuously advanced. The groove of the cam y , positively controls the lever z , and causes the rod t , to be shifted toward the left, with the following results: The belt i^4 , is shifted onto the loose pulley i^2 , and the belt i^5 , is shifted onto the tight pulley i' , the sprocket chain m^3 , and plate c' , are thrown out of action, and the sinker gear f^3 , is oscillated. Under these circumstances a flat web destined to constitute the heel portion of the stocking is formed. During the formation of the heel portion of the stocking the pawl w' drives the ratchet wheel w and the carriages e and e' , and the keys d and d' , are driven alternately toward the front stop a^{10} , Fig. 11, whereby a fashioning needle on one side of the machine is thrown out of action, then a fashioning needle on the other side of the machine and so on, first throwing out a fashioning needle on one side and then on the other at the formation of each course of stitches, until only the heel needles remain in action. The continued motion of the ratchet-wheel w , for the remaining portion of substantially a half revolution causes the carriages e and e' and keys d and d' , to be shifted toward the back stop a^9 , in Fig. 11, thus causing the fashioning needles to be brought into action, first on one side and then on the other at the formation of each course or row of stitches until the web is brought out to its full width. The rod t , is then shifted toward the right by the other V-shaped portion of the cam y , and the pawl w' , works in another one of the peripheral recesses of the wheel w , so that the tubular foot portion of the stocking is formed in substantially the same manner as the leg portion thereof. The rod t , is again shifted toward the left by the cam y , and the toe portion of the stocking is then formed on the needles operated by the plate c , which for this purpose is permitted to operate by itself, the plate c' , being thrown out of action and the wheel w , being started by another projection on the pattern chain and driven by the pawl w' for approximately another half revolution in substantially the manner hereinabove set forth in connection with

the production of the heel portion. The machine may be stopped by throwing the pulleys *h* and *h'*, out of gear and the stocking may then be removed and finished for use in any preferred manner. However, if preferred the machine may be permitted to continue in motion, and in such case a series of stockings connected at their legs and toes, or string work as it is sometimes called, is produced.

It will be obvious to those skilled in the art to which my invention relates that modifications may be made in details of construction and arrangement without departing from the spirit thereof. Hence my invention is not limited to the exact construction and arrangement of parts hereinabove set forth and illustrated in the accompanying drawings, but

Having thus described the nature and objects of my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A knitting machine provided with needles movable in respect to their cylindrical support and with semi-circular plates reciprocated longitudinally of the cylindrical support and operating to effect the required rise and fall of the needles alternately, substantially as and for the purposes set forth.

2. A knitting machine provided with needles movable in respect to their cylindrical support, semi-circular plates for operating said needles and means for elevating and depressing said plates alternately, substantially as and for the purposes set forth.

3. A knitting machine provided with needles movable in respect to their cylindrical support, semi-circular plates for operating said needles, and a main shaft provided with eccentrics and links for elevating and depressing said plates alternately, substantially as and for the purposes set forth.

4. A knitting machine provided with needles movable in respect to their cylindrical support and having bits or hubs, semi-circular plates provided respectively with grooves engaging the bits or hubs of the needles, and means for elevating and depressing the plates alternately, substantially as and for the purposes set forth.

5. A knitting machine provided with a bed-plate having an annular opening and a depending flange, a needle cylinder attached to said flange, needles movable in respect to the cylinder, plates working between the needle cylinder and the edge of the annular opening and adapted to operate the needles, and means for elevating and depressing said plates, substantially as and for the purposes set forth.

6. A knitting machine provided with needles operated in groups and a reciprocating ring having teeth for closing the beards of a group of descending needles and having spaces for permitting the beards of an ascending group of needles to open, substantially as and for the purposes set forth.

7. A knitting machine provided with needles movable in respect to their support, re-

ciprocating plates for operating said needles in groups, a ring having teeth for closing the beards of a group of needles as they descend and having spaces for permitting the beards of the needles to open as they ascend, substantially as and for the purposes set forth.

8. A knitting machine provided with needles operated in groups and a reciprocating ring having sets of teeth whereof the tooth and space respectively intermediate of the respective sets are wider than the others, substantially as and for the purposes set forth.

9. A knitting machine provided with needles operated in groups, a ring having teeth for closing the beards of a group of descending needles and having spaces for permitting the beards of an ascending group of needles to open, and a tappet-arm and connections for operating said ring, substantially as and for the purposes set forth.

10. A knitting machine provided with needles movable in respect to their cylindrical support, semi-circular plates for operating said needles, a main shaft, and eccentrics and their complemental links interposed between the shaft and plates, whereby said plates may be actuated alternately substantially as and for the purposes set forth.

11. A knitting machine provided with needles movable in respect to their support, plates for operating said needles, a toothed ring for opening and closing the beards of said needles, a main-shaft, eccentrics and their complemental links interposed between the shaft and plates, and a tappet and its accessories for reciprocating the ring, substantially as and for the purposes set forth.

12. A knitting machine comprising needles movable in respect to their support, reciprocating plates for operating said needles, a toothed ring for opening and closing the beards of the needles, a yarn-carrier, and means for operating the plates, ring, and yarn-carrier, substantially as and for the purposes set forth.

13. A knitting machine provided with needles movable in respect to their support, plates for operating said needles, mechanism for actuating said plates, and means for throwing the actuating mechanism of one of said plates out of action, substantially as and for the purposes set forth.

14. A knitting machine provided with needles, means for lifting and depressing groups of the needles, a thread or yarn carrier for laying the thread or yarn onto each group of needles as they approach and recede from their highest positions, sinker-bars provided with projections for holding bights or loops of the thread or yarn between the needles of each group until the bights or loops are positively drawn down by the descent of the needles and means for operating the sinker bars, substantially as and for the purposes set forth.

15. A knitting machine provided with needles operated in groups, and sinker bars hav-

ing projections for retaining bights or loops of thread between the needles, substantially as and for the purposes set forth.

16. A knitting machine provided with needles movable in respect to their support, a reciprocating plate for operating a group of said needles, and devices for disconnecting and connecting certain of said needles from and to the plate to permit of the narrowing and widening of the fabric, substantially as and for the purposes set forth.

17. A knitting machine provided with heel and fashioning needles movable in respect to their support, an oscillating plate provided with a recess engaging the bits of the heel needles and with cavities for the accommodation of the bits or hubs of the fashioning needles, and keys for locking and unlocking the bits or hubs of the fashioning needles, substantially as and for the purposes set forth.

18. A knitting machine provided with fashioning needles movable in respect to their supports, an oscillating plate provided with a cavity for the accommodation of the bits or hubs of the fashioning needles, and a key for locking and unlocking the bits or hubs of the fashioning needles, substantially as and for the purposes set forth.

19. A knitting machine provided with a bed plate having a flange, a fixed needle cylinder, fashioning needles movable in respect to the cylinder and provided with shanks adapted to rest on said flange, and a reciprocating plate provided with keys adapted for insertion beneath the bits or hubs of the fashioning needles when the bits or hubs thereof rest on said flange, substantially as and for the purposes set forth.

20. In a knitting machine, a needle cylinder, a set of heel needles having their bits or hubs comparatively near their hooks, a set of fashioning needles having their bits or hubs comparatively far from their hooks, a set of fashioning needles having their bits or hubs intermediate of the bits or hubs of the other two sets of needles, a plate provided with a recess engaging the bits or hubs of the heel needles and with cavities of different heights for the accommodation of the bits or hubs of the respective sets of fashioning needles, and keys adapted to be shifted into engagement with the bits or hubs of the fashioning needles and into a recess located beneath the heel needle recess, substantially as and for the purposes set forth.

21. A knitting machine provided with fashioning needles movable in respect to their support, an oscillating plate provided with a cavity for the accommodation of the bits or hubs of the fashioning needles, a key adapted to lock and unlock the bits or hubs of the fashioning needles and provided with a shank extending through a longitudinally ranging slot in the plate, and a movable carriage engaging said shank, substantially as and for the purposes set forth.

22. A knitting machine provided with fashioning needles movable in respect to their support, an oscillating plate provided with a cavity for the accommodation of the bits or hubs of the fashioning needles, a key carried by said plate and provided with a shank projecting through a slot therein, and a movable carriage having a transversely ranging slot engaging the projecting shank of the key, substantially as and for the purposes set forth.

23. A knitting machine provided with fashioning needles movable in respect to their support, an oscillating plate provided with a cavity for the accommodation of the bits or hubs of the fashioning needles, a key carried by said plate and provided with a shank projecting through a slot therein, a movable carriage having a transversely ranging slot, and a plate attached to a face of said slot by a yielding connection and adapted to engage the projecting shank of the key, substantially as and for the purposes set forth.

24. A knitting machine provided with a group of needles, a reciprocating plate having keys for connecting and disconnecting the needles and plate, carriages for operating the keys, rods provided with teeth meshing with teeth on said carriages, and mechanism for reciprocating said rods, substantially as and for the purposes set forth.

25. A knitting machine provided with a group of normally operated needles, means for throwing certain needles of the group out of and into action, a carriage, a rod provided with teeth meshing with teeth on said carriage, and a revoluble drum having a cam for operating said rod, substantially as and for the purposes set forth.

26. A knitting machine provided with a group of normally operated needles, means for throwing certain needles of the group out of and into action, a carriage, a rod provided with teeth meshing with teeth on said carriage, a drum having a step-by-step cam for operating said rod, and mechanism for intermittently rotating said drum, substantially as and for the purposes set forth.

27. A knitting machine provided with a group of normally operated needles, means for throwing certain needles of the group out of and into action, a carriage, a rod provided with teeth meshing with teeth on said carriage, a drum mounted on a ratchet wheel and provided with a cam for operating said rod, a pawl adapted to drive the ratchet-wheel and to work in peripheral recesses therein, a pattern chain for intermittently rotating the ratchet-wheel, a pattern chain feed wheel, and means for continuously driving the pattern chain feed wheel, substantially as and for the purposes set forth.

28. A knitting machine provided with a reciprocating plate, needles some of which are detachably connected with said plate, means for throwing certain of the detachable needles

dles out of and into action, a carriage, a rod provided with teeth meshing with teeth on said carriage, and mechanism for reciprocating said rod, substantially as and for the purposes set forth.

29. A knitting machine, comprising needles movable in respect to their support, plates for operating said needles, keys for detachably connecting certain needles to one of the plates, 10 carriages for controlling said keys, means for continuously operating the plate having detachable needles and for intermittently operating the other plate, and mechanism for shifting the carriages, substantially as and 15 for the purposes set forth.

30. A knitting machine comprising needles movable in respect to their support, plates for operating said needles, keys for detachably connecting certain needles to one of the plates, 20 carriages for controlling said keys, means for continuously operating the plate having detachable needles and for intermittently operating the other plate, rods provided with racks for shifting said carriages and a revolvable drum having a cam for operating said 25

rods, substantially as and for the purposes set forth.

31. A knitting machine comprising needles movable in respect to their support, plates for operating said needles, keys for detachably 30 connecting certain needles to one of the plates, carriages for controlling said keys, means for continuously operating the plate having detachable needles and for intermittently operating the other plate, rods for shifting said 35 carriages, a ratchet wheel having a cam for operating said rods, a pawl adapted to drive said ratchet-wheel and to work in peripheral recesses therein, a pattern chain for intermittently driving the ratchet-wheel, and a 40 continuously driven pattern-chain feed-wheel, substantially as and for the purposes set forth.

In testimony whereof I have hereunto set my signature in the presence of two subscribing witnesses. 45

EMIL J. FRANCK.

Witnesses:

THOMAS M. SMITH,
RICHARD C. MAXWELL.