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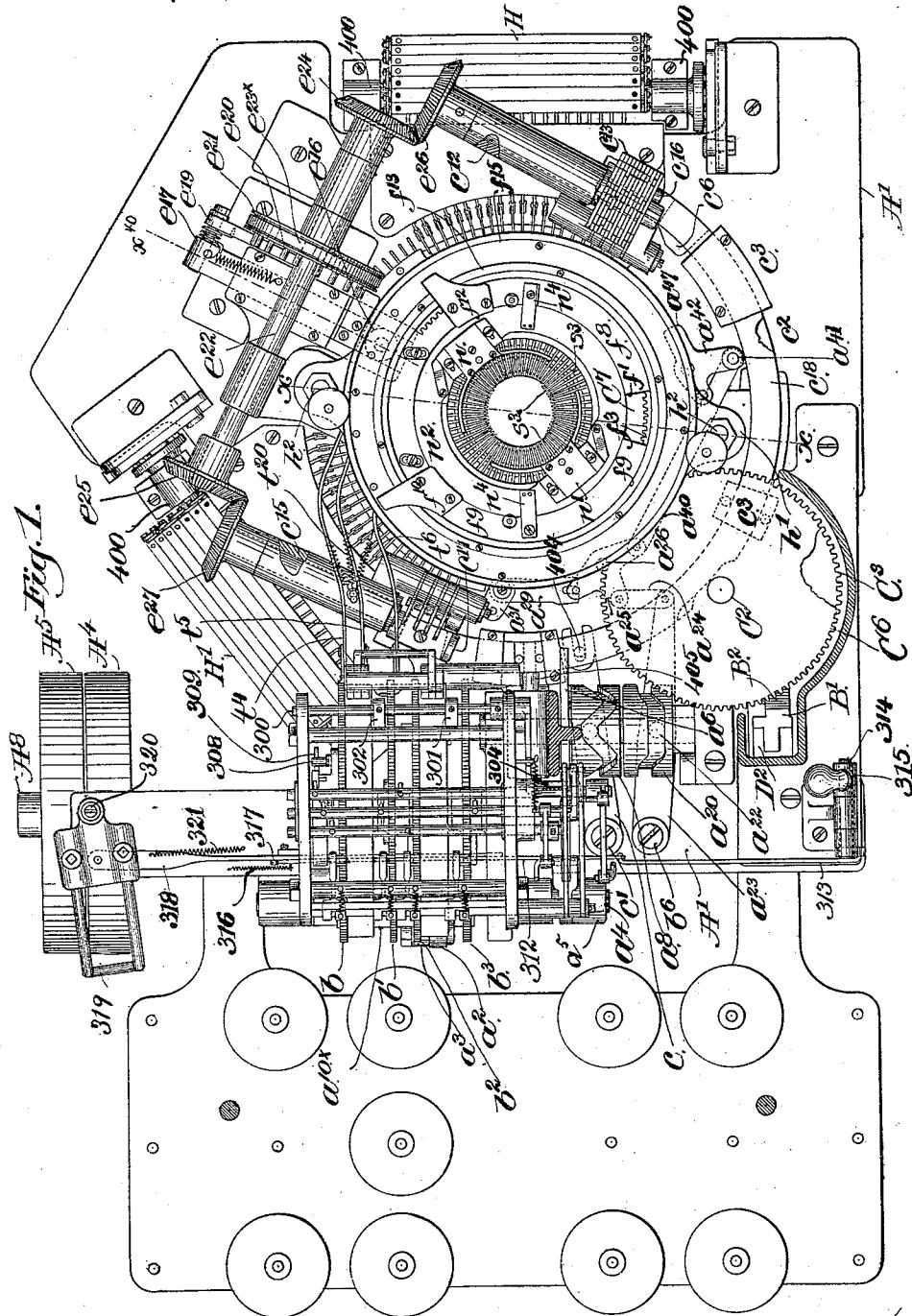
B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



witnesses.

John F. C. Brincker
Fred S. Greenleaf

Inventor:

Benjamin F. Shandeed
Treasurer & Executor
by Crosby & Gregory *Attn:*

(No. Model.)

18 Sheets—Sheet 2.

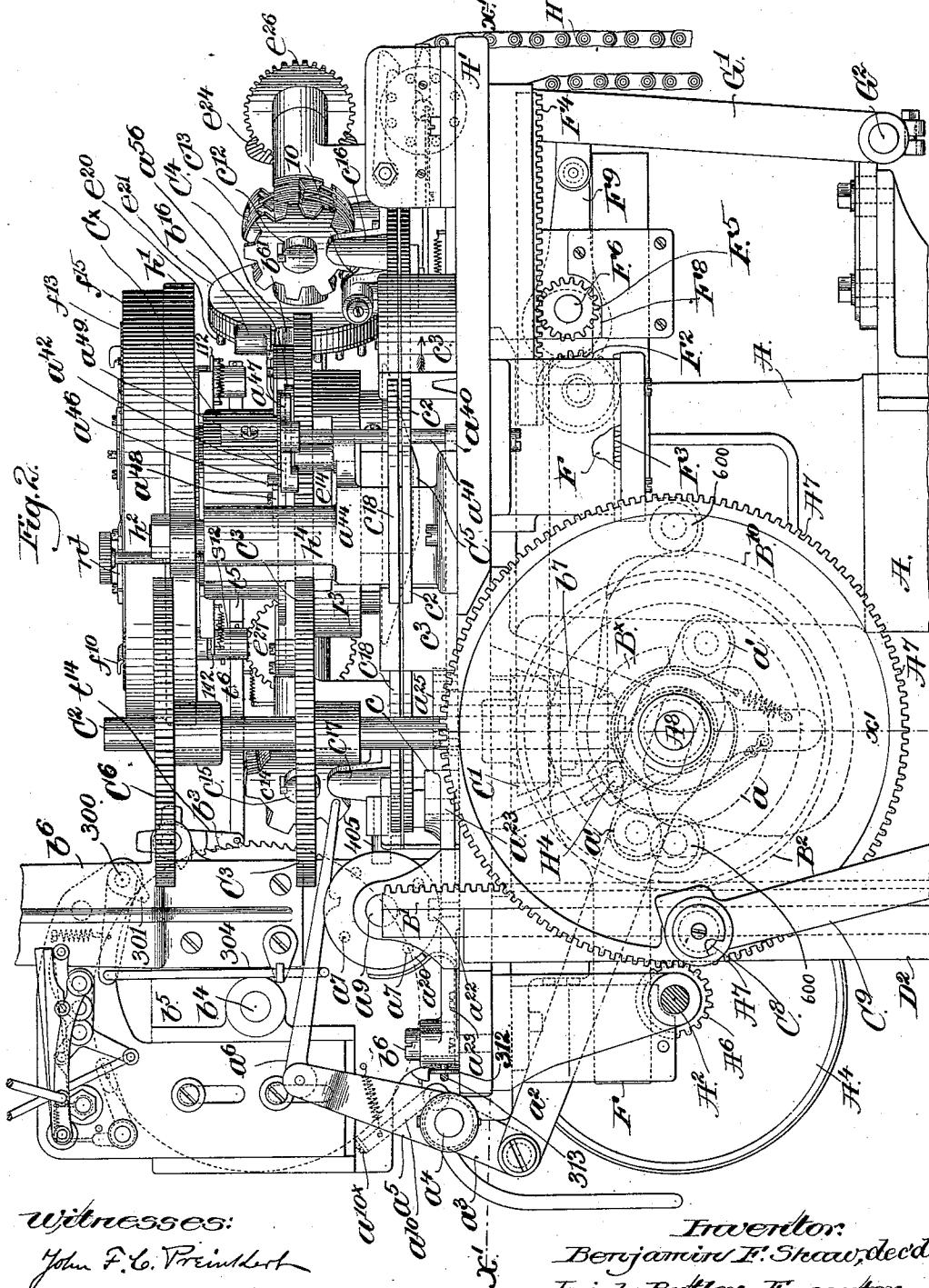
B. F. SHAW, Dec'd.

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KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



witnesses:

John F. C. Prentiss

Fred S. Greenleaf.

xc. Inventor: Benjamin F. Shaw, deceased
Josiah Butler, Executor
by Crosby & Gregory, citys.

(No Model.)

18 Sheets—Sheet 3.

B. F. SHAW, Dec'd.

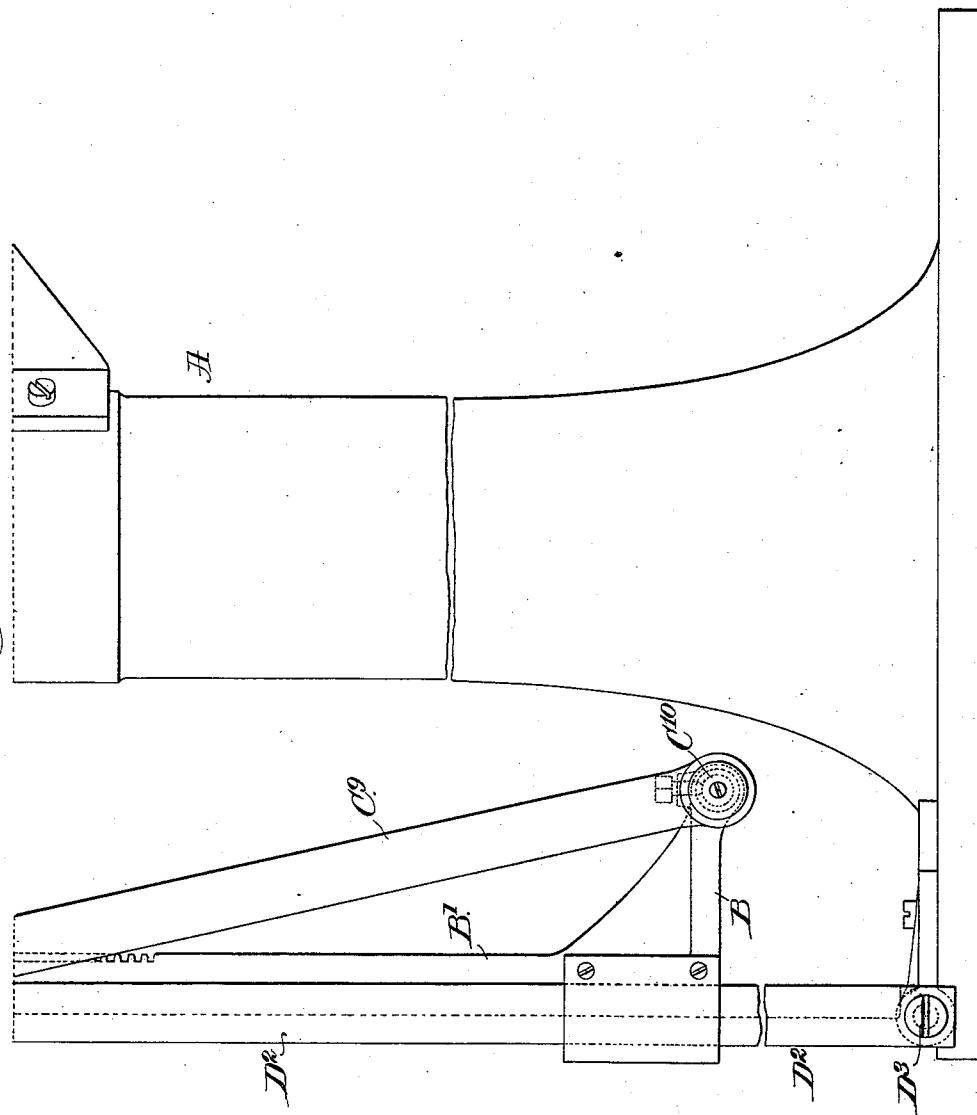
J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 3.



witnesses.

John F. G. Prentiss

Fred S. Granleaf.

Inventor:

Benjamin F. Shaw, dec'd.
Josiah Butler, Executor
by Crosby & Gregory attys.

(No Model.)

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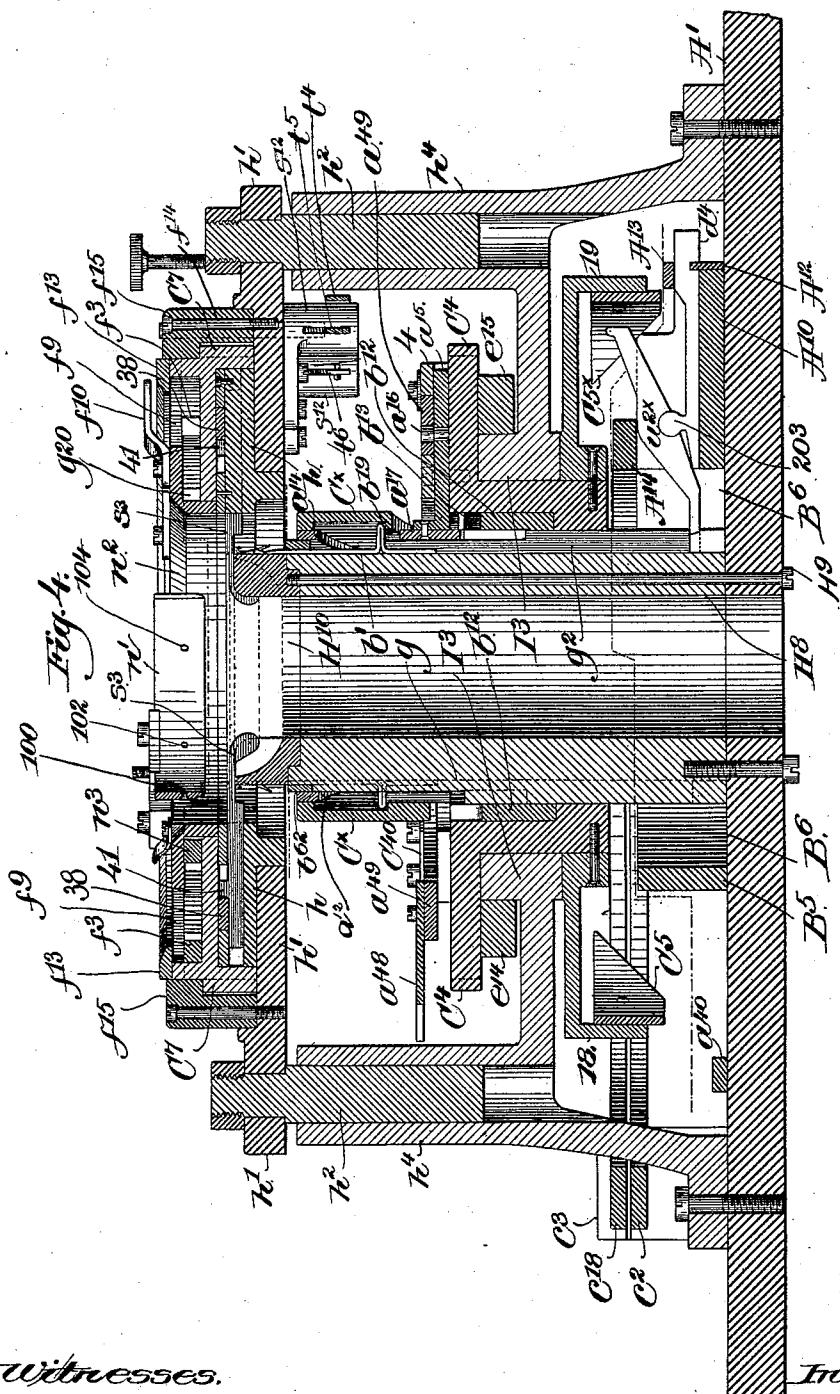
B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



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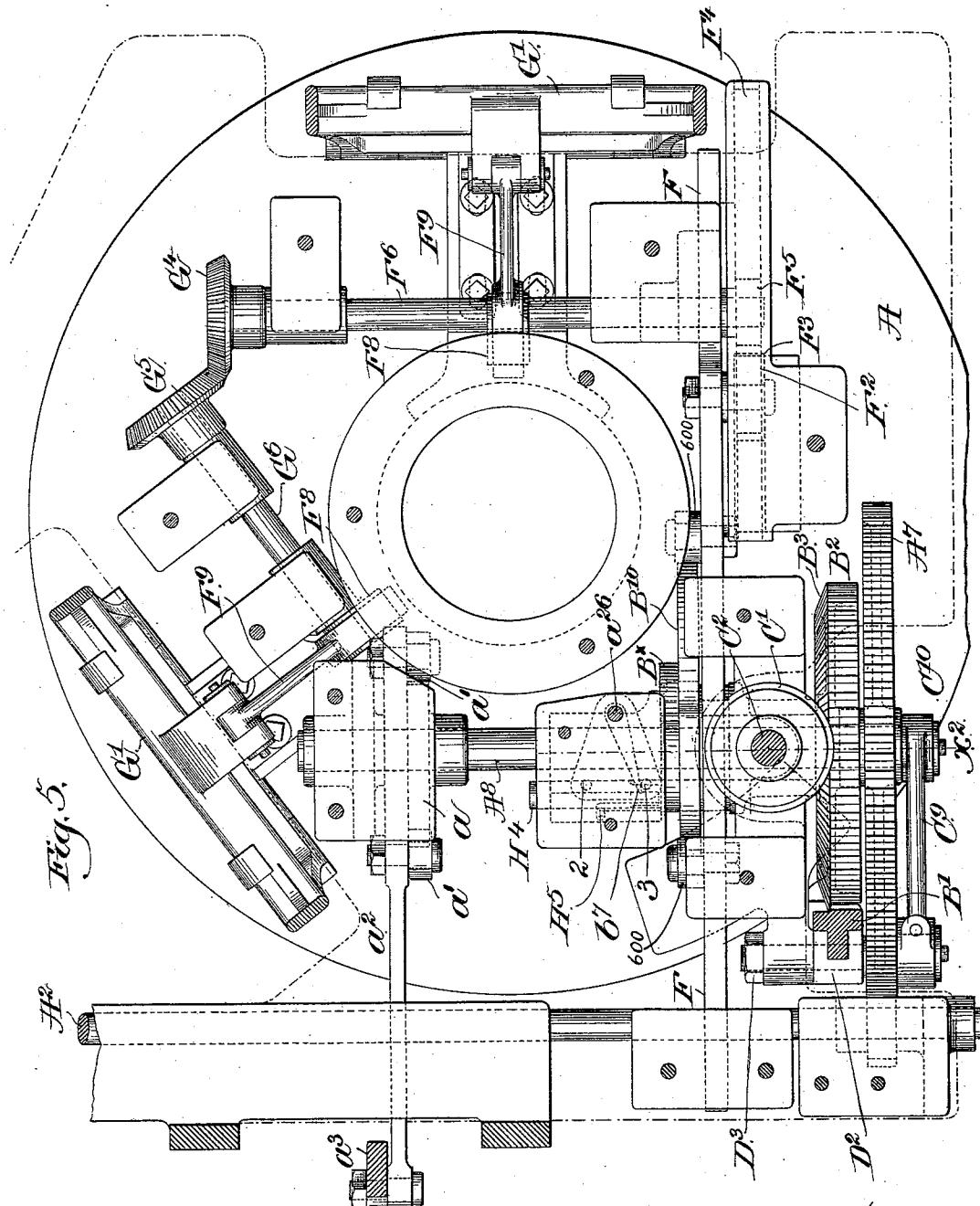
B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



Witnesses.

John D. C. Prentiss

Fred S. Greenleaf

Executor.

Benjamin F. Shauder

Tosiah Butler, Executor.

By Lenoxy & Gregory, Atlys

(No Model.)

B. F. SHAW, Dec'd.
J. BUTLER, Executor.
KNITTING MACHINE.

18 Sheets—Sheet 6.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 6.

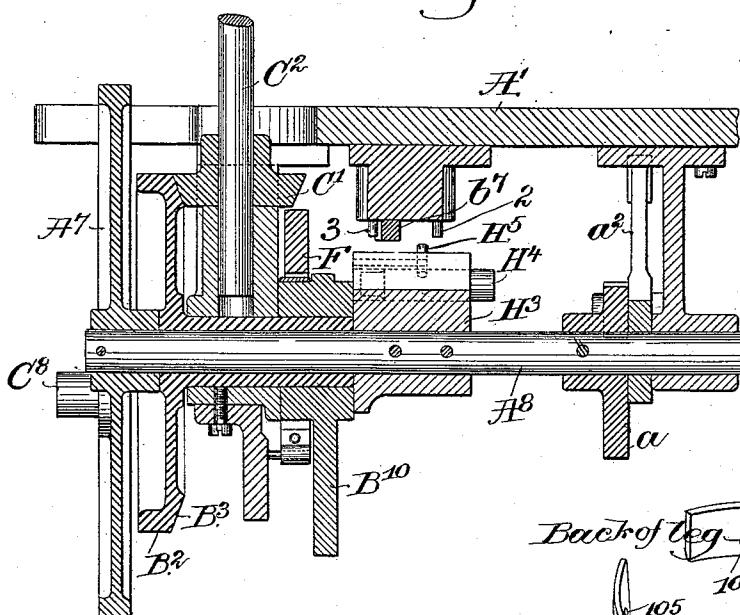


Fig. 9.

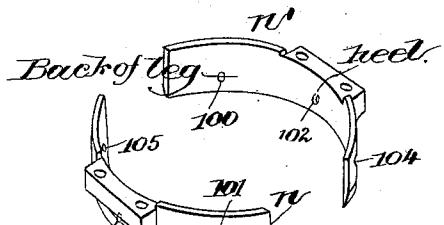


Fig. 7.



Fig. 7c

Fig. 7a

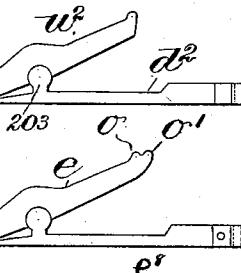
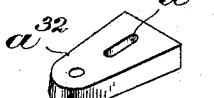


Fig. 7d

Fig. 7b



Witnesses

John F. C. Printner
Fred S. Greenleaf.

Inventor:

Benjamin F. Shaw, dec'd.
Josiah Butler, Executor
by Crosby & Grayson
Petts.

(No Model.)

18 Sheets—Sheet 7.

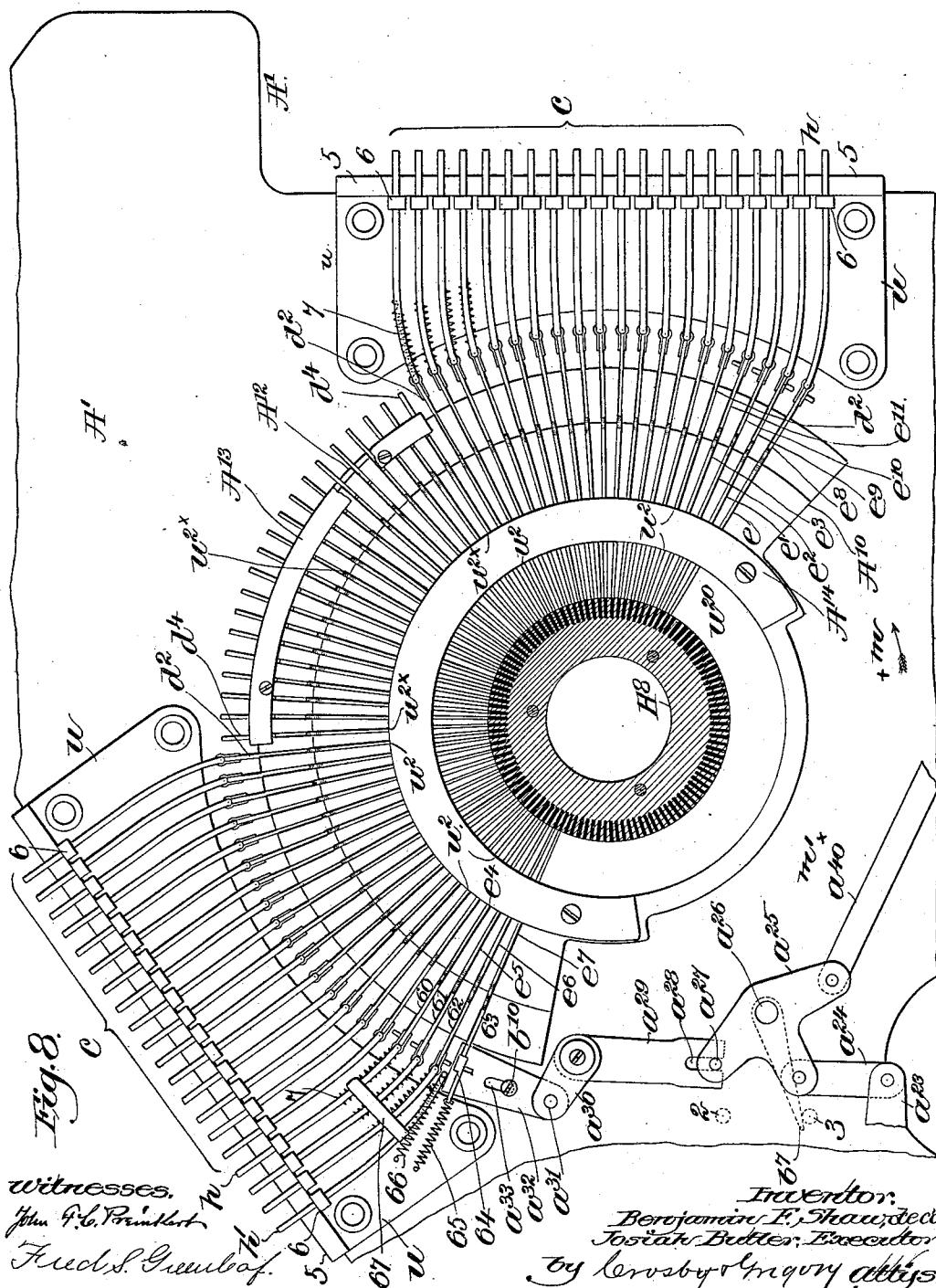
B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



witnesses,

John G. L. Pringle

John T. S. T. Francis

Fred S. G.

Inventor:

Benjamin F. Shaw, dec'd
Josias Butler, Executor.

*Oscar Deales: ~~mechanic~~
Boatman, ~~Boatman~~ ~~Boatman~~*

By Lewisby or Gregory ~~at his~~.

(No Model.)

B. F. SHAW, Dec'd.

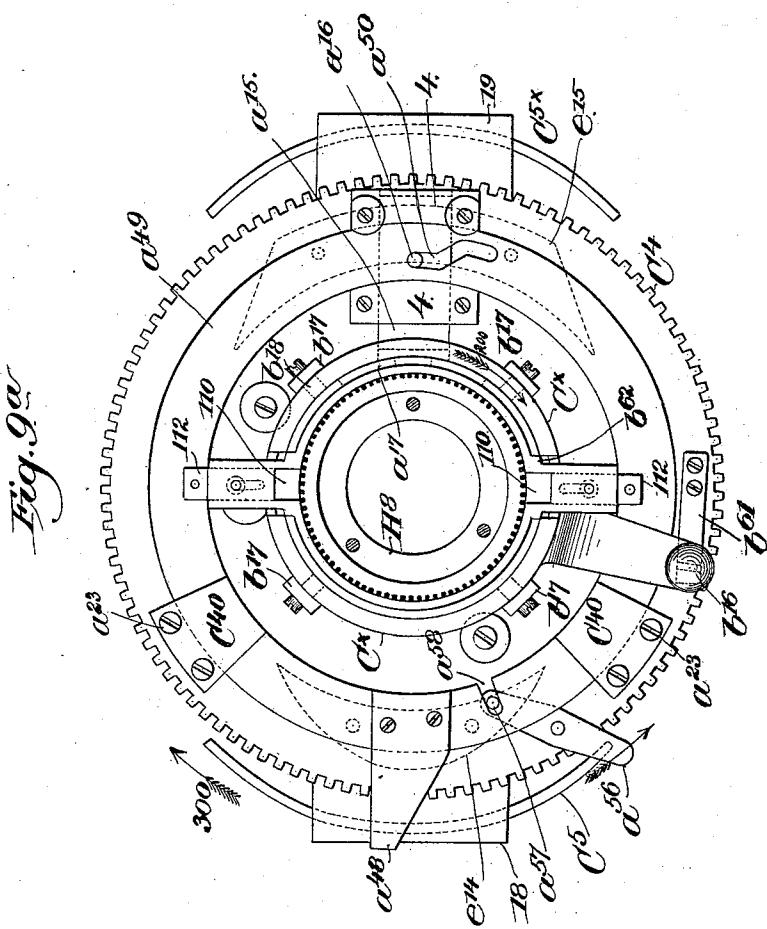
18 Sheets—Sheet 8.

J. BUTLER, Executor

KNITTING MACHINE

No. 469,200.

Patented Feb. 16, 1892.



witnesses

John F. C. Printzberg
Fred S. Greenleaf

Friar's Tor:

Benjaminc E. Shandec
Tosiate Butler. Executor:
By larvby & gregory, *attys.*

(No Model.)

B. F. SHAW, Dec'd.

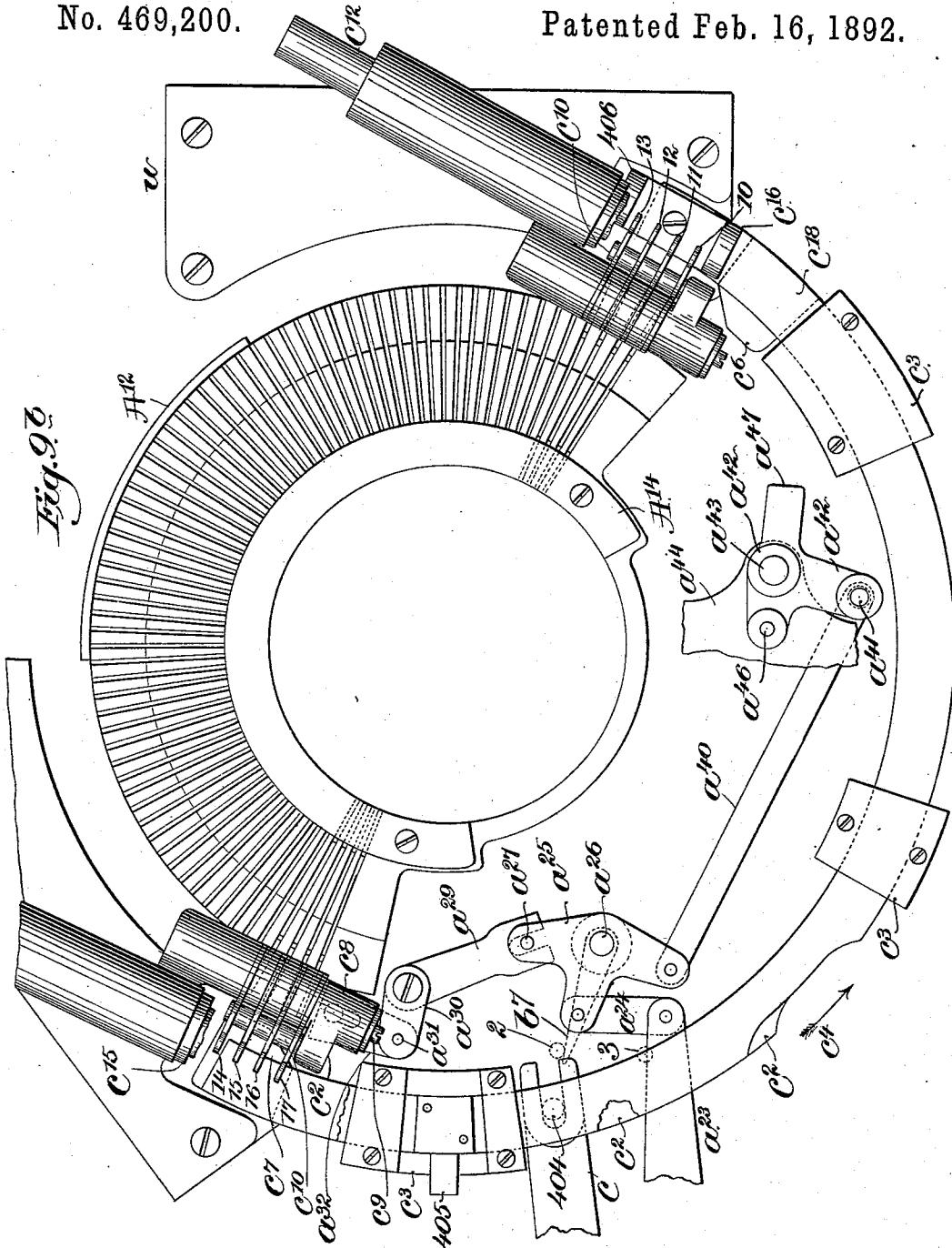
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J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



Witnesses.

John F. C. Prinkert
Fred S. Greenleaf

Inventor:

Benjamin F. Shourds
Josiah Buller, Executor,
By. Crosby & Gregory Atlys.

(No Model.)

B. F. SHAW, Dec'd.
J. BUTLER, Executor.
KNITTING MACHINE.

18 Sheets—Sheet 10.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 10.

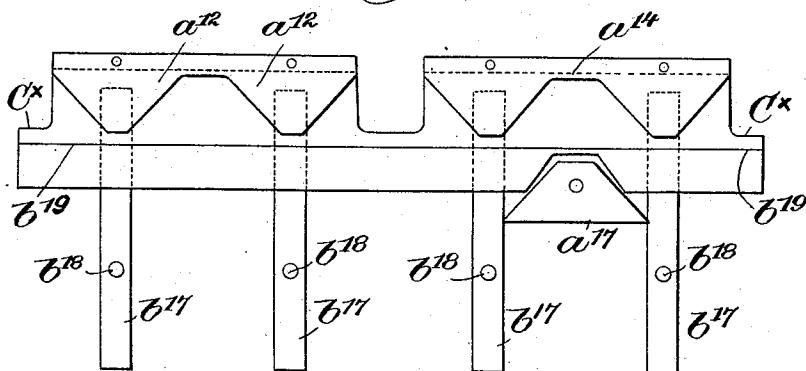


Fig. 11.

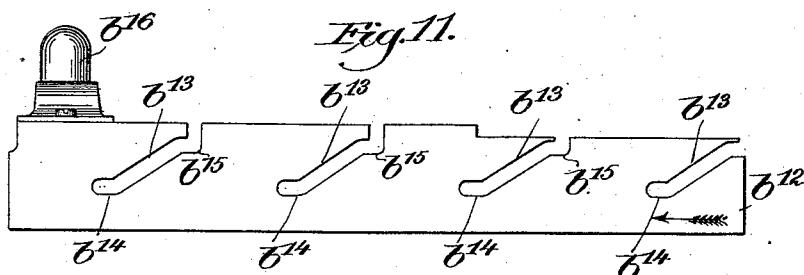
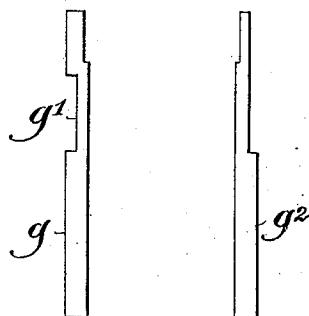


Fig. 12. Fig. 13.



witnesses.

John F. Lee Prentiss

Fred S. Greenleaf.

Inventor:

Benjamin F. Shaw, dec'd.
Josiah Butler, Executor

by Crosby & Gregory attys.

(No Model.)

18 Sheets—Sheet 11.

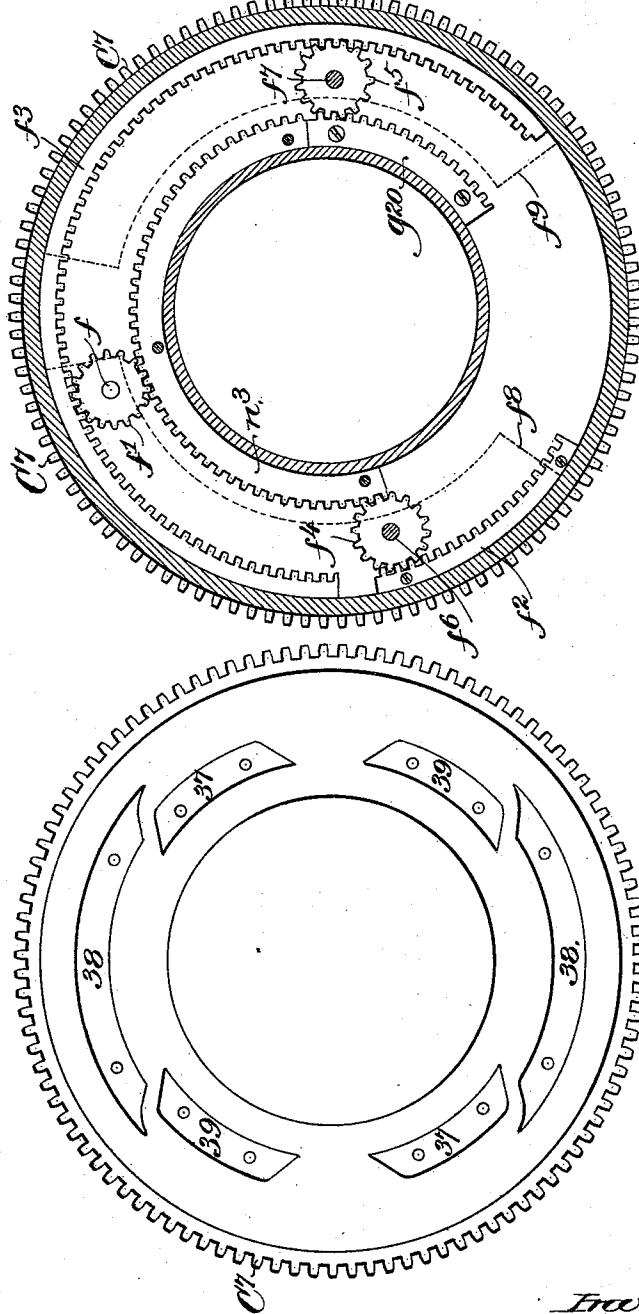
B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



witnesses.

John F. C. Brinkert

Fred S. Greenleaf.

Frivoldor:

Benjamine T. Shaw, deceased
Associate Doctor Executor;
by Crosby & Gregory, attorneys.

(No Model.)

18 Sheets—Sheet 12.

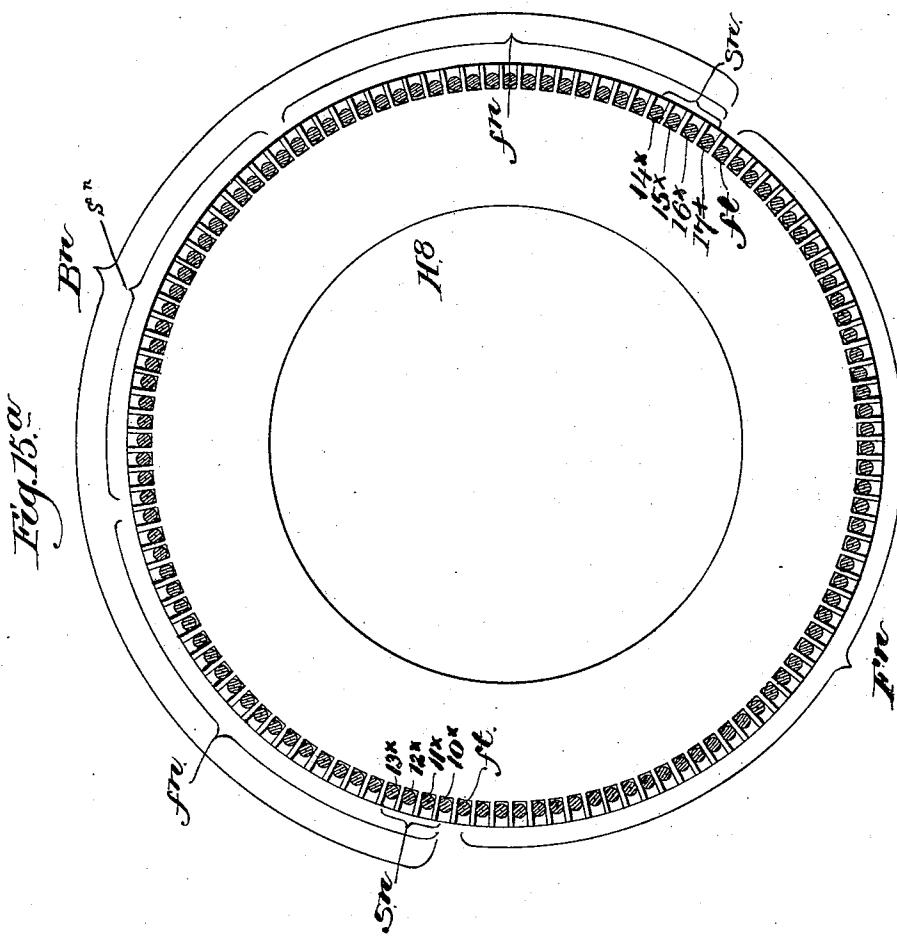
B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.



Witnesses

John F. C. Prinsler

Fred S. Greenleaf

Inventor:

Benjamin F. Shaw,
Josiah Butler, Executor
by Crosby & Gregory
Petts.

(No Model.)

18 Sheets—Sheet 13.

B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 16.

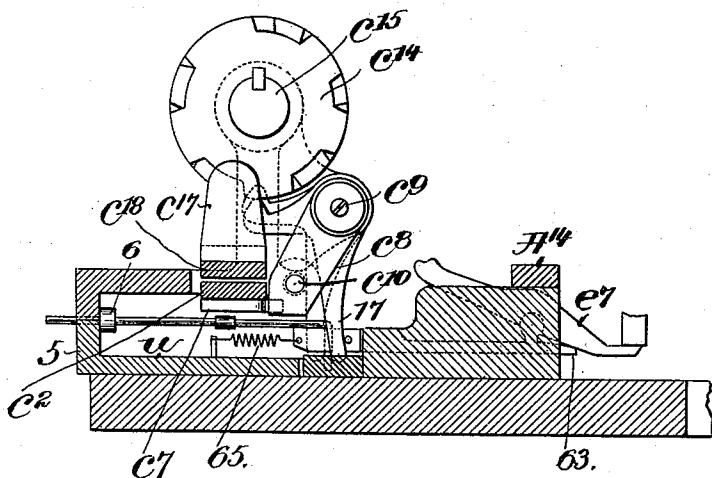
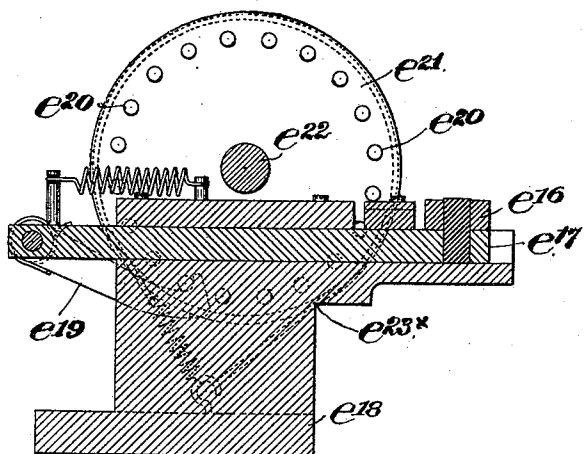


Fig. 17.



Witnesses.

John F. C. Prentiss

Fred S. Granleaf.

Inventor:

Benjamin F. Share, deceased
Josiah Bottler, Executor

by lessor & attorney *attys.*

(No Model.)

18 Sheets—Sheet 14.

B. F. SHAW, Dec'd.
J. BUTLER, Executor.
KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

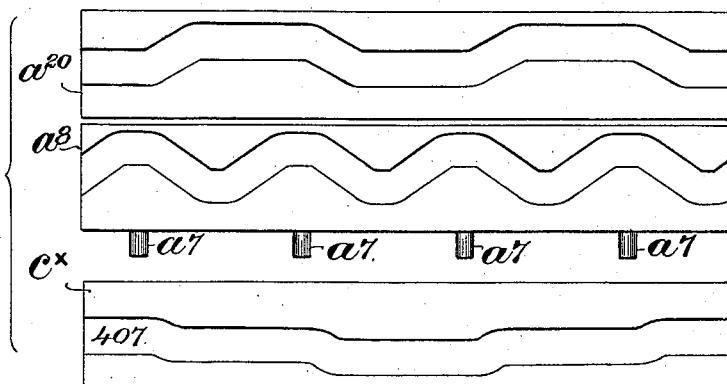
Fig. 18.



Fig. 19.



Fig. 20.



Witnesses

John F. C. Prinster

Fred S. Greenleaf

Executor:

Benjamin F. Shaw, dec'd

Associate Butler, Executor

by Crosby & Gregory, Atty's.

(No Model.)

18 Sheets—Sheet 15.

B. F. SHAW, Dec'd.

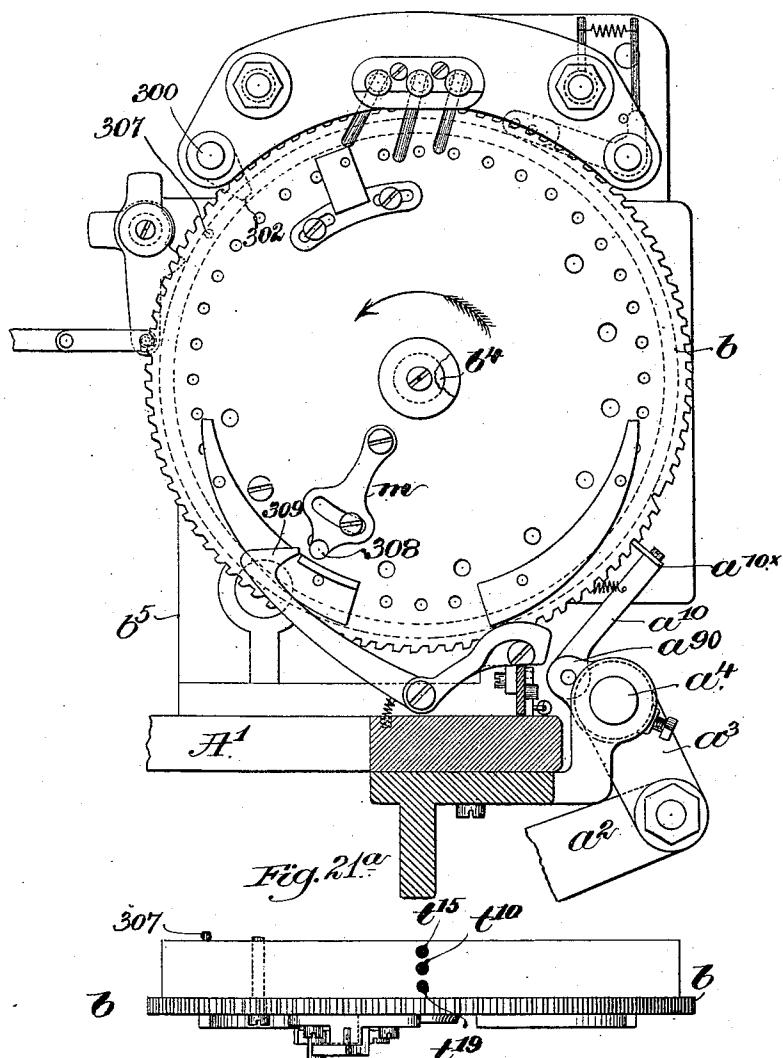
J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 21.



Witnesses.

John F. C. Prentiss

Fried. S. Greenleaf.

Inverdon.

Benjamin F. Shaw, dec'd.
Josias Butler, Executor
by Lewisby & Gregory attys

(No Model.)

B. F. SHAW, Dec'd.

18 Sheets—Sheet 16.

J. BUTLER, Executor.
KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 24.

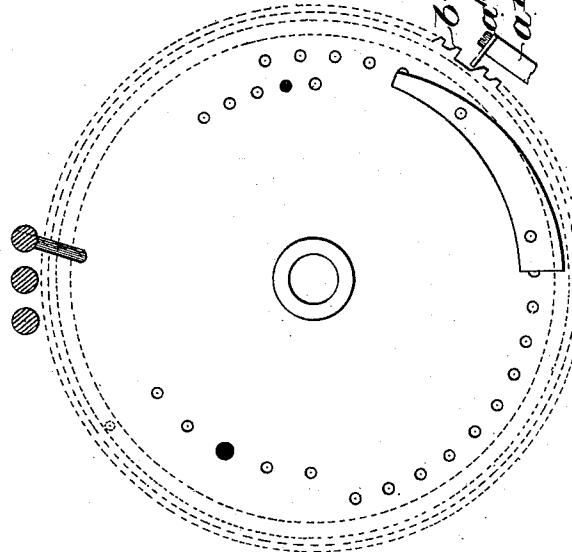


Fig. 25, t 15x

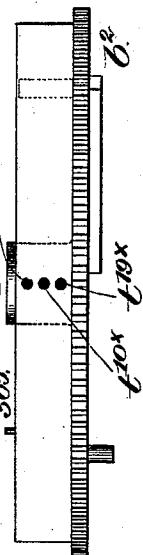


Fig. 26.

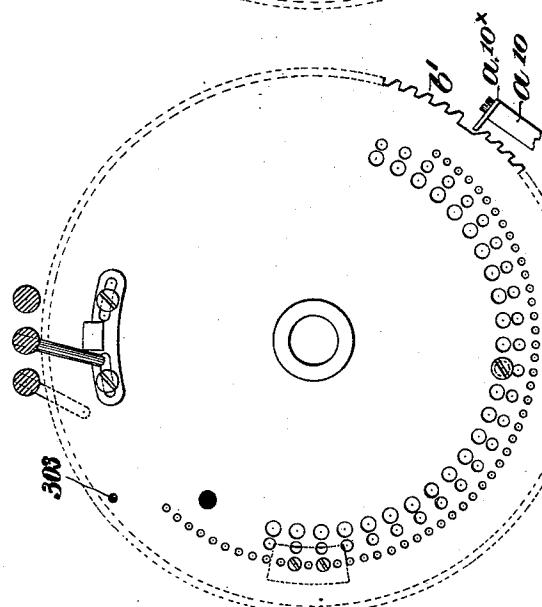
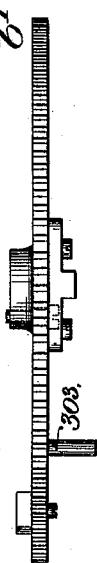


Fig. 23.



witnesses.

John F. L. Princkley

Fred. S. Greenleaf.

Inventor:

Benjamin F. Shaw, dec'd.

Josiah Butler, Executor:

By Crosby & Gregory
attys.

(No Model.)

18 Sheets—Sheet 17.

B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 26.

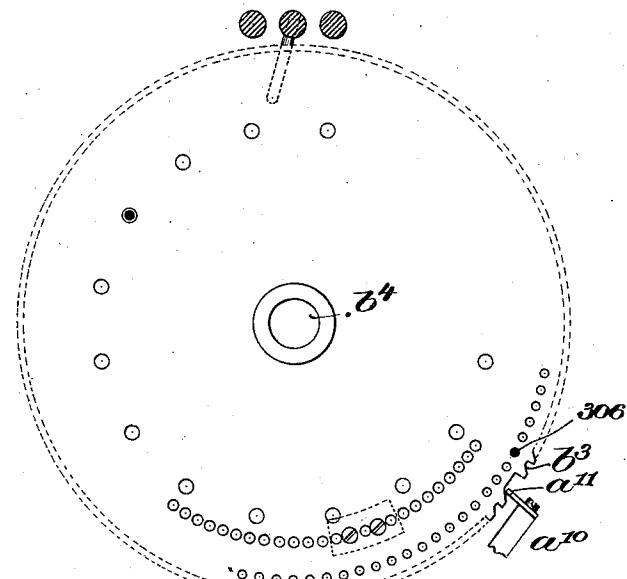


Fig. 27.

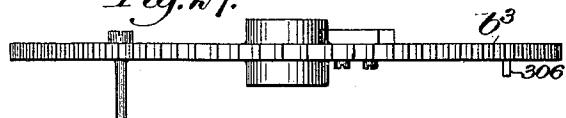
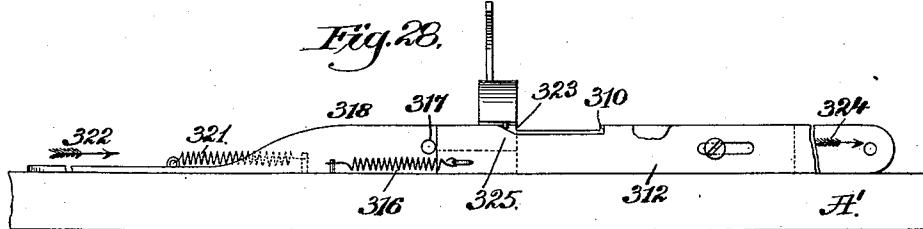


Fig. 28.



witnesses.

John F. G. Prinster.

Fred S. Grunkaf.

inventor:

Benjamin F. Shaw, dec'd
Josiah Butler, Executor
by Lewisby & Gregory, atty's.

(No Model.)

18 Sheets—Sheet 18.

B. F. SHAW, Dec'd.

J. BUTLER, Executor.

KNITTING MACHINE.

No. 469,200.

Patented Feb. 16, 1892.

Fig. 29.

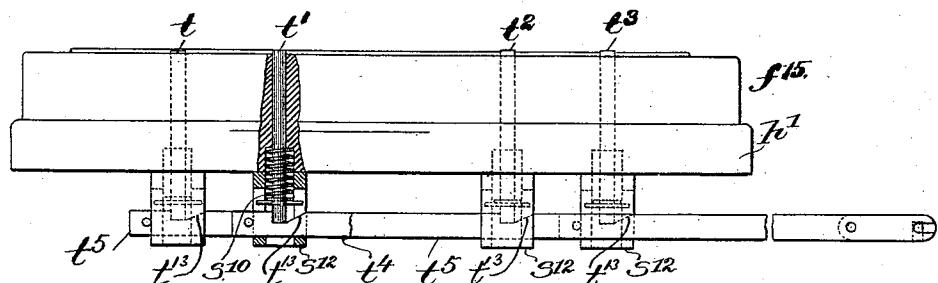


Fig. 30.

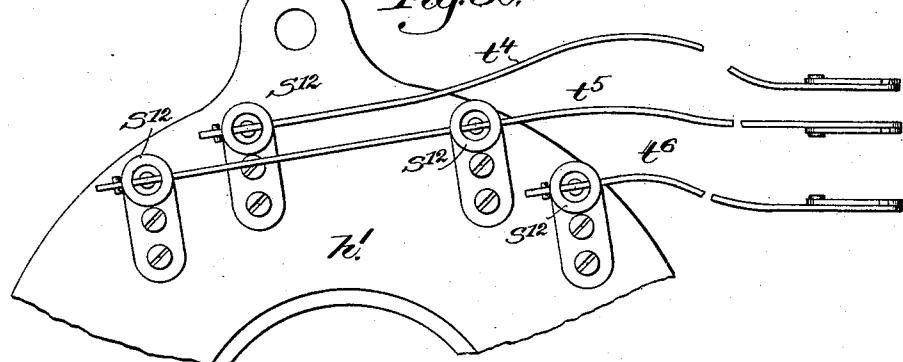
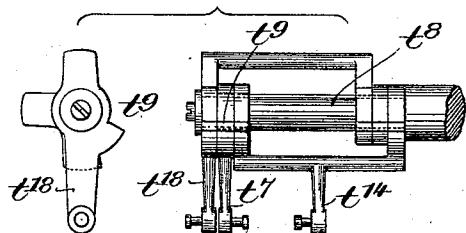


Fig. 31.



Witnesses:

John F. & Co. Printers
Fred. S. Greenleaf.

Invertors

Benjamine F. Shaw, dec'd
Josiah Butler, Executor
by James W. Oregon, attorney

UNITED STATES PATENT OFFICE

JOSIAH BUTLER, OF LOWELL, MASSACHUSETTS, EXECUTOR OF BENJAMIN F. SHAW, DECEASED, ASSIGNOR TO THE SHAW STOCKING COMPANY, OF SAME PLACE.

KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 469,200, dated February 16, 1892.

Application filed April 24, 1891. Serial No. 390,273. (No model.)

To all whom it may concern:

Be it known that BENJAMIN F. SHAW, deceased, late a citizen of the United States, and a resident of Moultonborough, county of Carroll, State of New Hampshire, did invent an Improvement in Knitting-Machines, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

In the manufacture of so-called "seamless stockings" on circular-knitting machines the cam-cylinder is rotated continuously when the circular or tubular parts of the leg and feet are being made and the same yarn is laid in circular courses and appears at the front and back of the leg and at the front or top and back or sole of the foot, the cam-cylinder being reciprocated or moved back and forth while heels and toes are being made, the fabric being narrowed and then widened, only part of the needles being used during the formation of heels and toes. The machine to be herein described has been devised to produce a more attractive and salable stocking of the so-called "seamless variety," and to do this the entire stocking, including the leg, foot, heel, and toe, is produced by reciprocal knitting.

The machine to be described contains what are denominated as "front needles," "suture-needles," and "back needles." The front needles knit the front of the leg and foot, the back needles the back of the leg and foot, as well as the heel and toe pouches, and the suture-needles unite the semicircular courses of loops made on the front and back needles from separate distinct yarns carried by different yarn-guides and alike or different in color or material, as desired, the said courses being joined together, semi-course to semi-course, end to end, as laid, the suture-needles thus acting to unite into a tubular fabric what would otherwise be two flat fabrics made on the front and back needles. These suture-needles, if but a single one should be used between the endmost needles of the two sets of front and back needles, will join the different yarns used in the front and back of the tubular part of the stocking along the sides of

the leg and foot, making a longitudinal wale containing loops of both yarns alternated; but when several suture-needles are used and each is controlled independently by a suture-needle pattern-surface the junction of the two fabrics may be so made as to leave an ornamental or sort of herring-bone stripe which may be greatly diversified by the order in which the suture-needles in succeeding courses are caused to take one or the other of the different yarns; or, in other words, the endmost loops of several consecutive semi-courses may be made to terminate upon any one of the four suture-needles of each set of suture-needles, thus enabling the ending of the semicircular courses to be "staggered." When the machine has knitted a sufficient number of courses for a leg, the front needles used in the front of the stocking are thrown out of operation, and they hold their loops while the series of back needles and the suture-needles are actuated to knit a narrowed portion of fabric and then a complementary widened portion to form a heel. Then all the needles are again put into operation to knit the top and bottom of the foot, and, the foot finished, the back and suture needles are again operated to narrow and then widen for the production of a toe. During the narrowing operation the suture-needles lose their individuality as needles for joining semi-courses of loops from different yarns and become regular members of the back fashioning-needles used in the formation of the heel and toe. The back needles and the suture-needles co-operating with them for the production of heels and toes are for this work placed under the control of a jacquard; but the pattern-surface referred to for the suture-needles continues to move and keeps some of the levers of the suture-needle carriages out of the path of the auxiliary Jacquard or lever cam, as will be described. The suture-needles and those of the back needles which are under the control of the jacquard become fashioning-needles, and as such some of them, commencing with the suture-needles, are rendered inoperative at each end of each course after the thread has been laid, as provided for in United States Patents Nos. 438,685 and 228,480, said needles holding their loops so that each

course of reciprocating knitting in narrowing is commenced on a needle nearer the center of the said course than at the end of the preceding course, the narrowing being continued 5 until there are left knitting only the short-course needles which are used in making the stitches for the shortest course of loops in the heel or toe, the latter needles not being under the control of the jacquard, but knitting all 10 the time, after which the needles previously thrown out of action and yet holding their loops are again lifted to knit in widening the fabric, as provided for in the said patents. In widening a better junction of the narrowed 15 and widened parts is made by throwing into action two needles at the farther side of the series of needles being used as the cam goes off the said series of needles, and at this time the last needle to be passed over by the said 20 cam is put out of action; but as the said cam completes its stroke in the opposite direction the single needle which was put out of action at the previous stroke is put into action, together with an adjacent needle, and at the 25 opposite end of the series of needles the end-most needle, or one of the two needles put into action at the previous stroke of the cam, is put out of action. In this way one of the 30 two needles put into action is the single needle which was put out of action at a previous stroke, and the single needle to be put out of action is one of the two needles which was put into action at a previous stroke. The 35 fashioning-needles are lifted by levers connected to longitudinally - reciprocating carriages, each carriage having an attached driver adapted to be acted upon by a bar or card of a jacquard, the said drivers being normally held out by suitable springs, the levers referred to being each in position to be 40 acted upon to reciprocate its co-operating needle whenever the driver joined to its carriage enters a hole in the Jacquard bar or chain. When the said drivers are acted upon 45 by the Jacquard chain and the said carriages are pushed in, their levers are put out of the path of movement of the Jacquard cam for actuating them and the needles opposite the carriages so moved in are put out of operative 50 position. In the last course of knitting in widening all carriages but one—viz., the one controlling the needle which is to be the first one crossed by the cam when going onto the levers—are left out; but this particular 55 carriage is pushed in, so that the needle controlling its lever will not be moved by the Jacquard cam, but said needle will hold its yarn, thus avoiding a hole or skipped stitch. Now this carriage during the first stroke of 60 the machine in tubular knitting must be out, so as to let its lever be struck and the needle co-operating with it knit, and to do this the machine has means for pushing aside the inner end of the driver which holds the carriage then pressed in, so that as the first semi- 65 courses for tubular knitting are to be laid the spring co-operating with that carriage

may pull it out. Substantially this same action is provided for, but with two needles, in United States Patent No. 438,685. The Jacquard chain and its cylinders stand still during tubular knitting, and each driver, with the single exception stated, enters a hole in a bar, thus leaving all the carriages of the said fashioning and suture needles but one 75 out, so that their levers are in the range of the main Jacquard or lever cam.

The machine herein to be described contains a series of web-holders; but as the cam-plate for actuating them has now only a 80 movement of reciprocation the cams for moving the web-holders are duplicated at diametrically-opposite points thereon. The yarn or thread guides have each two or more holes to thus present to the needles in the formation of the leg, heel, foot, and toe the proper 85 yarns.

The machine in practice will have a series of timing - wheels, which will be ratcheted along and at the proper time will effect certain changes—as, for instance, the change 90 from tubular knitting to heel-work when the leg is of proper length, the change from narrowing to widening, from widening to tubular knitting to determine the length of the 95 tubular foot, the application of a thickening-thread at any desired time upon the running thread used for heels and toes or for other parts of the stocking, the cutting off of the thickening-thread and the stopping of the 100 machine—and the yarns in practice may be taken from any suitable spindles and be led over and through suitable tension and take-up devices, all substantially as provided for in said patents, so the said parts need not be 105 herein specifically described; yet some of the timing-wheels will be shown and brief reference made to the parts attached to them.

One part of this invention consists in a knitting - machine containing the following 110 instrumentalities, viz: a needle-cylinder containing a series of front and back needles and suture - needles arranged between the front and back needles, as described, a reciprocating cam-cylinder having cams for reciprocating said needles in the needle-cylinder, independent yarn - guides, one to present a 115 yarn to the front needles and the other to the back needles, each guide at times presenting its yarn to the suture-needles, and a pattern 120 device to select which of the suture-needles shall be elevated and take yarn while the cam-cylinder has imparted to it reciprocal movements and the machine is operating to produce a tubular fabric, whereby the inter-loopment of the semi-courses made upon the different series of needles by reciprocal movements of the machine may be joined in pattern, substantially as will be described.

Other features of invention will be herein- 130 after described in the specification and made subject of claim at the end thereof.

Figure 1 is a plan view of a machine embodying the invention to be herein described,

the yarn take-ups, tension-bars, thickening-thread carrier, shears, and other usual parts common to the machines described in the said patents being omitted from the top of the machine, because they do not constitute part of this present invention, the suture-needle pattern-surface c^{13} being broken away to show the jacks below it. Fig. 2 is a partial side elevation, somewhat enlarged, of the upper part of the machine shown in Fig. 1. Fig. 3 is a side elevation of the lower part of the machine, Figs. 2 and 3, taken together, showing most of the parts of the machine at that side. Fig. 4 is a section taken through the upper part of the machine in the dotted line x , Fig. 1. Fig. 5 is a plan view of the machine chiefly below the dotted line x' , Fig. 2. Fig. 6 is a section on the dotted line x^2 , Fig. 5, the section going the length of the cam-shaft A^8 , leaving the same, however, in elevation, as is also left the shaft C^2 . Fig. 7 represents one of the carriages and levers co-operating with the needles used in the narrower courses of the heel and toe. Fig. 7^a is a detail showing one of the carriages and levers under the control of the jacquard in heel and toe work. Fig. 7^b is one of the suture-carriages and levers. Fig. 7^c is another of the suture-carriages and its lever. Fig. 7^d shows the pusher a^{32} detached. Fig. 8 is a detail showing the needle-cylinder in cross-section, together with the carriages having levers for moving the needles used in narrowing and widening and for knitting the back of the leg and sole of the foot, together with the drivers interposed between the carriages and the jacquard, the said figure showing also the suture-needle carriages and levers, they in heel and toe work being under the control of the jacquard and forming part of the fashioning-needles, the said figure showing the carriages in the position they will occupy in the first of the first course for tubular knitting. Fig. 9 is a detail showing the two yarn-guides in perspective. Fig. 9^a is a detail in plan view showing the needle-cylinder, the cam-cylinder and shell, and the cam-ring to automatically withdraw the needle-elevating cam, which is not used when narrowing and widening is being done, the said shell acting to lift all the needles of the machine preparatory to the application to them of a rib top, the said figure also showing the main and the auxiliary Jacquard or levercams. Fig. 9^b is a detail chiefly to show the carriage-bed, the suture carriages and levers, and the jacks to move them, the said carriages shifting when tubular knitting is being done, said figure also showing the segmental bar having cams to act upon the jacks and put them in position to enable the suture pattern-surfaces to be shifted longitudinally. Fig. 10 shows developed the interior of the shell, having the drawing-down cams to actuate certain of the needles to be described, together with the needle-elevating cam, which acts to lift the front needles when the cam is in working position, the scale being the same as in Fig. 9^a, the shell rotating in unison with and forming part of the cam ring or cylinder C^4 . Fig. 11 shows the needle-elevating ring developed. Fig. 12 shows the form of jack employed in the same grooves with the front needles, which are lifted only by the needle-elevating cam, said needles not being employed in making the heel and toe. Fig. 13 shows one of the jacks employed in the grooves containing all the other needles, which are actuated by the levers to be described. Fig. 14 is a top or plan view of the web-holder-actuating cam and devices carried by it to change the position of the yarn-guides with relation to the needle-elevating cams, the said figure also showing the segmental racks attached to the lower side of the ring carrying the yarn-guides and other racks to be described. Fig. 15 is an under side view of the said actuating-cam plate and the cams for reciprocating the web-holders. Fig. 15^a is a detail, enlarged, showing the cylindrical needle-bed in cross-section, with the needles also in section, the said figure being made chiefly to enable the needles to be grouped and designated by letter when describing their operations. Fig. 16 is a detail showing one of the pattern-surfaces for the suture-needles and jacks actuated by it to place in position at the proper times the carriages and levers for actuating the suture-needles. Fig. 17 is a sectional detail chiefly to show the devices used to rotate the shaft carrying the suture-needle pattern-surface employed to determine the order of selection of the suture-needles, the section being in the line x^0 , Fig. 1. Figs. 18 and 19 show developed the pattern-surfaces for controlling the suture-needles. Fig. 20 shows developed a series of cams to be described, they all being in practice carried by the shaft a^9 , Fig. 2. Fig. 21 is a side elevation of the outermost or leg timing-wheel, the said figure showing the wheel in the position it will occupy just as the machine is to be started, a rib top or cuff having been applied to the needles, all of which have been elevated. Fig. 21^a is a plan view of the leg timing-wheel and the parts carried and actuated by it. Figs. 22 and 23 are respectively a side elevation and edge view of the heel timing-wheel. Figs. 24 and 25 are like views of the foot timing-wheel. Figs. 26 and 27 are like views of the toe timing-wheel. Fig. 28 is a detail view representing part of the devices instrumental in stopping the machine. Fig. 29 is a detail in elevation showing the curb containing the cam-wheel C^7 of Figs. 14 and 15, broken to illustrate the position of the pins instrumental in arresting certain segments when the thread-guide carriers are to be moved or shifted in position relatively to the cams, as will be described. Fig. 30 is an under side view of the parts shown in Fig. 29, and Fig. 31 is a detail of the levers to which are joined certain bars to be described.

The frame-work A, having a table-plate A', has suitable bearings for the power-shaft A²,

provided with usual fast and loose pulleys A⁴ A⁵ and with a pinion A⁶, which engages with and rotates a tooth-gear A⁷, fast on the continuously-rotating main shaft A⁸ of the machine. The gear A⁷ has a crank-pin C⁸, which is engaged by a link C⁹, jointed at C¹⁰ to the foot B of a vertically-reciprocating rack-bar B', guided in its movements by a guide D², having its fulcrum at D³, the teeth of the said rack-bar engaging teeth at the periphery of and imparting a rotary reciprocating movement to a gear B², mounted loosely upon the shaft A⁸, the said gear having a series of beveled teeth B³, which engage a beveled gear C', (see Figs. 5 and 6 and dotted lines, Fig. 2,) fast on an upright shaft C², provided with toothed gears C³ C⁶. The gear C⁶ engages the teeth of the ring or plate C⁷, (represented as detached in Figs. 14 and 15,) it being provided at its under side with suitable cam projections 37 38 39 to work the web-holders s³, the said cam projections being duplicated at opposite sides of the center of the said plate, because in the operation of the machine to be herein described the said plate has only a to-and-fro or reciprocatory motion. The gear C³ engages the teeth of and rotates a gear forming part of the cam-cylinder C⁴.

In the operation of the machine the cylinder C⁴ and plate C⁷ are never rotated continuously, but are reciprocated by or through the rack in engagement with teeth B² of the loose wheel referred to, the rack deriving its movement from the rotary main shaft. The Jacquard pattern-chains H H' surround suitable sprocket-shafts mounted in bearings 400 at the upper ends of swinging frames G', pivoted at G², actuated by or through links F⁹, having eccentric-straps, which embrace eccentricities F⁸ on like oscillating shafts F⁶ G⁶, (see Fig. 5,) connected each with the other at one end by bevel-gears G⁴ G⁵. The shaft F⁶ derives its oscillating or rotary reciprocating movement from a rack F⁴, (see Figs. 2 and 5,) in engagement with a pinion F⁵ on one end of the shaft F⁶, the said rack being engaged by a pinion F², mounted on a stud of a slide-bar F, having roller-studs 600, (see Figs. 2 and 5,) and actuated at the proper time by the rotation of a cam B¹⁰, normally loose on the shaft A⁸, it being coupled thereto at intervals, as will be described. The pinion F² at a point below its pivot engages a stationary rack F³, and as a result thereof as the slide-bar F is reciprocated the pinion F² is rotated in one and then in the opposite direction, causing it to reciprocate the rack F⁴, so that the latter, in engagement with the pinion F⁵ on the shaft F⁶, rotates it first in one and then in the other direction.

The stationary needle-cylinder H⁸ of the machine is grooved externally in usual manner to receive the needles and jacks to be described, and above the needle-cylinder and attached thereto in suitable manner is a ring H¹⁰, provided at its upper end with a series of grooves, one for each of the web-hold-

ers s³, the bodies of the web-holders lying in grooves in the web-holder bed h, the nibs 41 of the web-holders being acted upon at 70 the proper times by the cams 37, 39, and 38, so that the said web-holders, having suitable points to engage the work, are actuated in such time and order as to keep the work down upon the needles and avoid the use of weights 75 or sinkers in knitting. It will be here stated again that when a tubular web is being made for the leg or foot by or from the independent yarns delivered by independent yarn-guides, respectively, to the front and back 80 needles that all the back needles are worked regularly, the Jacquard pattern-surface being at that time silent and being held forward. During the time a tubular fabric is being made by reciprocal knitting the suture-needle carriages are slid in their grooves, so that one or more suture-needles of each set of suture-needles controlled by levers, or the said carriages may at will be made to receive either 85 one of the two yarns coming from the yarn-carriers, and, being knitted, to form semi-courses of loops, the suture-needles connecting the endmost loops of the fabrics so produced upon the independent front and back needles from independent yarns. When, however, the front needles are thrust out of action to retain their loops while narrowing and widening is being done in the production of heels and toes, then the pattern-surface controlling the suture-needles becomes for the 90 time inoperative and the said needles and their carriages are placed under the control of the Jacquard surfaces, so that the said suture-carriages are so manipulated that the needles to be used in narrowing are, commencing with the suture-needles, dropped one at a time until the narrowest course is completed, and they are then thrown into operation 95 reversely one or more at a time in widening, until all the back needles and suture-needles 100 have been again brought into operation, when the front needles are again raised and the needle-elevating cam, co-operating therewith, is slid or put into place to actuate the front needles to be reciprocated for knitting tubular work.

The machine has suitable posts h⁴ for the reception of studs h² to support a ring h', to which is secured the said web-holder bed h, so that it remains stationary while the web-holder-actuating cam-ring C⁷ is being reciprocated.

In Fig. 4 are shown but two web-holders, because their presence in this drawing confuses the same, and from that half of the ring H¹⁰ shown in elevation are omitted the grooves in which the web-holders rest; but it will be understood that there will be a web-holder between adjacent needles and each will rest in its own groove.

The table-plate A', opposite each jacquard, has a guide-plate u, consisting, essentially, of an L-shaped plate having its upright part 5 notched to guide the drivers c, having collars

6, and jointed to the carriages d^2 , having projections 203, on which are pivoted levers u^2 . The drivers are each pulled normally out to keep the shoulders 6 against the upturned 5 notched flange 5 by springs 7, but few of the springs being shown to avoid confusion of drawings.

d^4 represents stationary carriages, they corresponding in number with the number of 10 back needles used in the shortest course of loops in the heel and toe. Each stationary carriage has a lever like that mounted on the carriages d^2 , but marked u^{2x} .

The parts so far described, with the exception of the duplication of cams on plate C^7 , 15 are common to the patent, No. 438,685, referred to.

The shaft A^8 has fast upon it a hub H^3 , in which is fitted to slide a bolt H^4 , having a projection H^5 . The cam B^{10} , loose on the said 20 shaft A^8 , is provided at one side, near its hub, with a sort of shoulder or lump B^X . (See dotted lines, Fig. 2, and full lines, Fig. 5.) When it is desired to rotate the cam B^{10} to 25 set in motion the Jacquard pattern-chain, the pin H^5 , carried by the bolt H^4 , will in the rotation of the shaft A^8 strike against one of the inclined sides of the switch-finger b^7 , (see Figs. 5, 6, and 8,) so that the said bolt will be 30 pushed to the left, viewing Fig. 6; but when the cam B^{10} is to be left loose upon the said shaft, as when the Jacquard pattern-chain is to remain at rest, then the said pin H^5 in the rotation of the shaft A^8 will strike against the 35 opposite side of the said inclined finger, thus withdrawing the bolt H^4 from its engagement with the said cam. While the projection H^5 is being acted upon by one side or the other of the said switch-finger b^7 the latter is sustained near its front end by a pin 2 or 3, 40 whichever position the finger is then occupying, the said pins being shown in Figs. 5, 6, 8, and 9^b. The switch-finger b^7 referred to is attached to a short vertical shaft a^{26} . (See 45 Fig. 9^b.)

The bolt is made to engage and rotate the cam B^{10} whenever the jacquard is to be moved to actuate the needles for narrowing and widening, and the bolt is disengaged from the 50 cam whenever tubular knitting is being done.

The barrels carrying the Jacquard chains may be rotated step by step, as provided for in Patent No. 438,685.

The main shaft A^8 of the machine has a 55 cam a , (see Figs. 2 and 6,) which acts upon rolls a' , carried by a link a^2 , slotted to embrace the said shaft, the opposite end of the said link being jointed to an arm a^3 of a rock-shaft a^4 , provided near one end with an arm a^5 , to 60 the upper end of which is jointed a pawl a^6 , which engages suitable pins or projections a^7 (see Figs. 1, 2, and 20) of a cam-hub a^8 , fast upon and thus rotating a shaft a^9 , having suitable bearings in stands erected upon the 65 top of the frame. The shaft a^9 also has fast upon it two additional cams a^{20} and c^x, c^x being shown only in Fig. 20. The shaft a^4

has two collars a^{90} , (shown best in Fig. 21,) which serve to receive the pivots of the yoke-shaped pawl a^{10} , having a bar a^{10x} , suitably shaped to engage the peripheries of and rotate the several time-wheels b, b', b^2, b^3 , to be described, the said time-wheels being placed side by side loosely on a stud b^4 , mounted in an upright b^5 of the frame-work. 75

The "cam-cylinder," as is denominated the toothed wheel engaged by the gear C^3 , has a tubular hub, (see Fig. 4,) which takes bearing in a stationary casting I^3 , supported on the bed A' . The hub of the cam-cylinder is cut out 80 to receive a cam-ring b^{12} , (shown separately in Fig. 11,) having a series of inclined cam-slots b^{13} , having straight bottoms b^{14} and tops b^{15} , the ring having a hand-piece b^{16} .

The cam-cylinder is provided with suitable 85 guideways to receive the four like posts b^{17} , each having a pin b^{18} , on the upper end of which posts is attached the circular shell C^x , (shown in section, Fig. 4, and developed in Fig. 10,) the said shell having a shoulder b^{19} , 90 below which the butts of the latched needles, all alike, cannot descend, the shell also having attached to it the drawing-down cams a^{12} for the back needles, to be described, and the drawing-down cams a^{14} for the front needles, 95 to be described.

The needle-elevating cam a^{17} for the front needles is adapted to be put into or out of operative position with relation to the cams a^{14} , it being withdrawn from operative position whenever the front needles, or those employed in the front of the leg and top of the foot, are to remain inactive and hold their loops, as when heel and toe knitting is being done. The cam a^{17} is attached to a shank a^{15} , (see Figs. 4 and 9^a,) having a pin a^{16} . The shank rests on the top of the toothed gear C^4 , and is kept down in place by guide blocks or caps 4, attached by suitable screws. (See right of Fig. 9^a.) 110

The cam a^{20} receives in its groove a roll a^{22} of a lever a^{23} , pivoted upon the bed-plate A' of the machine at b^6 , the said lever being connected by a link a^{24} with a three-armed lever a^{25} , (see Figs. 1, 2, 8, and 9^b,) fast on the short shaft a^{26} , before referred to, extended down through the bed A' and provided with the wedge-shaped arm or switch b^7 , adapted to swing between pins 2 and 3. One end of the lever a^{25} has a pin a^{27} , which enters a slot a^{28} (see Fig. 8) in an elbow-lever a^{29} , having a second arm a^{30} , jointed by a pin a^{31} to one end of a pusher a^{32} , slotted at a^{33} and embracing a guide-pin b^{10} . The second arm of the three-armed lever a^{25} has jointed to it a link a^{40} , 125 which at its outer end has erected upon it a stud a^{41} , (see Figs. 2 and 9^b,) upon the upper end of which stud is a tappet-plate a^{42} , pivoted on a stud a^{43} , (see Figs. 1 and 9^b,) erected in a stud a^{44} , said stud being shown by dotted lines in Fig. 2. 130

The tappet-plate has at one end a vertical stud a^{46} , (see Figs. 2 and 9^b,) and at its other end an arm a^{47} , which, when in the full-line po-

sitions, Fig. 9^b, will put the stud a^{16} in position to be struck during the movement of the cam-cylinder C^4 by an arm a^{48} , attached to the cam-ring a^{49} , thus arresting said ring while the said cam-cylinder C^4 continues to move in the direction of arrow 200, Fig. 9^a, so that in the further movement of the said cam-cylinder the pin a^{16} , projected upwardly from the shank a^{15} of the needle-elevating cam a^{17} for the front needles, travels longitudinally in the cam-groove a^{50} of the said arrested cam-ring a^{49} , and as a result thereof the said needle-elevating cam is withdrawn from working positions, this being done just as narrowing is to be commenced, it remaining out of position, so that it will not lift the said front needles until the widening for the heel or toe to be made is completed, when it is thrown into position.

To put the needle-elevating cam back into operative position again at the proper time the cam-cylinder is provided with a lever a^{56} , having at its inner end a pin a^{57} , which enters a slot a^{58} in the said cam-ring a^{49} , and when the tappet-plate a^{12} referred to is shifted to place its arm a^{47} in position, as in Figs. 1 and 2, to strike the outer end of the lever a^{56} it will turn that lever in the direction of the arrow upon it, Fig. 9^a, to move the cam-ring a^{49} and cause the needle-elevating cam to be put into working position, the position shown in Fig. 9^a, and thereafter in the movement of the cam-cylinder the front needles will be actuated and tubular knitting will be done.

The cam a^8 receives a roller of a lever c , pivoted at c' , the inner end of the said lever being slotted, as best shown in Figs. 1 and 9^b, to embrace a pin 404 at the under side of a segmental-shaped bar c^2 , adapted to be reciprocated in suitable guides c^3 , the said bar having at or near its opposite ends at its inner sides (see Figs. 2 and 9^b) cam projections $c^6 c^7$, which, as the said bar is moved to the right, viewing Fig. 16, acts upon the lower or the longer arms of two series of like jacks 10 11 12 13 14 15 16 17, employed to control the order of knitting of the suture-needles 10^x 11^x 12^x 13^x 14^x 15^x 16^x 17^x when joining together the loops of the independent yarns employed in the front and back of the tubular leg or foot of the stocking. The under ends of the jacks are acted upon by projections of the suture pattern-surfaces $c^{13} c^{14}$, loosely splined upon like shafts $c^{12} c^{15}$, it being possible to move the said pattern-surfaces longitudinally upon their shafts whenever the jacks referred to are pushed back by one of the rods c^{10} , carried by its lever c^8 , acted upon by the cam projection c^6 or c^7 of the plate c^2 . To move these pattern-surfaces longitudinally a bar c^{18} is provided of the same shape as the bar c^2 , the bar c^{18} lying directly on top of the bar c^2 and being provided with suitable uprights, as $c^{16} c^{17}$. (See Figs. 1 and 16.)

In Figs. 18 and 19 are shown the suture-needle pattern-surfaces developed, the one c^{14}

being nearest that end of the machine containing the shaft A^8 . These pattern-surfaces are made up by placing peripherally-notched disks upon a hollow hub between clamping-collars, the said disks having projections, (shown in the drawings in white, the spaces being shown in solid black,) the said disks having their projections and spaces in the desired order to thereby move the jacks referred to in any predetermined order, according to the particular plan or order of inter-loopment desired for the independent front and back yarns manipulated during knitting by the suture-needles.

As represented herein, each pattern-surface is made up of twelve disks; but it is desired to have it understood that the number of disks used will correspond with the number of 85 jacks and suture-needles to be actuated. These disks are arranged in groups corresponding with the number of jacks, and as there are four jacks and twelve disks there are three groups of disks, so arranged each 90 with relation to the other that when the pattern-surfaces occupy either of three different positions the proper disks will come opposite the proper jacks.

Referring to Fig. 18, showing the pattern-surface c^{14} , and commencing at the upper side of the said figure, the third, sixth, ninth, and twelfth disks will be in operative position when the leg of the stocking is being knitted; the second, fifth, eighth, and eleventh disks 100 when the heel and toe are being knitted, as the heel and toe are produced in like manner, and the first, fourth, seventh, and tenth disks are opposite the jacks and actuate them while the foot is being knitted. 105

Referring to Fig. 19, showing the pattern-surface c^{13} , and commencing at the top of the figure, the first, fourth, seventh, and tenth disks will be opposite the jacks next that pattern-surface when the leg is being knitted; the second, fifth, eighth, and eleventh disks 110 operating the jacks both when the heel and when the toe are being knitted, the third, sixth, ninth, and twelfth disks being in operative position next the jacks when the foot 115 is being knitted. The suture-needle pattern-surfaces, splined loosely on their carrying-shafts, are embraced by yokes $c^{16} c^{17}$, erected upon the opposite ends of the yoke-carrying bar c^{18} , laid just above the segmental slide c^2 120 and guided in the same guides c^3 , the said yoke-bar having a pin 405, which enters a cam-groove 407 in the cam c^x , fast on the shaft a^9 , the said yoke-bar being reciprocated by the cam c^x , rotated at the proper times by or 125 through time-wheels to thus shift the suture pattern-surfaces upon their shafts to occupy any one of their three positions, according to the order in which it is desired to move the suture-needles. The hub of the cam-cylinder 130 C^4 has attached to it at nearly diametrically opposite points arms 18 19, provided, respectively, with cams $C^5 C^{5x}$, the cam C^5 being located nearest the center of the needle-bed H^8 ,

and being herein designated as the "main Jacquard or lever cam," the said cam being common to Patent No. 438,685, referred to. The cam C^{5x} on the arm 19 is located at a greater distance from the center of the needle-cylinder than the cam C^5 , and the cam C^{5x} is denominated as the "auxiliary Jacquard or lever cam," it standing in vertical line with cam a^{17} and under thread-guide n . The reciprocating stroke of the cam-cylinder about the needle-bed in each direction is sufficient to carry the cam C^5 from about the position in the direction of the arrow to about the position m' , (see Fig. 8.), and in such movement the said cam acts on all the levers u^2 of all the carriages d^2 , unless the said carriages have been pushed inwardly by the jacquard acting upon the carriers, also on all the levers u^{2x} , mounted on the carriages d^4 , and also on all the levers $e^1 e^2 e^3 e^4 e^5 e^6 e^7$, mounted on the suture-carriages $e^8 e^9 e^{10} e^{11}$ and 60 61 62 63, unless the carriages containing the said levers have been pushed in by either the jacquard or by the suture-needle pattern-surface, that depending on the part of the stocking being knitted, the said cam C^5 acting upon the said levers which are left within range of its movement during the first part of the knitting of each semi-course, the cam C^{5x} acting upon such of the levers e to e^7 as may be left out within the range of its movement as said cam completes its stroke, it at such time passing beyond the suture-carriages toward the carriages d^4 at each end of each stroke. The needle-depressing cam a^{12} acts upon the butts of and depresses all the back needles which are elevated by the action of cam C^5 on any of the carriage-levers referred to, the inner end of each lever resting in practice, when raised, below a slide g^2 , such as represented in Fig. 13, the butts of the back needles resting upon the upper ends of the said slides, as represented at the right in Fig. 4. The needle-depressing cam a^{14} , during circular knitting acts upon the butts of and depresses the front needles, which in practice are elevated by the needle-elevating cam a^{17} when in working position, the said needle-elevating cam to lift the front needle, as herein represented, entering a notch g' (see Fig. 12) in a slide g . The bed A' has on it a carriage-bed A¹⁰, provided with a series of radial grooves, in which all the said carriages, except those marked d^4 , are free to slide longitudinally, the latter carriages being held in place by means of a lip A¹², which enters notches in the said carriages, the carriages being kept down in their grooves by a curved bar A¹³. The inner end of the carriage-bed A¹⁰ has attached to it a plate A¹⁴, which prevents the inner ends of the carriages from being lifted out of the grooves, and the tops of the levers are so placed as always to contact with the said plate. The carriages D⁴ are not reciprocated, because the levers which are mounted upon them and the needles co-operating with the said levers, they being the ones used in the

shortest course for the heel or toe, are always moved to take yarn and knit no matter what part of the stocking is being knitted. All 7c the suture-carriages e^8 , e^9 , e^{10} , e^{11} , and 60 61 62 are alike, but the carriage 63, instead of having pivoted to it the inner end of a driver (such as represented by h) is notched or cut away at its sides to leave a shoulder 64, as 75 best shown in Fig. 8, against which the inner end of a driver h' works at suitable times when it is desired to push the carriage 63 forward and place its lever e^7 out of reach of movement of the cam C^5 . The carriage 63 80 has a spring 65, which normally pulls the carriage out, and the driver h' has an attached spring 66, which normally keeps it pressed outwardly, the driver h' also having an arm or finger 67, which coacts in such manner 85 with the drivers h as to prevent rotation of the drivers h' , the said arm or finger 67 being used also in the Patent No. 438,685 for a like purpose. The drivers h and c , jointed to the carriages referred to, are adapted to be struck 90 by the jacquard, and in practice all the drivers h and c will have suitable springs 7 to pull them outwardly to normally hold the carriages with the levers thereon in the range of movement of the cam C^5 , the ends of the drivers at such times entering holes in the Jacquard bars. Prior to knitting the last course 95 in widening the heel or toe the jacquard, co-operating with the drivers described, acts only upon the driver h' , causing it by its end 100 against the shoulder 64 of the carriage 63 to push it in preparatory to the commencement of the knitting of that course, so that when the knitting is commenced for that course the suture-needle 10^x , co-operating with the lever e^7 , is rendered inactive to hold its loop, 105 thus avoiding a skipped stitch, as is well understood and as provided for in Patent No. 438,685. It is necessary, however, when the first course for tubular knitting is laid that the needle 10^x , which was inactive at the commencement of the last course in widening, should be actuated, so that said carriage 63 must, preparatory to making the first semi-course for tubular knitting, be moved outwardly, so that its lever e^7 will be put in position to be actuated. To effect the release of the carriage 63 and let it be moved outwardly by the spring 65, the pusher a^{22} is moved by the lever a^{23} into the position shown in Fig. 8, so 110 that the inner end of the said pusher, by acting against the inner end of the driver h' , pushes the same out from engagement with the notch 64, when the carriage 63 is then moved outwardly by the spring 65 to bring its lever 115 within the range of the cam C^5 , leaving the carriage 63 with its lever in the range of the cam during tubular knitting, the said lever, however, at such time being subject to be moved independently by the jack 17, according to the requirements of the pattern-surface c^{14} . During tubular knitting the jacquards remain stationary and in their innermost positions close to the upturned lips 120

5, and the driver h' is kept in; but as soon narrowing is to be again commenced for heels and toes the jacquard is started, the spring 66 immediately pulls the driver h' outwardly, so that its inner end immediately catches the shoulder 64 of the carriage 63, ready to push the said carriage inwardly the first time that the jacquard comes forward, and its card or bar strikes the said carriage.

10 Substantially the movement described for the carriage 63 by the driver h' is provided for in the Patent No. 438,685.

Referring now to Fig. 15^a, which represents the needle-cylinder in cross-section with needles therein, the group of needles f' , inclosed by the bracket F' , (shown as fifty-one in number,) constitute what have been designated as "front needles," the said needles in practice receiving a yarn, as $f'y$, coming from an eye 101 in a yarn-guide n , the said yarn being knitted by the said needles to constitute the front of the leg, the said needles also acting to knit the yarn which enters into the front or top of the foot. The group of needles B' included within the bracket, Fig. 15^a, (shown as fifty-nine in number,) are designated at times as "back needles," they receiving a yarn from an eye 100 in a yarn-guide n' and knitting the said yarn to constitute the back of the stocking, 30 the said needles also receiving and knitting the yarns employed in the production of heels and toes and of the sole of the foot. For convenience of description the back needles have been subdivided into groups, making of them two groups of needles s' , which will be at times called "suture-needles," two groups of needles f'' , which will be called at times "fashioning-needles," and a group of needles s'' , which will be called "short-course" needles.

40 It will be understood, however, that the needles called "suture-needles" will be moved to knit one or more during the production of each semi-course of loops from the two independent yarns for the production of tubular web by manipulating the carriages and levers co-operating with the said suture-needles through the agency of the suture pattern-surfaces, the jacquard during tubular knitting remaining stationary, leaving all the carriages under its control except the carriages co-operating with the suture-needles, stationary; but when narrowing and widening is being done then the fashioning-needles, as well as the suture-needles, are controlled by the jacquard, and the suture-needles really become prolongations of the series of fashioning-needles, constituting the endmost needles of the said series, some of the suture-needles, however, during narrowing and widening being also acted upon by the suture pattern-surfaces, which continue to move intermittently during all the knitting, the movements imparted, however, to the suture-carriages by the jacks and suture pattern-surfaces during heel-and-toe knitting being chiefly to push the suture-carriages temporarily, as between the times of action of the main Jacquard or

lever-cam C^5 , so that the auxiliary Jacquard or lever cam C^{5x} will not act upon the levers of the suture-carriages and move the suture-needles out of time for the production of the interloopment desired. It will be understood that the suture-needles during the first or longer courses in narrowing and during the last or longer courses in widening constitute the endmost needles to receive loops and form stitches, and during heel-and-toe work these suture-needles are selected for stitch-making purposes solely by or through the Jacquard pattern-surfaces, yet as the machine herein described and shown is constructed the suture pattern-surfaces rotate not only when tubular work is being done, but while narrowing and widening is being effected; but the movements given by the suture pattern-surfaces to the carriages carrying the levers which actuate the suture-needles are so timed as not to make a stitch; or, in other words, the longitudinal movements as the suture-needle carriages derived from the suture-needle pattern-surfaces during the heel-and-toe work are false movements and effect nothing; but the machine is rendered more simple by continuing the movement of the suture-needle pattern-surfaces during the narrowing and widening than were a stop-motion provided for the said suture-needle pattern-surfaces to arrest the movement of the same during narrowing and widening. The number of suture-needles employed to interloop the two independent yarns along the sides of the leg and foot of the stocking may be one or more, according to the particular design or pattern desired to be shown in the stocking, where the said independent yarns interlooped at the ends of the semi-courses of loops as they are laid. The employment of more than one suture-needle enables the ornamental interloopment to be made correspondingly intricate. In the embodiment of my invention herein represented I shall assume that the interloopment of the two independent yarns constituting the one the back and the other the front of the leg will be done by or through the action of some of the suture-needles, and in effecting such interloopment the suture-needle, co-operating with and constituting the endmost needle of the set of front or back needles, will receive a yarn as the said cams C^5 C^{5x} pass off the devices employed for reciprocating the said needles, but the said suture-needle to receive the last loop of a semi-course will be rendered inactive as the said cams C^5 C^{5x} move in the direction to come onto and actuate the said needles. In this way the suture-needles used receive alternately loops from the two yarns, making a junction substantially such as represented in Fig. 2 of United States Patent No. 459,992, dated September 22, 1891, one yarn being supposed to come from the eye 101 in the yarn-guide n , while the other yarn comes from the eye 100 in the yarn-guide n' . During narrowing for the production of heels and toes

the suture-needles, then forming extensions of the fashioning-needles, are thrown out of operation in the order before mentioned to hold their loops and are thereafter thrown into action, as hereinbefore provided for, until the pouch for the heel or toe is properly knitted. The fashioning-needles are thrown out of operation after the suture-needles are thrown out or rendered inactive until all the needles in the back of the fabric, except those employed in the shortest course for the heel or toe only, are used to receive yarns and knit. The cam-cylinder C^4 at its under side (see dotted lines, Fig. 9^a) has two cams e^{14} e^{15} , which during each reciprocation of said cylinder act in succession upon a roller or other stud e^{16} (shown best in Fig. 17) of a slide-bar e^{17} , guided in a stand e^{18} , erected upon a framework, the said bar having a spring-controlled pawl e^{19} , which engages one after another the pins e^{20} of a wheel e^{21} , fast on a shaft e^{22} , the said wheel being represented as surrounded by a spring-controlled friction-band e^{23x} , so that it will not overrun its motion. The shaft e^{22} , having suitable bearings, is provided at its opposite ends with bevel-gears e^{24} e^{25} , which engage, respectively, bevel-gears e^{26} e^{27} , fast on the respective shafts c^{15} c^{12} , upon which are splined loosely, as stated, the pattern-surfaces. The suture-needles during tubular knitting will be moved by or through the suture-needle pattern-surfaces and intermediate devices to take the loops formed from the independent yarns used in the front and back of the stocking at the end of each semi-course of loops knitted on the front and back needles and interloop the said yarns, semi-course after semi-course, to form a tubular fabric for feet, and by causing any one of these suture-needles, of which there may be any desired number, to constitute the endmost working needle of any course to be laid. A great variation in design may be effected where the said yarns are interlooped and the semi-courses so laid with yarns differing in color, although containing the same number of loops, may be made to terminate in different longitudinal wales, although the same number of loops are employed in each semi-course made from the same yarn. The gear-plate C^7 , having the cams to actuate the web-holders, is chambered at its upper side, (see Fig. 14,) and has a stud f , upon which is mounted a pinion f' , and the said gear has attached to it two short segmental racks f^2 g^{20} . Just within the chamber in the said plate, and close to the inner wall thereof, is laid loosely a segmental rack f^3 , which always remains in engagement with the pinion f' and with one or the other of the two pinions f^4 f^5 , mounted, respectively, upon the lower ends of pins f^6 f^7 , depending from segmental plates f^8 f^9 , (shown by dotted lines in Fig. 14,) having, respectively, arms f^{10} f^{12} , the said plates being kept in position in the chamber of the said plate C^7 by a bezel at f^{13} , confined by suitable screws f^{14} , through

the cap or cover f^{15} , within which the gear-plate C^7 rotates. The plates f^8 f^9 have a friction device n^4 , (shown as a spring,) preferably faced at the under side with some soft material like leather, which bears upon the ring n^2 , to which are attached the two yarn-guides n n' , the one n presenting its thread f^y chiefly to the front needles, while the one n' presents its thread b^y chiefly to the back needles, each, however, presenting at times its yarn to the suture-needles when the endmost loops of the semi-courses are to be united by the said suture-needles to form a tubular fabric.

The curb f^{15} of the machine is provided, as herein represented, with four holes, in which are placed four pins t t' t^2 t^3 , which are acted upon by like springs s^{10} , which normally keep the lower ends of the pins pressed down in contact with bars, to be described, the lower ends of the said pins being extended into like hubs s^{12} , secured in suitable manner to the under side of the bed-plate h' , (see Figs. 4, 29, and 30,) the said hubs being slotted to receive the free ends of and guide a series of bars t^4 t^5 t^6 . The bar t^5 lifts simultaneously the two pins t and t^2 to put them in range of motion of the arm f^{10} whenever it is desired to shift the thread-carrier ring n^2 to put the center eye 102 of the thread-guide n' in position for heel-and-toe work, the pin t not, however, being absolutely necessary, but being employed chiefly as a safeguard in case, for any reason, the arm f^{10} should pass the pin t^2 . The bar t^6 is connected at its inner end to one arm of a yoke t^7 , mounted upon a stud t^8 and having a suitable cam projection at each rear side, which is acted upon at the proper times by suitable pins, either on the leg-wheel b , where the said pin is marked t^{10} , or by a corresponding pin t^{10x} on the foot-wheel b^2 . The bar t^6 lifts the pin t^8 to put its upper end in position to be struck by the arm f^{10} when the thread-carrying ring n^2 is to be shifted to put the endmost eyes 100 and 101 in position for tubular knitting. The inner end of the bar t^6 is connected to an arm of a yoke t^{14} , also mounted on the said stud t^8 , the said yoke having suitable projections adapted to be acted upon by pins t^{15} t^{15x} of the said leg and foot wheels b b^2 . In case each thread-guide is to have three eyes, then the bar t^4 will act to lift the pin t' , putting it in position to be struck by the arm f^{12} , and bring eyes 104 and 105 in place. In case the bar t^4 is used, it will be connected to an arm of the yoke t^{18} , having the same fulcrum as the other yoke, and provided with suitable projections, which at proper times are acted upon by pins t^{19} t^{19x} on the said wheels b b^2 . These yokes will be operated in the proper time and order to cause the bars to lift the pins, so as to arrest the devices for shifting the thread-guides, so that they will at the proper times, according to the particular work to be done, put the proper thread substantially in vertical line with the different needle-elevating cams. Each bar

mentioned has a suitable cam-face t^{13} to act on the lower ends of the said spring-pressed pins to lift them.

The yarn-guides n n' (shown detached in Fig. 9 and also in Fig. 1 and partially in Fig. 4) are attached to a yarn-guide-carrying ring n^2 , to the under side of which by suitable screws is attached a segmental rack n^3 . (Shown in plan view in Fig. 14.) Herein, however, the yarn-guide n , which presents yarn to the series of front needles, is represented as having three eyes 101, 103, and 105, while the yarn-guide n' , which presents yarn to the back needles, is provided with eyes 100, 102, and 104, the eyes 100 and 101 working in pairs, 102 and 103 in pairs, and 104 and 105, if employed for striping, in pairs. The eyes 101 and 100 will deliver the yarn respectively to the front needles and to the back needles when the leg is being knitted by reciprocal knitting. The eye 102 will deliver yarn to the back needles for the heel, and if the heel is to have two yarns, and be what is called "high-spliced," the said two yarns being incorporated before the narrowing commences, then the yarn going to the front needles while the high-splicing is being done will be delivered to the said front needles from the eye 103. Should the yarns coming from the eyes 101 and 100 be of like color, the leg will be of the same color front and back. Should the yarn coming from the guide-eye 102 be of a different color from that contained in the eye 103, going to the front needles, then the heel and toe will be of a different color from the front of the leg, and if the sole of the foot is to be of a different color from the front of the leg and front of the foot, then in such instance the eye 104 would contain a yarn of the color desired for the sole of the foot, while the eye 105 would contain a yarn of the color desired for the top of the foot.

By arranging yarns of different colors in the eyes referred to any desired number being used according to the desired colors, any desired part of the stocking may be given any desired color, the yarn-guides being shifted in one or the other direction, so that the particular eye employed to deliver the yarn desired at that part of the fabric shall occupy the proper position relative to the needle-actuating cams, well understood by those conversant with the art of knitting to enable the yarn delivered by the said eyes to be taken by the hooks of the needles and made into loops for knitting.

The bobbins or other sources of supply for the different yarns going to the different eyes of the yarn-guides are not herein represented, nor are represented the take-up devices or tension devices co-operating with the said yarns, nor yet the devices for delivering an extra or thickening yarn in contact with the yarn going to the eye which is delivering or to deliver a yarn to the needles for the heel and toe knitting, nor the devices for cut-

ting off the extra or thickening thread at the proper time, as it will be understood that said devices are and preferably will be such as represented in United States Patent No. 438,685, hereinbefore referred to, or such as represented in United States Patent No. 228,480.

Referring again to Fig. 9^a, the cylinder C⁴ has attached to it friction-plates C⁴⁰, which bear upon and prevent the movement of the ring a⁴⁹ due to momentum. The handle b¹⁶ of the ring b¹², while knitting is being done, is engaged and held by a suitable locking device b⁶¹, attached to the cam-cylinder C⁴.

The machine herein represented (see Figs. 9^a and 4) has a ring b⁶², provided with suitable spaces 110, so that any needle opposite the said spaces may be readily lifted out from the grooves in the needle-bed, the slides 112, carried by the said ring b⁶², being at such times withdrawn, as represented in Fig. 9^a. The movement of the ring b¹² by the operator engaging the handle b¹⁶ by hand, will cause the cam-surfaces b¹³ of the said ring to act on the pins b¹⁸ of the rods b¹⁷ and lift the shell C^X, and at such times the shoulder b¹⁹ of the said shell will act upon the under sides of the butts of all the needles in the machine and will lift them above the upper end of the needle-bed and the parts thereabout to enable a rib top to be put upon the said elevated needles by a transferring device of any usual construction. The rib top having been transferred upon the needles, a reverse movement of the ring b¹² will bring all the needles into proper position to be actuated for knitting.

In explanation of the operation of the machine let it be supposed that a stocking has been run off the needles after the widening operation for the toe; that the operator has engaged the handle b¹⁶, referred to and lifted the needles, and that the rib top has been put upon them and the shell again drawn down. In this condition of the parts both Jacquard pattern-chains occupy their innermost positions and are stationary, and all the drivers at the front of the machine are out in holes of the chain H, most of the said holes being omitted from the present drawings because represented in the Patent No. 438,685, and all the drivers next the Jacquard chain H' are also out, with the exception of the driver h', co-operating with the carriage 63, that driver being, however, pushed aside, as represented in Fig. 8, so that the carriage 63 may present its lever e⁷ in position to be struck by the cam which is to actuate the needle controlled by it. The machine is now started, it having only a movement of reciprocation; but the part of the stocking being made is the top. The yarn coming from the eye 101 of the yarn-guide n is presented to the series of front needles fⁿ, and the said yarn is knitted to form semi-courses of loops for the front of the leg, the yarn coming from the eye 100 of the yarn-guide n' being presented to the series of needles included in the bracket Bⁿ or to all the

needles of the set of back needles including the suture-needles, the said yarn being knitted to form semicircular courses to constitute the back of the leg, the suture-needles inter-looping the endmost loops of the said semi-courses of loops as laid, thus making a tubular fabric. In the present embodiment of the invention the suture-needle-pattern surface is so formed that while tubular knitting is being done for the leg but one suture-needle of each set of suture-needles effects the interlooping of the independent yarns, as has been previously described. When the heel is to be formed, the last courses for tubular work having been made, the pawl a^6 is permitted to drop by the movement of the time-wheel controlling it, and in the first forward movement of the said pawl it engages one of the pins a^7 , extended from the cam a^8 , and rotates that cam and the other cams a^{20} and c^x alongside of it. In the movement of these cams the cam a^8 first actuates the lower segmental bar c^2 , causing its cams to effect, as described, the movement of the jacks about their fulcrum c^9 , so as to remove their short arms from contact with the pattern-surfaces for the suture-needles, so that the said pattern-surfaces may be shifted in order to put the disks thereon next to be used while the heel is being made in proper position opposite the said jacks, the movement of the said pattern-surfaces upon their actuating-shafts being effected by the cam c^x , which moves the yoke-bar in the proper direction, and the pattern-surfaces having been shifted, as stated, the lower bar c^2 is returned to its normal position to again permit the upper ends of the jacks to contact with the pattern-surfaces to move them. At this time the tappet-plate a^{42} is turned by the devices described, the said devices including the three-arm lever a^{25} , actuated by the lever a^{23} , and the stud a^{46} is put into such position that it will be struck during the movement of the cam-cylinder C^4 in the direction of the arrow 200, Fig. 9^a, by the arm a^{48} , attached to the ring a^{49} , causing the cam in the said ring, acting on the pin a^{16} , to withdraw the needle-elevating cam a^{17} out of operative position, so that in the further movement of the machine, while the heel is being done, the said cam will not lift the front needles, and consequently the latter needles will remain inactive and hold their loops. As the cam a^{17} is withdrawn from action the switch-point b^7 is swung into position to effect the engagement of the bolt H^4 with and to start in rotation the cam B^{10} , which latter will immediately start, through the mechanism previously described, the movement of the jacquards, and for heel-work the narrowing and widening will be carried on, putting out of and into action the needles in the proper time and way, as hereinbefore stated, and as provided for in Patent No. 438,685. The heel having been finished, tubular work will be again commenced for the foot of the stocking, and for the last widening course the pusher will push aside the driver

h' , releasing the suture-carriage 63 and permitting it to be moved outwardly into position for tubular knitting.

The foot of the stocking will be described as produced from two yarns united semi-course to semi-course of loops as laid by four suture-needles situated at substantially diametrically-opposite points to thus make an ornamental or zigzag stripe at each side of the stocking.

Before commencing to describe the action of the suture-needles it will be stated that there are two groups of suture-needles, one group 17^x 16^x 15^x 14^x and another group 13^x 12^x 11^x 10^x, the last group being located at a point nearer the main shaft than the first group. These needles are lifted, respectively, by their own suture-levers $e^1 e^2 e^3 e^4$ and $e^5 e^6 e^7$, the suture-levers being mounted, respectively, on their respective carriages, (marked $e^8 e^9 e^{10} e^{11}$ and 60 61 62 63,) all the carriages but 63 being alike. Let it be supposed that the yarn-guide n delivers a white yarn and that all the elevated needles lifted by levers passed over by the cam C^{5x} will take white yarn and all the elevated needles lifted by levers passed over by the cam C^5 will take black yarn from the yarn-guide n' . The cam C^5 always acts on all the levers u^{2x} of the stationary carriage d^4 and all the fashioning or suture needles whose carriages are left out either by the Jacquard or by the suture-jacks, the said cams acting only on the inner nibs o of the suture-levers when the said nibs are in the same circle as the single nibs of the fashioning and narrow-course needles. The cam C^{5x} acts only on the outer nibs o' , and to act on the said nibs the carriages having the said suture-levers must be out.

Before describing the action of the two sets of four suture-needles, all of which it is supposed in this instance of the invention coact for a purpose in making tubular fabric by reciprocal knitting for the foot, it will be further supposed that there are fifty-one front needles, twenty-one narrow-course needles, and twenty fashioning-needles each side and four suture-needles at the end of the fashioning-needles; but any other number may be used, according to the work to be done. Counting the narrow-course needles, the fashioning-needles, and suture-needles, makes sixty-nine back needles to fifty-one front needles.

In tubular knitting with independent yarns by reciprocal movements, as herein provided for, where the endmost loops of the simultaneously-laid semi-courses of loops are joined or interlooped end to end as laid, it will be understood that every semi-course of loops made from the front yarn requires the employment of all the front needles and each semi-course of needles employed in the production of each semi-course will be the same; but in the production of the said semi-courses some of the suture-needles forming the endmost needles of the back needles, or it may be the endmost needles of the series of front needles, may at

some semi-courses be left down for one or more courses, they at such time retaining their loops, the said needles being subsequently raised at other courses to take yarn and cast off their loops about the yarn just taken. In certain courses certain of the suture-needles are not acted upon by either cam C^{5x} or C^5 ; but in succeeding courses such needles are acted upon by both said cams, and it will be understood that to effect a zigzag suture-stripe at the sides of the leg the consecutive semi-courses knitted from either the front or back yarns will not terminate always on adjacent suture-needles, but may terminate on a second needle remote from the needle which received the particular yarn at a previous course. Having this fact in mind, and the fact that it is possible by the suture-needle pattern-surface to select any one of the four suture-needles as the first needle of each semi-course and finish the course with the prescribed number of loops for that particular size of stocking—that is, the needle 13^x might be the first needle to take white yarn to knit a semi-course on the front needles and the course be finished on the fifty needles or on the needle 17^x , and by commencing on needle 10^x and ending on 14^x it will be understood that the ends of the courses of the two colored yarns will be "staggered" or the junction be given a zigzag or herring-bone appearance, as represented in United States Patent No. 459,992, dated September 22, 1891, which contains and describes a stocking having a suture or interloopment of its independent yarns, such as will be produced on the machine herein shown and described. To knit each semi-course of loops from each of the two threads, both sets of suture-needles are distributed before the cams C^5 and C^{5x} start to knit the semi-courses, one chiefly on the back and the other on the front needles, the courses being started and finished on some of the suture-needles, and after each cam traveling in unison with the other and in the direction of the hands of a watch has passed the first set of suture-needle levers in its path and acted on those levers, the suture-needle pattern-surface acts and redistributes the suture carriages and jacks in a different order before the other cam comes to the suture-needles acted upon by the first cam. In other words, there are two different distributions of the suture-needle carriages for the production of each semi-course and while the cams are moving in the same direction for one stroke. During the first distribution the cam C^{5x} will act opposite the narrow-course needles and the cam C^5 is diametrically opposite. The second distribution of the levers takes place by the suture pattern-surface, and while the said cams continue to travel in the same direction the cam C^5 acts on the levers $e^3 e^2 e$, while the cam C^{5x} acts on the levers $e^7 e^6 e^4$. The next semi-course will be knitted while the cam-cylinder and cams thereon make their opposite stroke. With

this explanation it is unnecessary to fully describe the action of each yarn-guide for each half of each course, as the action may readily be read from the drawings. Rock-shaft 300 has two like lugs 301 302. (See Figs. 1, 2, and 21.) The lug 302 is struck by a pin 303, carried by the heel-wheel, Figs. 22 and 23, and throws rod 304 down to let pawl a^6 engage pins of wheel a^8 and rotate the shaft a^9 , when, after knitting the leg, the segments c^2 and c^{18} for moving the jacks and shifting the pattern-surfaces are actuated, and also the jacquard started and the outer suture-needle carrier is released to let it be moved by the jacquard. The heel having been finished and the foot to be made, the projection 305 on the foot-wheel (see Figs. 24 and 25) strikes the projection 301 and drops the rod 304 a second time to enable the pawl a^6 to again start the shaft a^9 and effect the necessary changes for reciprocal tubular knitting. To change from foot to toe work the pin 306 on the toe-wheel b^3 , Figs. 26 and 27, strikes the lug 301 and effects the necessary changes, before described, for the change from tubular knitting to narrowing, and, the toe produced, a pin 307 on the leg-wheel b , Figs. 21 and 21^a, acts on lug 302 to stop the jacquard, and at this time the projection 308 on the leg-wheel b meets the inclined end of a lever 309, lifts its inner end from engagement with the shoulder 310 of the slide 312, connected by a rod 313 with a short arm of a shipper-shaft 314, having a handle 315. (See Fig. 1.) This slide 312 has a spring 316, which normally acts to keep the inner end of the said bar against a stud 317 on the shipper-bar 318, connected at its outer end to a belt-fork 319, pivoted at 320, the said fork embracing the driving-belt, (not shown,) the spring 321 normally acting on the said bar 318 to draw it in the direction of the arrow 322, Fig. 28, and keep the belt-fork on the loose pulley. The bar 318 has a notch 323, which is also engaged by the end of the lever 309 when the bar 318 is moved in the direction opposite the arrow 322 to thus keep the belt on the fast pulley A^5 . The operator by the hand-lever 315 may draw the slide 312 in the direction of the arrow 324 and cause the incline 325 of the slide to act on the lever 309 and disengage the bar 318. In narrowing after the cam C^5 runs off the series of needles the two endmost needles of the series of needles next to it are thrown out of action, while the endmost needle of the series of needles farthest from the said cam is put into action, the needle so put into action being one which was put out of action at the end of a previous stroke. As the cam comes back again it passes off and fails to operate the two needles previously put out of action, and these needles remain down, hold their loops, and do not take yarn; but the single needle referred to as put into action does take yarn. After the cam has completed its second stroke the operation is repeated and the two needles at that end of the series of needles next to it are thrown

out of action and the endmost needle at the end of the series of needles farthest from the cam is put into action, that needle being one which was put out of action at the completion of the previous stroke of the cam. This action is repeated throughout the narrowing. One of the two needles previously thrown out and held out is thrown in, so that it and the next needle to the center take yarn, and then 10 that needle, with its fellow-needle, is thrown out and it remains out, but its fellow comes back after the cam has run on.

It will be obvious that the interloopment between the front and back of the leg and 15 the top and sole of the foot performed through the medium of the suture-needles may be more or less ornamental, according to the number of the suture-needles employed and the particular set-up of the pattern-surface for selecting the said needles. The interloopment of the leg parts of the fabric by a single needle and the interloopment of the foot parts by 20 four needles have been described; but it will be obvious that any number of suture-needles 25 contained in the machine may be employed either in the leg or foot, according to the pattern desired.

Prior to this invention a circular-knitting machine having a cam-cylinder provided with 30 a laterally-movable needle-elevating cam to raise part of the needles during the knitting of tubular fabric has never had the said cam moved automatically out of and into operative position under the control of an indicating-wheel acting as a pattern, and this invention 35 is therefore not limited to the particular devices employed to arrest the cam-ring which moves the needle-elevating cam laterally.

Having described the invention, what is 40 claimed is—

1. A knitting-machine containing the following instrumentalities, viz: a needle-cylinder containing a series of front and back needles and suture-needles arranged between the 45 front and back needles, as described, a reciprocating cam-cylinder having cams for reciprocating said needles in the needle-cylinder, independent yarn-guides, one to present a yarn to the front needles and the other to the 50 back needles, each guide at times presenting its yarn to the suture-needles, and a pattern 55 device to select which of the suture-needles shall be elevated and take yarn while the cam-cylinder has imparted to it reciprocal movements and the machine is operated to produce tubular fabric, whereby the interloopment of the semi-courses made upon the different series of needles by reciprocal movements of the machines may be joined in pattern, substantially as described.

2. A knitting-machine containing the following instrumentalities, viz: a needle-cylinder having grooves for the reception of front and back needles, a series of front needles 65 upon which to knit the front of a stocking, a series of back needles upon which to knit the back of a stocking, the sole of the foot, and

the heel, suture-needles located between the said series of front and back needles referred to, a pattern-surface to determine the time of movement of the suture-needles, a reciprocating cam-cylinder having cams to actuate the needles contained in the needle-cylinder, two yarn-guides having each two or more eyes for delivering independent threads, one to the 70 needles which knit the front of the leg and foot and the other to the needles which knit the back of the leg and sole of the foot, a thread-carrying ring, a pattern-surface, and intermediate devices to effect the change in 75 position of the yarn-guides to place one or the other of their thread-eyes and one or the other of the threads carried by them into position to be delivered to the needles, substantially as and for the purpose set forth. 80

3. The needle-cylinder, a series of front needles, a series of back needles, and the suture-needles therein, the carriages and levers co-operating with the said suture-needles, cams to actuate the said levers, and jacks to 85 reciprocate the said carriages, combined with a pattern-surface to actuate the said jacks and carriages in predetermined time and order, substantially as described.

4. The needle-cylinder, front and back needles therein, means to actuate them, suture-needles, carriages and levers to actuate the suture-needles, the jacks to move the carriages, and the pattern-surfaces to actuate the 90 said jacks, combined with a device to act upon the said jacks and remove them from contact with the pattern-surfaces and with means to shift the pattern-surfaces longitudinally, as and for the purpose set forth. 95

5. In a knitting-machine, two rotating 105 shafts having pattern-surfaces keyed thereon loosely, combined with a segmental bar having yokes to embrace the said pattern-surfaces and with a cam to reciprocate the said bar, as and for the purpose set forth. 110

6. The reciprocating cam-cylinder having a needle-elevating cam a^{17} and a ring having a cam, an arm, and a lever, combined with a tappet-plate, a cam a^{20} , and means between the said cam and tappet-plate to move the same and cause the said tappet-plate to arrest either the said arm or the said lever when it is desired to put the needle-elevating cam into or out of operative position, according as it is desired to reciprocate the front needles 115 for tubular work or to leave them out of action while the remaining needles of the machine are operated for narrowing and widening. 120

7. The tappet-plate, the reciprocating 125 toothed gear C^4 , having the short racks g^{20} and f^2 , the longer segmental rack-bars f^3 and n^3 , the toothed pinions f' , f^4 , and f^5 , and the yarn-carrying ring and attached yarn-guides having two or more eyes, combined with the 130 slide-plates, upon which are mounted the pinions f^4 and f^5 , engaging the said racks, whereby by change of position of the said plates the said yarn-guides have their positions

changed with relation to the actuating-cams of the machine, substantially as described.

8. The reciprocating cam-cylinder provided with cam projections e^{14} and e^{15} , the pattern-surfaces, their shafts, the shaft e^{22} , and gearing to enable the latter to rotate the said pattern-surface shafts, combined with a pawl-carrying carriage actuated by the said cam projections and adapted to engage and rotate a pin or ratchet wheel on the said shaft e^{22} , to operate substantially as described.

9. The driver h' to hold the carriage 63, and the pusher and levers a^{29} and a^{35} , combined with the cam a^{20} , devices actuated by it to move the lever a^{25} , and means to rotate the said cam step by step, whereby the pusher is moved at the proper time to release the said driver from the said carriage, as and for the purposes set forth.

10. The cam-cylinder, the laterally-movable needle-elevating cam a^{17} , a cam-withdrawing ring mounted on the said cylinder and provided with an arm a^{48} , and a lever a^{56} , pivoted with relation to said cam-cylinder and engaging the said cam-ring, combined with a tappet-plate adapted in its movements to be put into position to be engaged by either the said projection a^{48} or the said lever a^{56} , a pattern-surface, and intermediate devices to operate the said tappet-plate when it is desired to put into or out of operation the said needle-elevating cam, substantially as described.

11. A knitting-machine containing the following instrumentalities, viz: a needle-bed adapted to receive a series of front and back 35 and suture needles, a cam-cylinder having cams to actuate the said needles, devices for moving the said cam-cylinder reciprocally, two thread-guides, each adapted to receive a separate yarn, a web-holder bed adapted to 40 receive therein a series of web-holders, and a cam-plate moved in unison with the said cam-cylinder and having two sets of web-holder-actuating cams, the said instrumentalities being organized to operate substantially as described, whereby the said yarns knitted in each semi-course are joined as laid at the ends of the said semi-courses, one to the other, to produce a tubular fabric from independent yarns, one of which appears in the front of 50 the stocking to the exclusion of the other, and vice versa, substantially as described.

In testimony whereof I, JOSIAH BUTLER, executor of the last will and testament of BENJAMIN F. SHAW, have signed my name 55 to this specification in the presence of two subscribing witnesses.

JOSIAH BUTLER,
Executor of the will of Benjamin F. Shaw.

Witnesses:

GEO. L. HOOPER,
WILL H. HOWE.