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A. NELSON, Dec'd.

P. NELSON, Administratrix.

KNITTING MACHINE.

No. 562,553. Patented June 23, 1896.

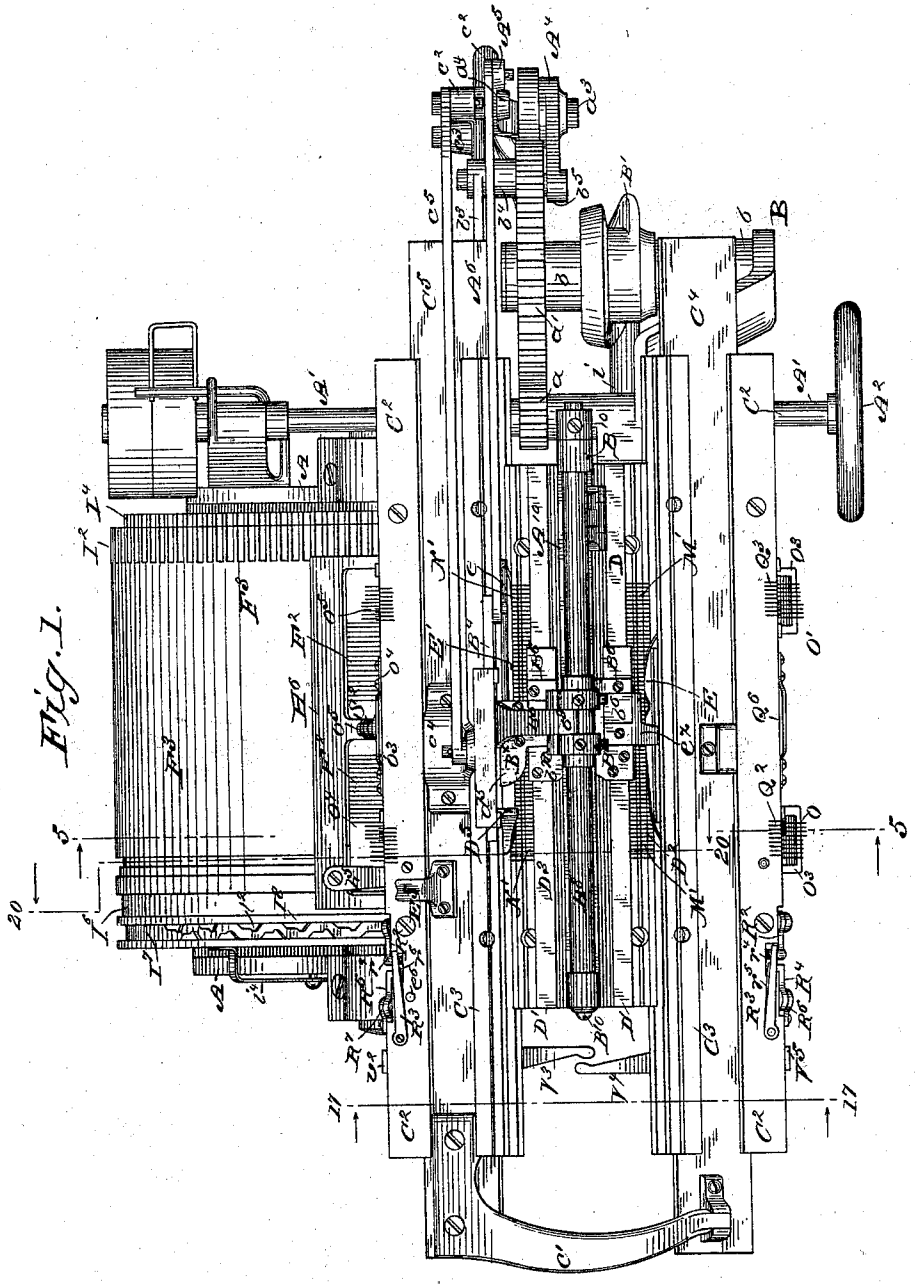

Fig. 1.

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Ed. A. Newman.
Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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P. NELSON, Administratrix.

KNITTING MACHINE.

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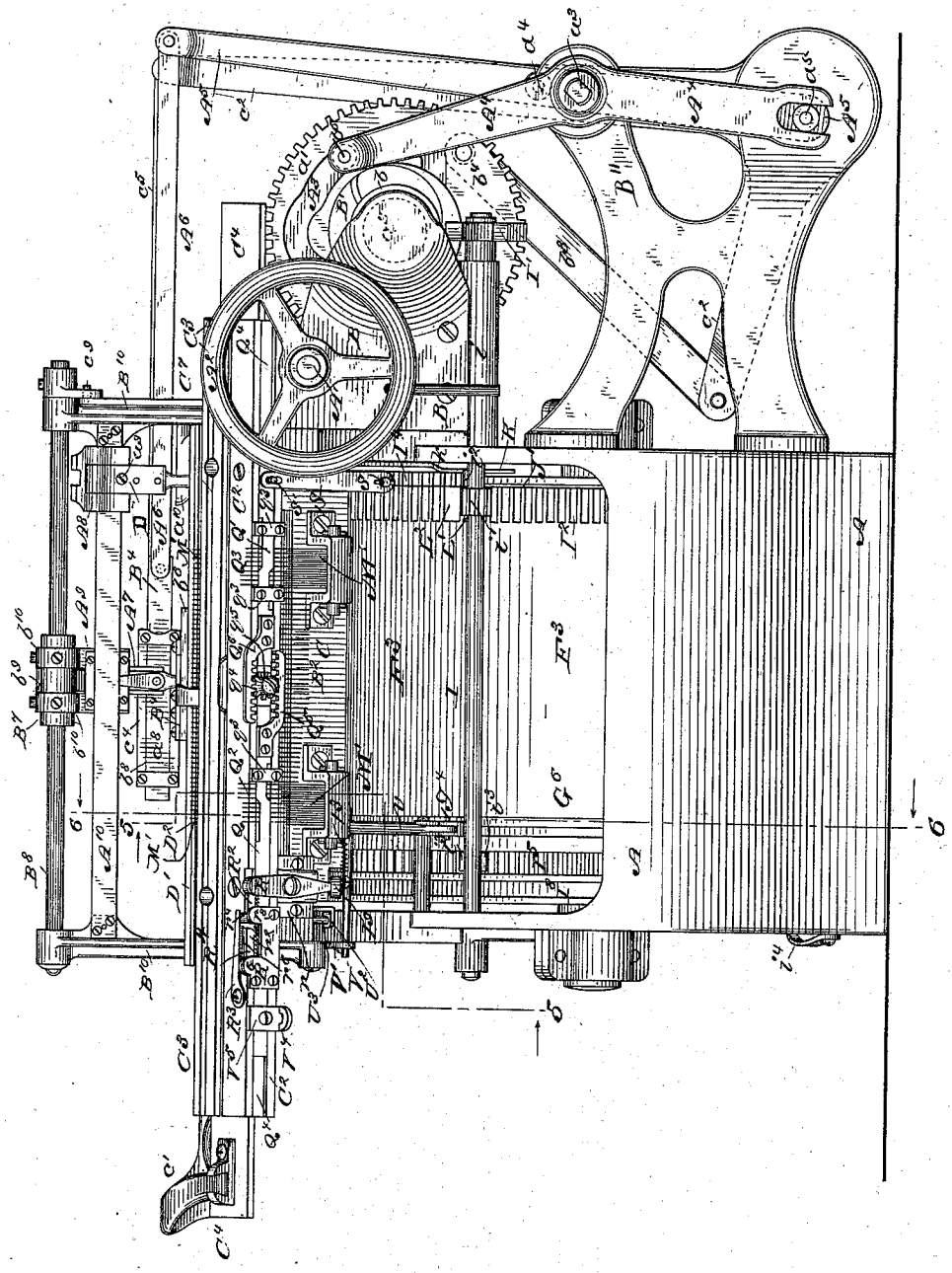
Fig. 2.



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Ed. A. Newman.
Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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P. NELSON, Administratrix.

KNITTING MACHINE.

No. 562,553

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Fig. 11.

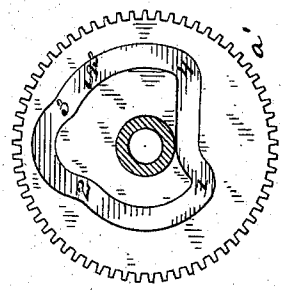


Fig. 29.

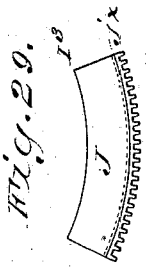
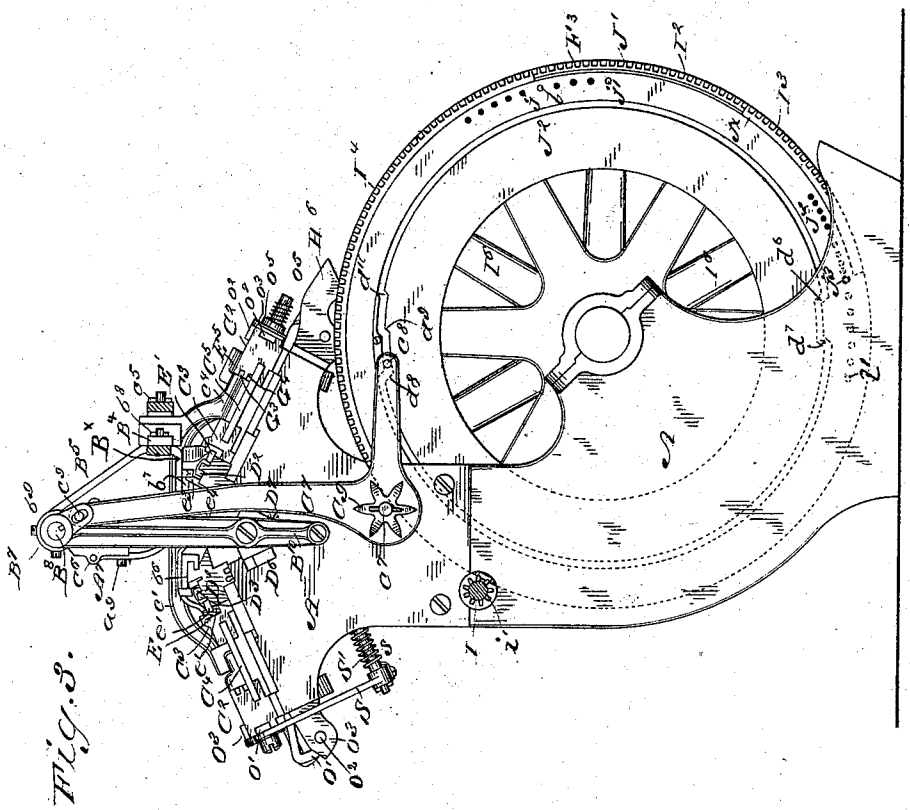


Fig. 8.



WITNESSES

Ed. A. Newman.
Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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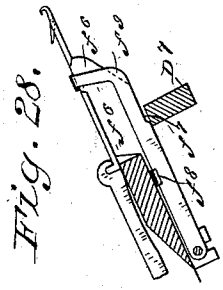

Fig. 28.

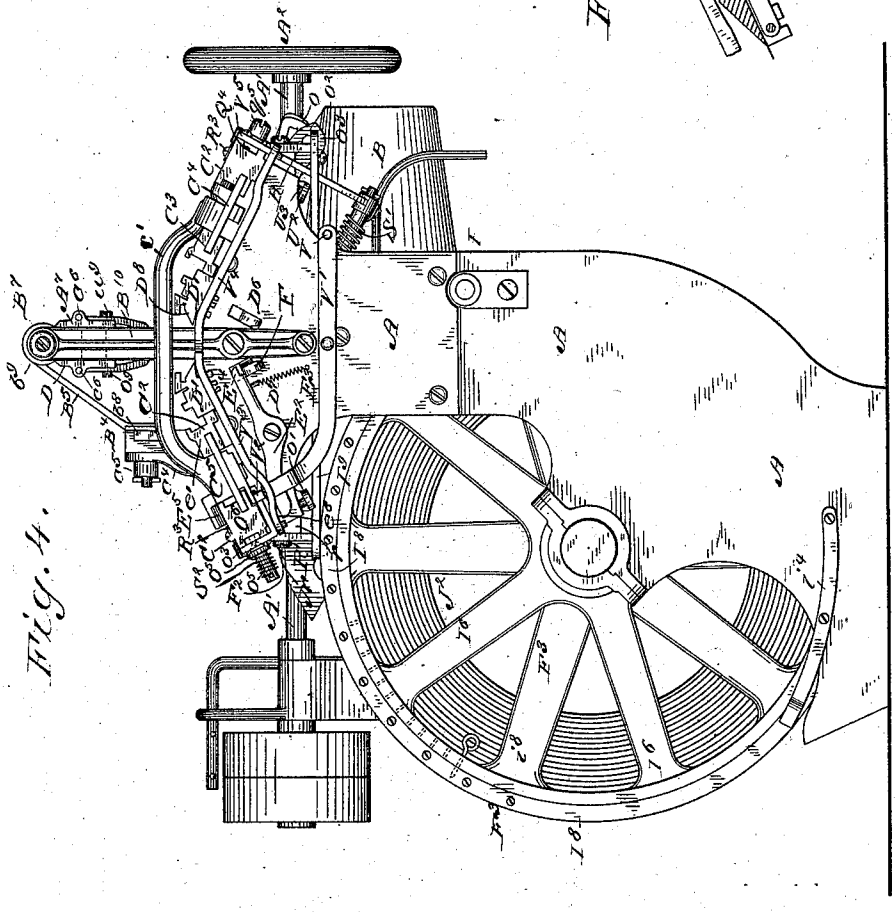

Fig. 4.

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Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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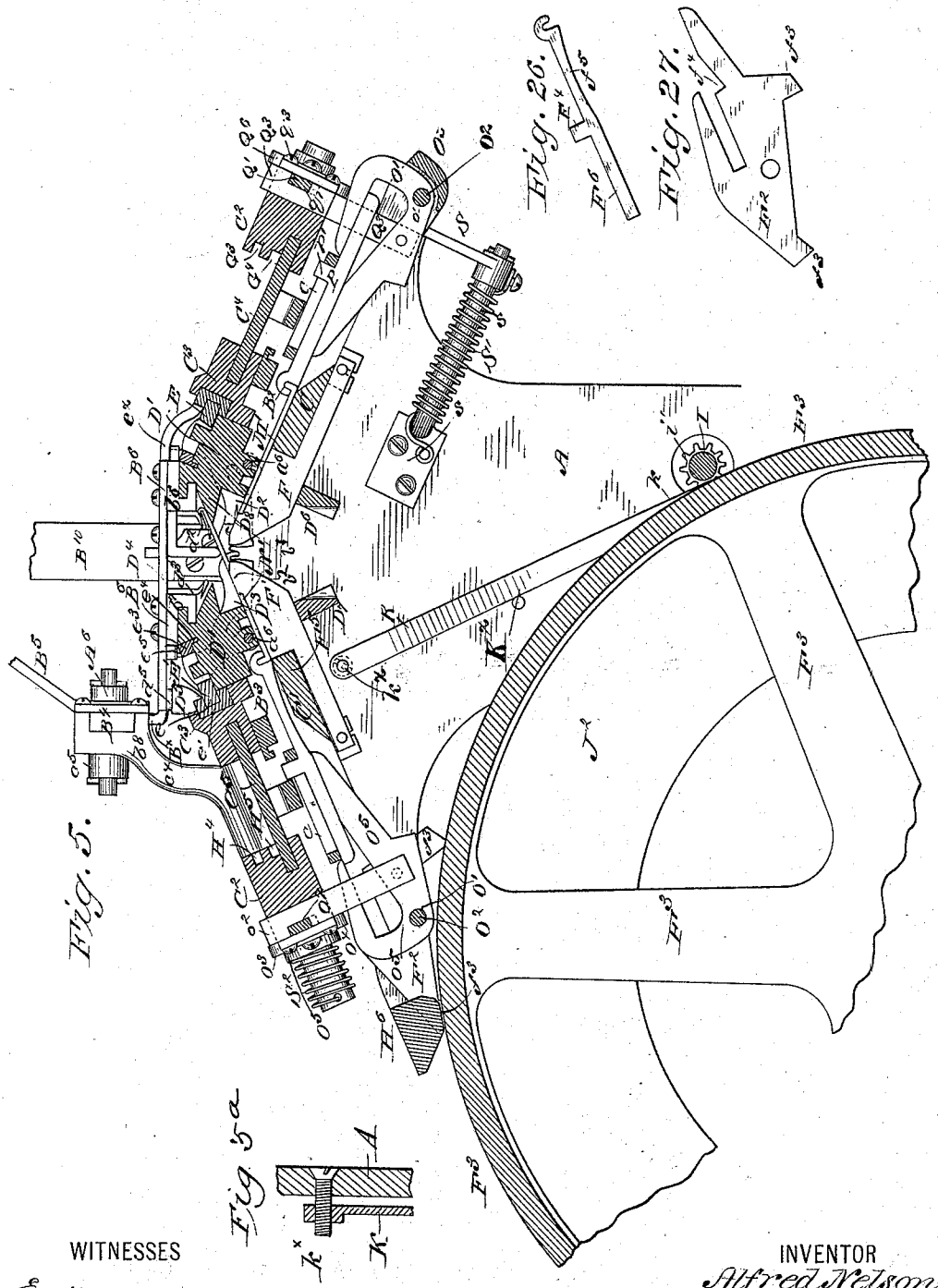

Fig. 5.

Fig. 26.

Fig. 27.

Fig. 5a

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Ed. A. Newman.

A. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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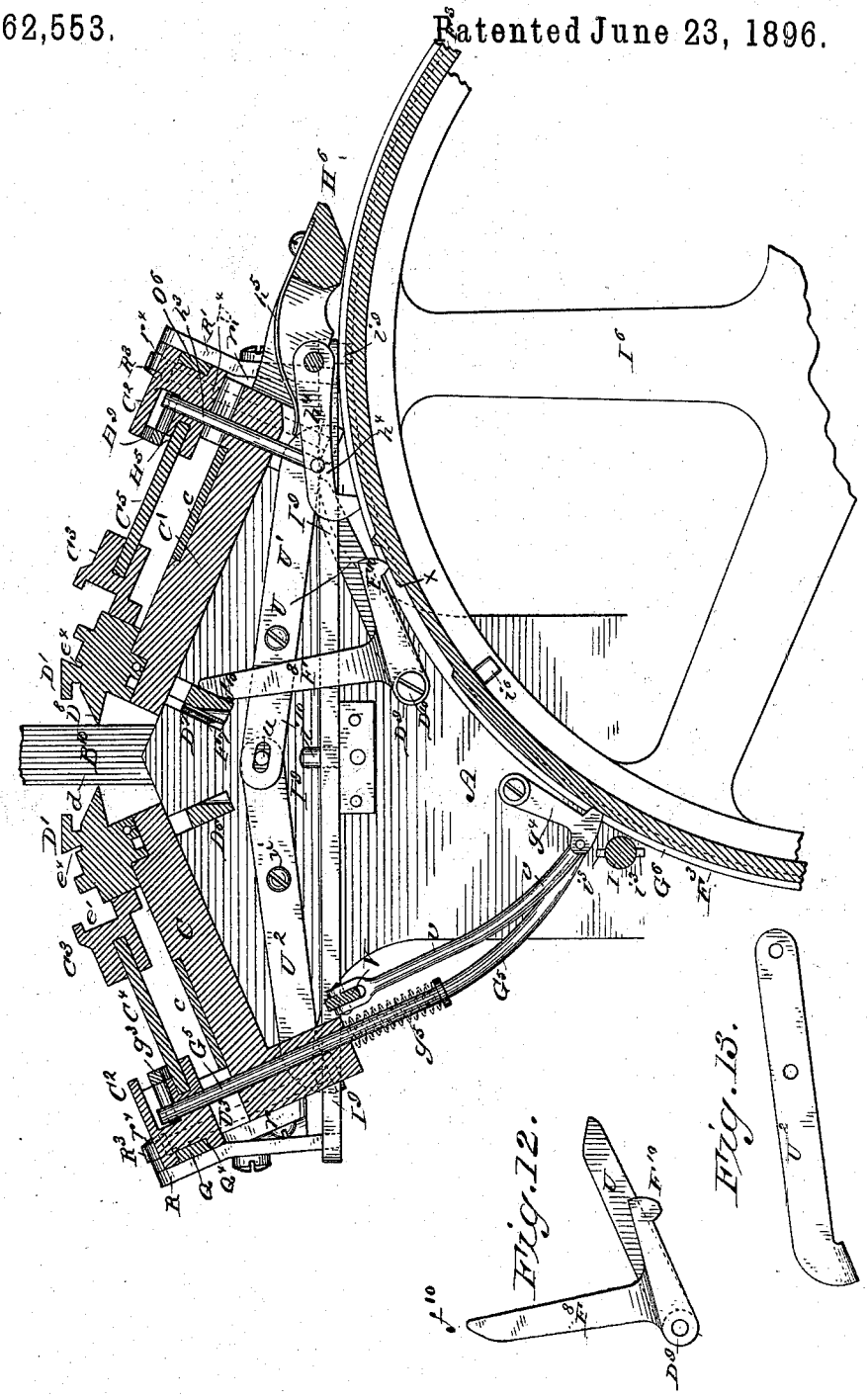

Fig. 6.

Fig. 12.

Fig. 13.

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Cal. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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KNITTING MACHINE.

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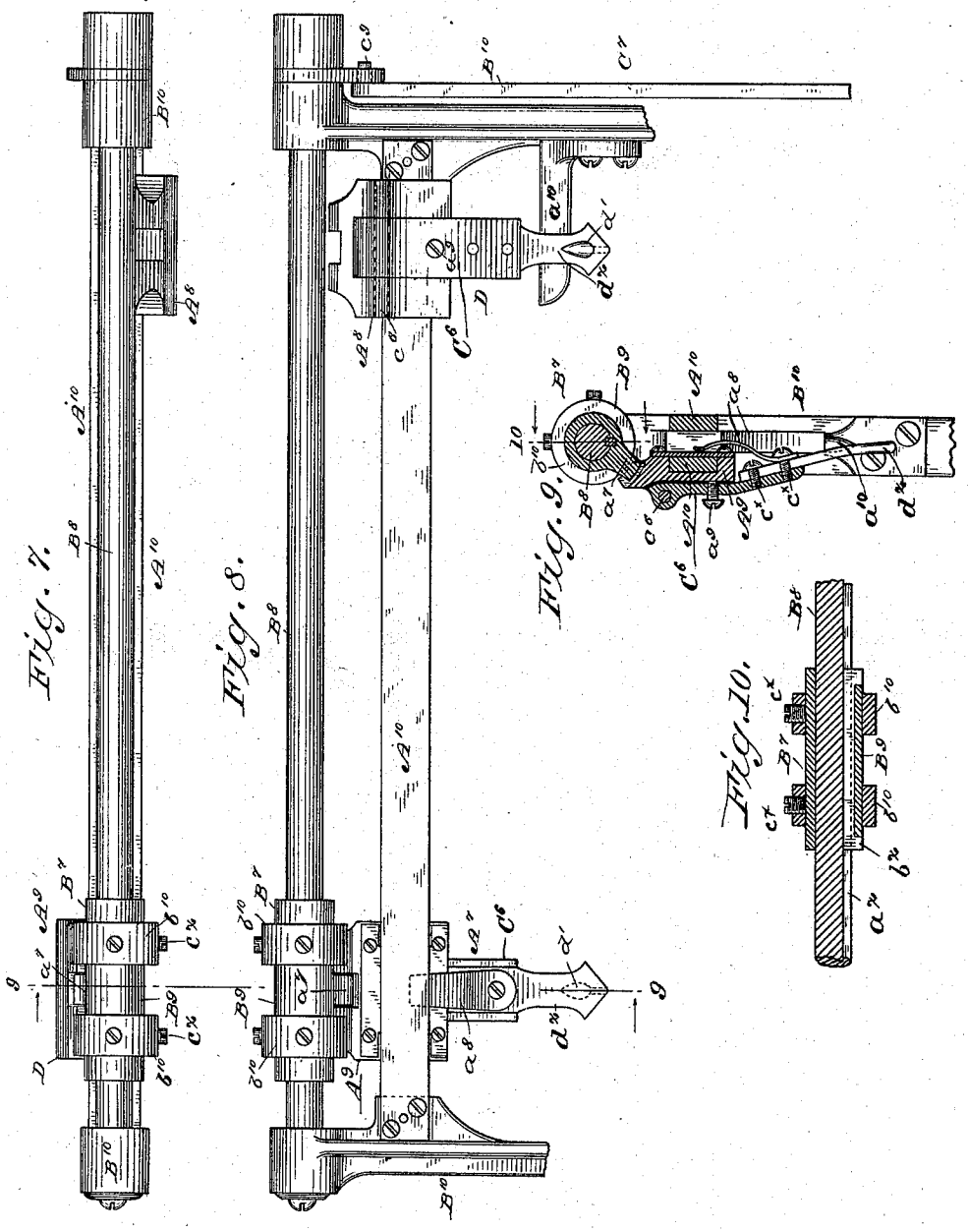

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

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Ed. A. Newman.

Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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P. NELSON, Administratrix.

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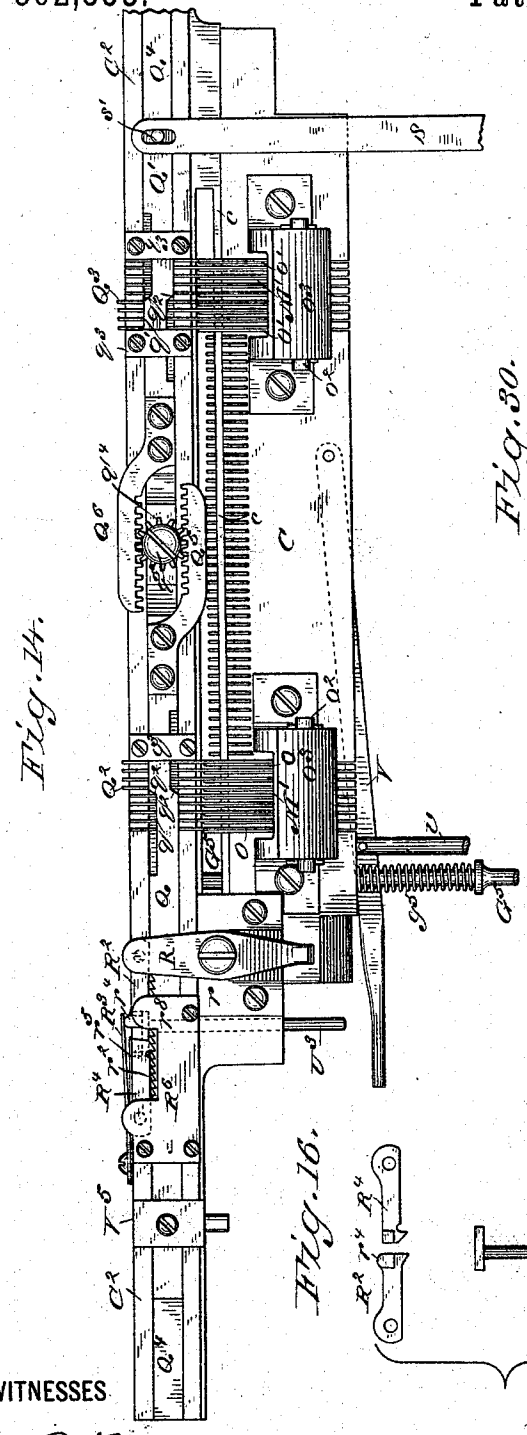

Fig. 14.

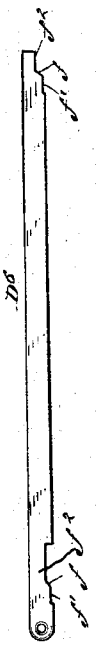

Fig. 30.

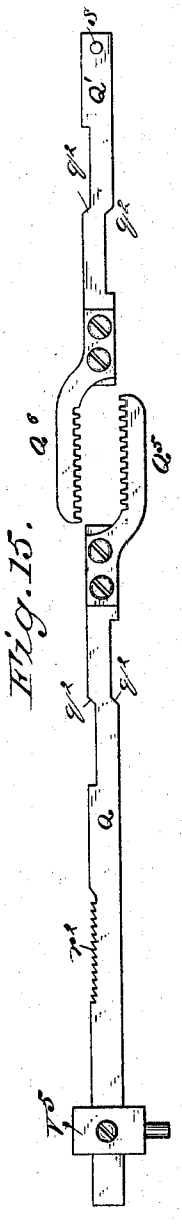

Fig. 15.

Fig. 16.

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Ed. A. Newman.

Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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A. NELSON, Dec'd.

P. NELSON, Administratrix.

KNITTING MACHINE.

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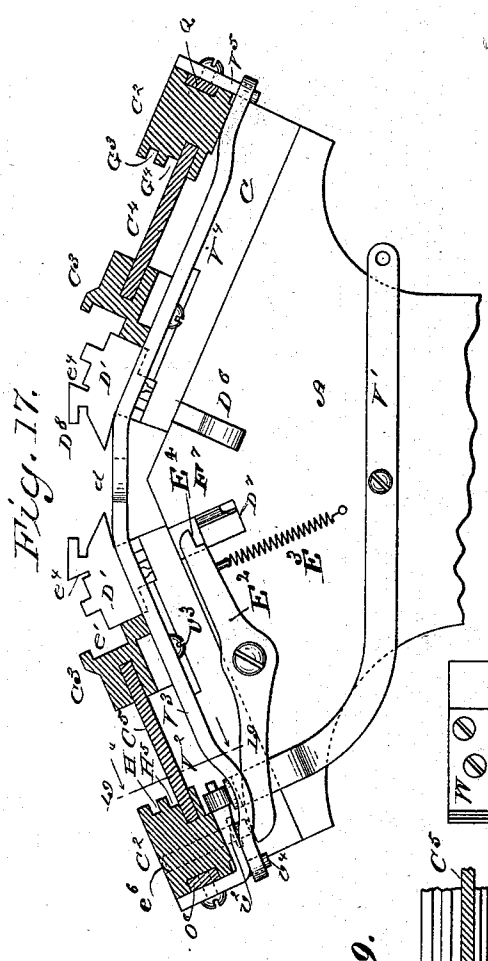

Fig. 17.

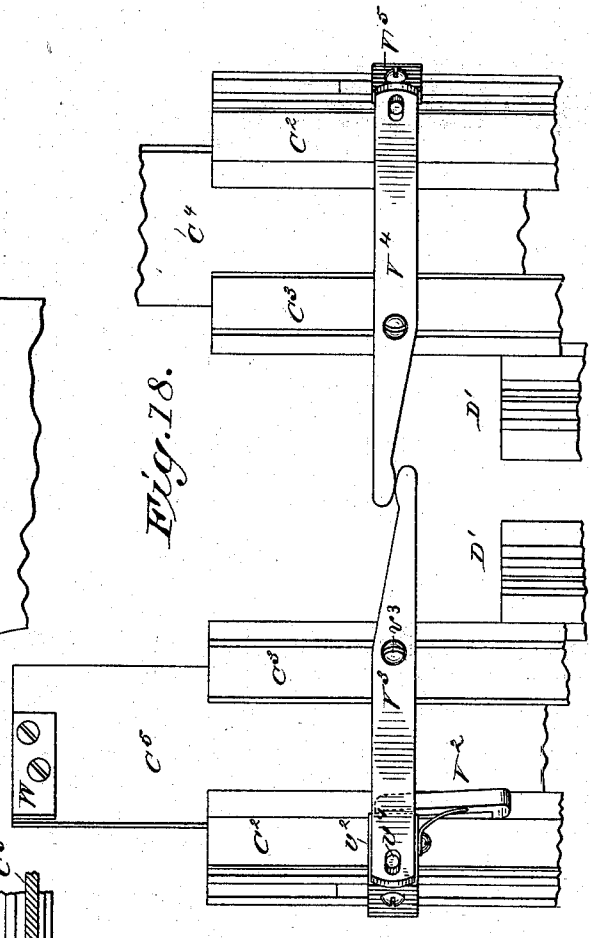

Fig. 18.

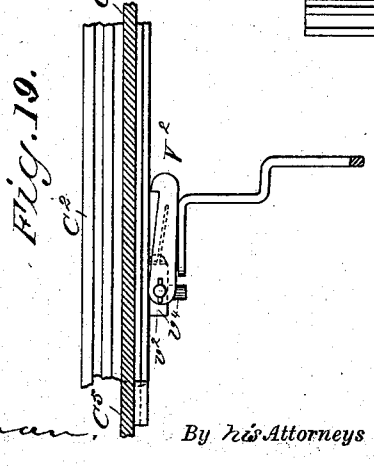

Fig. 19.

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Ed. A. Newman.

Al. C. Newman.

INVENTOR

Alfred Nelson.

By his Attorneys

Baldwin Hopkins & Peyton

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P. NELSON, Administratrix.

KNITTING MACHINE.

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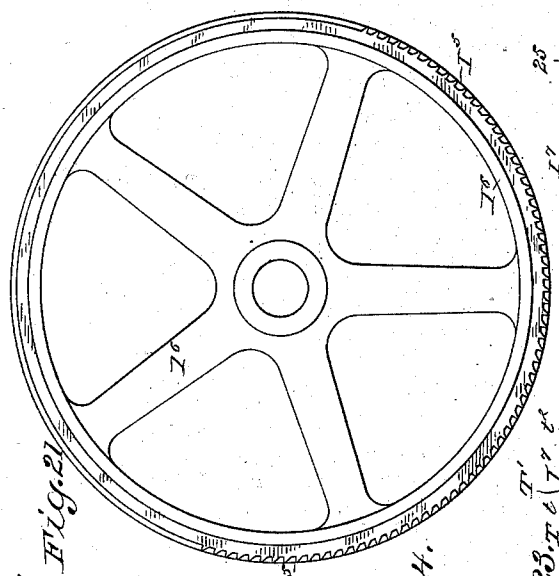

Fig. 21.

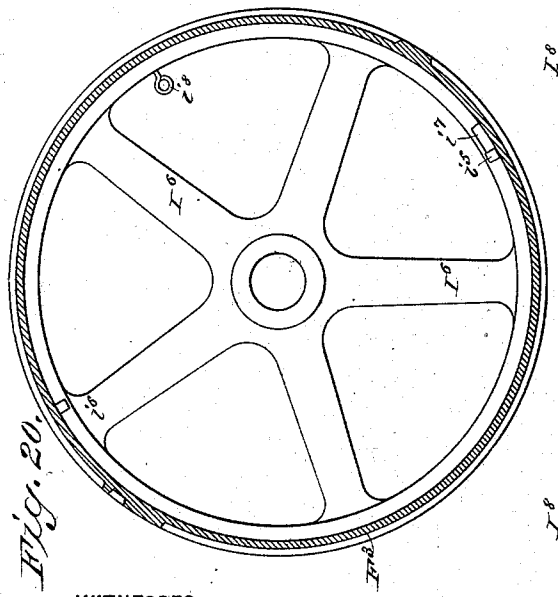

Fig. 20.

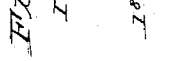

Fig. 25.

Fig. 24.

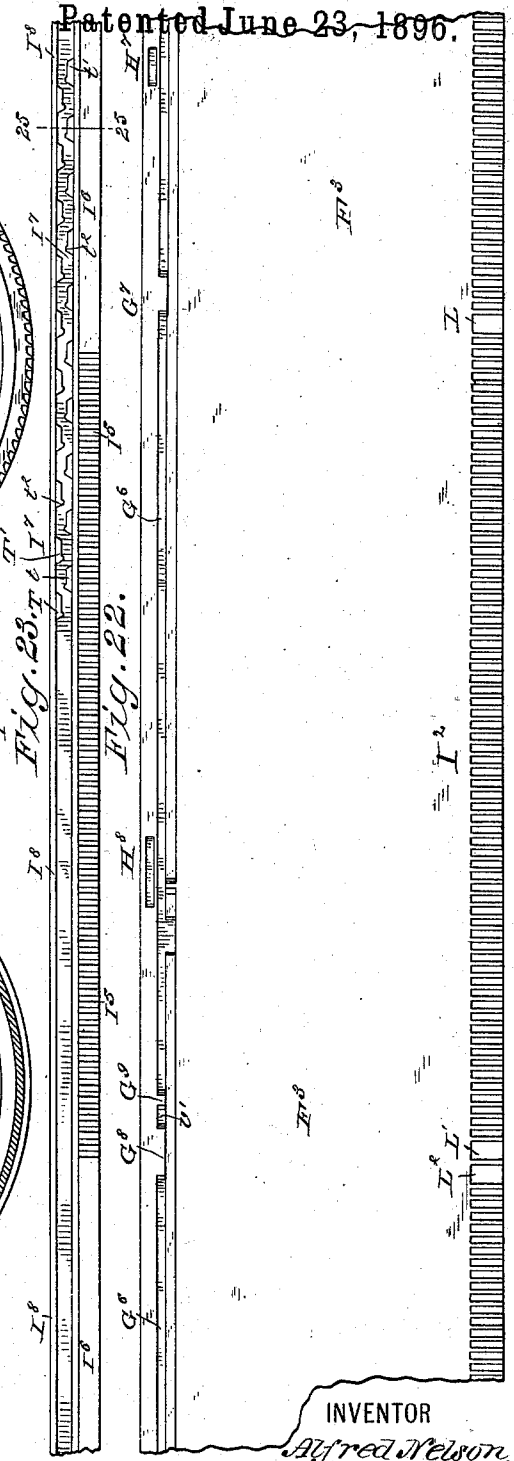

Fig. 23. Fig. 22.

WITNESSES

Ed. A. Newman.

Al. C. Newman.

INVENTOR

Alfred Nelson,

By his Attorneys

Baldwin Hopkins & Peyton

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A. NELSON, Dec'd.

P. NELSON, Administratrix.

KNITTING MACHINE.

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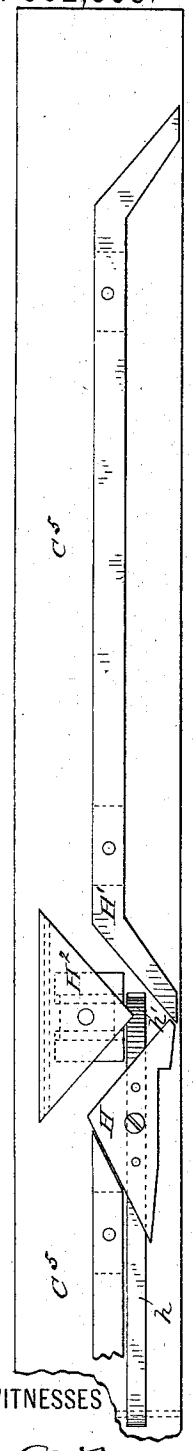

Fig. 31.

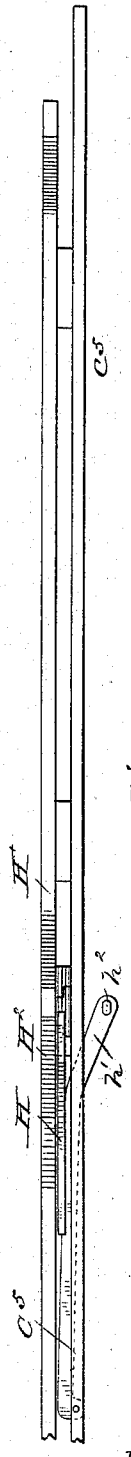

Fig. 32.

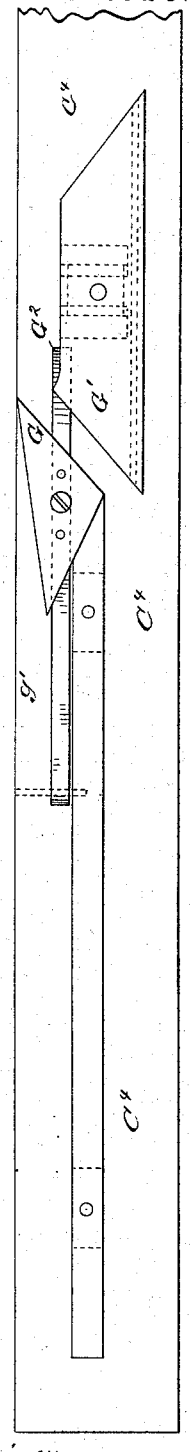

Fig. 33.

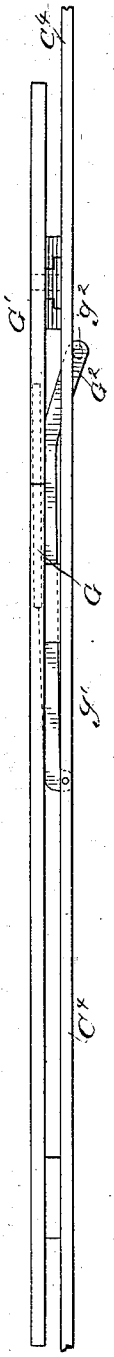

Fig. 34.

WITNESSES

Ed. A. Newman

Cel. C. Newman.

INVENTOR

Alfred Nelson

By his Attorneys

Baldwin Hopkins & Peyton

(No Model.)

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A. NELSON, Dec'd.

P. NELSON, Administratrix.

KNITTING MACHINE.

No. 562,553. Patented June 23, 1896.

Fig. 35.

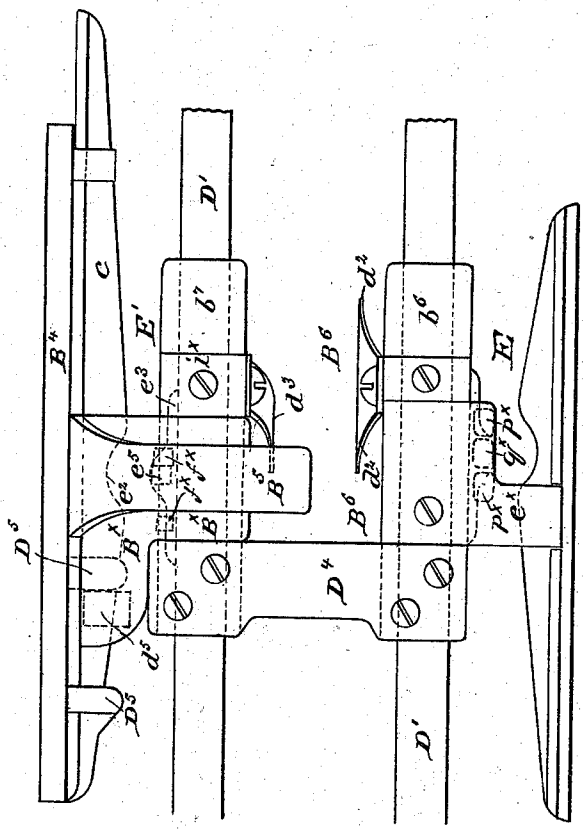

Fig. 37.

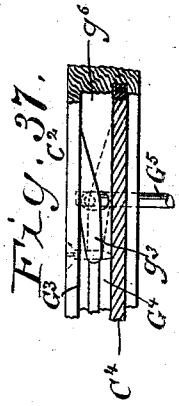

Fig. 36.

WITNESSES

A. C. Newman,
Enos S. Newman.

INVENTOR

Alfred Nelson,
By his Attorneys
Goldsborough, Hopkins & Peyton.

UNITED STATES PATENT OFFICE.

ALFRED NELSON, OF ROCKFORD, ILLINOIS; PIEDAD NELSON, ADMINISTRATRIX OF SAID ALFRED NELSON, DECEASED, ASSIGNOR TO RALPH EMERSON, WM. A. TALCOTT, EVA C. NELSON, WILLIAM NELSON, OSCAR NELSON, FRITHIOF NELSON, AND JOHN FRANKLIN NELSON, OF SAME PLACE, WILLIAM ZIOCK, OF ST. LOUIS, MISSOURI, AND ANNA NELSON RECK, OF CHICAGO, ILLINOIS.

KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 562,553, dated June 23, 1896.

Application filed May 23, 1885. Serial No. 166,481. (No model.)

To all whom it may concern:

Be it known that I, ALFRED NELSON, of Rockford, in the county of Winnebago and State of Illinois, have invented certain new and useful Improvements in Knitting-Machines, of which the following is a specification.

This invention relates to improvements in machines of the class known as "straight-row knitting-machines," especially that type of this class of machines shown and described in United States Letters Patent No. 214,308, granted April 15, 1879, to John Nelson, and also in an application, Serial No. 165,731, for United States Letters Patent for improvements in knitting-machines invented by said Nelson, and filed May 16, 1885.

My object mainly is to improve the said John Nelson machines, and this invention relates principally to mechanism for gradually widening or enlarging tubular-knit fabrics, such as the legs of stockings, the arms of shirts, &c.

My invention also relates to yarn-carrying mechanism and various details.

The subject-matter deemed novel will hereinafter be specifically designated by the claims.

In the accompanying drawings an appropriate organization of mechanism is shown for knitting stockings, but, instead of using all the improvements thereby illustrated and hereinafter in detail described, essential features of these improvements may be employed without the others, and the mechanism be modified in various ways without departing from the spirit of the invention herein claimed.

Figure 1 is a plan view of the machine. Fig. 2 is a front elevation. Fig. 3 is an elevation of the right end of the machine with the driving mechanism removed and the shaft for actuating the pattern-cylinder in section. Fig. 4 is an elevation of the left end of the machine. Fig. 5 is a view, partly in elevation and partly in section, on the line 5 5 of Fig. 1, with the upper and lower parts of the mechanism broken away. Fig. 5^a is a detail view showing particularly the adjusting-screw $k^\times$ of the yielding stop-arm K. Fig. 6 is a view, partly in elevation and partly in section, on the line 6 6 of Fig. 2, with the upper and lower parts of the mechanism broken away. Fig. 7 is a plan view of the yarn-carrying mechanism. Fig. 8 is a front elevation of the same. Fig. 9 is a view, partly in elevation and partly in section, on the lines 9 9 of Figs. 7 and 8. Fig. 10 is a section on the line 10 of Fig. 9. Fig. 11 is a front elevation of the main actuating-gear, with its bearing-sleeve in section. Fig. 12 is an elevation of a device for actuating the dropping-needle and the mechanism which trips the pawls of the reciprocating needle-controlling rack-bars. Fig. 13 is a side elevation of one of the levers for tripping the pawls of the needle-controlling reciprocating rack-bars. Fig. 14 is a front view of the upper portion of the machine with the yarn-carrying mechanism and other parts detached. Fig. 15 is a front elevation of the front needle-controlling reciprocating rack-bars. Fig. 16 shows a rear elevation of the actuating and holding pawls and the tripping-rod thereof of the reciprocating controlling rack-bars for the front widening-needles. Fig. 17 is a view, partly in end elevation and partly in section, on the line 17 17 of Fig. 1. Fig. 18 is a bottom view of the left ends of the main cam-slides, the channel-plates, and the guide-bars, and some of the attachments thereof, representing parts of the mechanism for actuating the needle-controlling reciprocating rack-bars to throw the widening-needles out of action. Fig. 19 is a view, partly in side elevation and partly in section, on the line 19 19 of Fig. 17. Fig. 20 is a view, partly in elevation and partly in section, on the line 20 20 of Fig. 1, representing the pattern-cylinder and attachments thereof. Fig. 21 is an elevation of the auxiliary wheel for controlling the mechanism for actuating the widening-needles with its tire

removed. Fig. 22 is a view showing a portion of the periphery of the pattern-cylinder flattened out. Fig. 23 is a similar view of the auxiliary wheel and its tire. Fig. 24 is a plan view of one of the cam-blocks of the auxiliary wheel detached. Fig. 25 is a section on the line 25 25 of Fig. 23. Fig. 26 is a side elevation of one of the needle-jacks of the back row of needles. Fig. 27 is a similar view of one of the rocking levers for supporting the needle-jacks of the needles of said row. Fig. 28 is a side elevation, partly in section, designed to represent the manner of dropping the left needle of the back row of needles. Fig. 29 is a side elevation of one of the segment-gears of the pattern-cylinder detached. Fig. 30 is a front elevation of the sustaining-bar for raising and lowering the needles of the front row detached. Fig. 31 is a bottom view of a portion of the back main cam-slide with its attached cams, and Fig. 32 is a rear elevation of these devices with the parts in the same positions. Fig. 33 is a bottom view of a portion of the front main cam-slide and its attached cams, and Fig. 34 a front elevation of these devices with the parts in the same positions. Fig. 35 is a plan view, on an enlarged scale, of the sectional sliding saddle and connections thereof and the presser-hook cams. Fig. 36 is a view of one of the presser-hooks. Fig. 37 is a view, partly in elevation and partly in section, showing details of the switch-gate-controlling mechanism for the cams which actuate the front needles.

In many respects the mechanism hereinafter referred to, and more or less fully described, is the same as embodied in the John Nelson knitting-machines above alluded to; but all mechanism similar to that of the said John Nelson machines is disclaimed by me.

That side of the machine at which the work is discharged, and from which a hand-wheel projects convenient to the right hand of the operator when facing the machine, is called the "front," and the other the "rear" side, while the end on the right of the operator is termed the "right" and the other the "left" end of the machine throughout this specification.

The mechanism is mounted upon a suitable sectional main frame A. A driving-shaft A′, extending transversely to the machine and suitably mounted at the right end thereof in the main frame, is provided with fast and loose pulleys to be driven in an obvious way from any appropriate motor. A hand-wheel A^2 is secured to the front end of the driving-shaft, and this shaft is provided with a fast pinion a, which engages with a main actuating gear-wheel a' on a stud-axle a^2, cast with a projecting portion or bracket B at the right end of the main frame. This gear-wheel a' is cast with a sleeve-bearing b, by which it is mounted upon its stud-axle. A cam-wheel or irregular snail-gear B′ is also formed with this sleeve for a purpose in turn to be explained.

A front needle-bed C and a rear needle-bed C′ are each slotted and provided with a slotted steel plate c, to constitute guide-grooves for the front and rear rows of needles b' and b^2, respectively, as well as for their jacks B^2 B^3. The bed-plates are inclined as heretofore and provided each with a lower longitudinally-grooved guide-bar or channel-plate C^2 C^2, and an upper longitudinally-grooved guide-bar or channel-plate C^3 C^3. A front main cam-slide C^4, and a back main cam-slide C^5, rigidly connected by a yoke c', reciprocate longitudinally in their guideways in the front and back channel-plates. These main cam-slides carry cams for actuating the needles of the front row b' and the needles of the back row b^2, respectively, to advance and retract them.

An elbow-lever c^2, pivotally mounted upon the main-frame bracket by a stud c^3, is connected at the upper end of its longer arm with a bracket c^4 on the back main cam-slide C^5 by means of a pitman c^5. The other end, or the shorter arm of this elbow-lever, is linked by a connecting-rod b^3 with a wrist-pin b^4 on the gear-wheel a'. The result of this construction is that the main cam-slides are caused to reciprocate together, or make two strokes for each revolution of their actuating-gear a', and to operate the two rows of needles by their cams, farther on to be described.

Alternating carriers A^7 D for the thread employed in knitting, (the thread may be of yarn, cotton, silk, &c.,) which carriers will hereinafter be termed "yarn-carriers," are similarly constructed, and are supported, and thrown into and out of engagement with their actuating mechanism, so as to be reciprocated by turns, as and for a purpose farther on to be explained.

Each of the alternately-acting yarn-carriers is mounted to reciprocate over the central opening d, across which the needles are projected and retracted, and moves in a path transversely to the paths traveled by the needles, as is well understood.

The yarn-carriers are actuated in the desired order by connections with a slide B^4, to which the proper reciprocating movement is imparted, as farther on explained. This actuating-slide B^4 carries a controlling-arm B^5, forming a part of the mechanism which connects it alternately with the yarn-carriers. A sliding saddle B^6 is reciprocated by connection, as next to be described, with the actuating-slide of the yarn-carriers and is guided in ways formed in the adjacent or inner edges of guide-bars D′ D′, secured to the needle-beds over their inner edges above and on opposite sides of the central opening d.

The saddle is made in two sections b^6 b^7, united by a cross-piece or connecting-plate D^4 and connected with the actuating-slide by means of an inwardly-projecting base extension or connecting-piece $B^\times$ of the controlling-arm B^5. This connecting-piece $B^\times$ detachably interlocks with the sliding saddle by fitting in a space provided between the shoulder

formed by the connecting-plate D^4 and an attached lug $i^\times$ of the section b^7 of the saddle, as clearly shown by the drawings.

The front section b^6 of the sliding saddle is provided with two horns d^2 d^2 for opening the latches of the back row of needles, Fig. 35, and the rear section b^7 of the saddle is provided with a horn d^3 for opening the latches of the front row of needles on the outward stroke of the main cam-slides, (the stroke toward the left end of the machine.) As the needles of the back row at times both advance and retract at each stroke of the yarn-carrier and the sliding saddle, or make two reciprocations for every reciprocation of the yarn-carrier, the sliding saddle, the main cam-slides, and the cams E E′ for actuating the front and rear presser-hooks D^2 D^3, it is essential that the same order of action of the yarn-carrier, the sliding saddle, the needles of the back row and their coöperating presser-hooks D^3 shall be maintained at such times, thus necessitating the reversal of the relative positions of these parts at each stroke. Were it not for this reversal in the relative positions of the parts, it is obvious that the retracting movement of the needles of the back row to the proper extent to receive yarn upon their open latches and the action of the back presser-hooks (the details of which and their actuating mechanism will soon be described) would occur in advance of the proper order during those operations of the mechanism when the needles of the back row are making two reciprocations for each reciprocation of the main cam-slides and the cam which actuates the back presser-hooks. The result of thus maintaining the order of operation of the yarn-carrier and the reciprocating saddle, and the needles of the back row and their coöperating presser-hooks, obviously is that the yarn is always laid upon the open latches of the needles while they are retracting and while their coöperating presser-hooks are elevated preparatory to descending upon the yarn at the completion of the downward stroke of the needles.

In the organization of mechanism shown the shifting of parts, so as to reverse their relative positions at the end of each stroke of the main cam-slides, and the cams for operating the presser-hooks, is accomplished by causing the main cam-slides to move a short distance after the yarn-carrier, the sliding saddle, and the cam for actuating the back presser-hooks have finished their stroke, and by causing the cam for operating the back presser-hooks to begin its return stroke shortly after the yarn-carrier, the sliding saddle, and the main cam-slides have commenced another stroke.

It should be borne in mind that, as in the before-mentioned John Nelson machines, the front needles b' make one reciprocation for each reciprocation of their actuating-cams carried by the front cam-slide C^4, and that these needles operate only when circular work is being done, they being thrown out of action during toe and heel knitting; and that the needles of the back row, while making two reciprocations for each reciprocation of their actuating-cams carried by the back main cam-slide, at the time of heel and toe knitting, make but one reciprocation for each reciprocation of their actuating-cams during circular knitting, at the time the front needles are working. It consequently follows that the change in the position of parts relatively to each other, as above described, is not necessary so far as the front needles, their coöperating presser-hooks, their actuating-cams, and the yarn-carrier, and the horn d^3 are concerned. Nor is it necessary that the change should take place in the relative positions of the yarn-carrier, the horns d^2 d^2, the cams for actuating the back row of needles, and the cam for actuating the back presser-hooks, at the time that the needles of the back row are making but one reciprocation for each reciprocation of their actuating-cams. Nevertheless, as the parts are organized these changes occur throughout the operation of the machine and do not interfere in the least with the proper working of the mechanism at times when such changes effect no result.

The shifting mechanism employed for maintaining the above-described order of operation of parts is as follows: The gear-wheel a' is provided on its front face (the face opposite that from which the wrist-pin b^4 projects) with a cam-groove A^3, in which works a pin b^5, which is provided with a roller on the upper end of a lever A^4, which is pivotally supported intermediate its ends by a stud a^3 on the main-frame bracket B^{11}, and at its lower end is forked or slotted, and has self-adjusting jointed connection with the lower end of a lever A^5, mounted upon the before-described elbow-lever c^2 by means of a pivot a^4. A pivot-pin a^5, at the lower end of the lever A^5, is provided with a roller which enters the slot in the lower end of the lever A^4, making the needed self-adjusting connection of these levers. At its upper end the lever A^5 is connected by a link or pitman A^6 with the yarn-carrier-actuating slide B^4. The result of this construction is that while the roller upon the pin b^5 travels that portion of the cam-groove extending from 1 to 2 (see Fig. 11) the yarn-carrier-actuating slide will make the outward stroke of a reciprocation, and move correspondingly with the main cam-slides. Next, while that portion of the cam-groove extending from 2 to 3 is acting on the roller the yarn-carrier-actuating slide remains at rest, though there is no pause in the movement of the main cam-slides other than that which takes place at the dead-center point of their stroke. Next, while that portion of the cam-groove extending from 3 to 4 is acting upon the roller of the lever A^4 the inward stroke (the stroke toward the right end of the machine) of the yarn-carrier-actuating slide takes place simultaneously with the corresponding stroke

of the main cam-slides, and at the completion of this inward stroke the yarn-carrier-actuating slide again comes to rest while that portion of the cam-groove extending from 4 to 1 acts upon the roller, the main cam-slides continuing to move, except when pausing at the dead-center of their stroke, during this cessation in the operation of the yarn-carrier-actuating slide. Next, the yarn-carrier-actuating slide is again moved outward with the main cam-slides at the commencement of another revolution of the gear-wheel a'.

The yarn-carrier-actuating slide B^4 is supported or carried by and reciprocates in a suitable guideway b^8, formed in the bracket c^4 on the back main cam-slide. The controlling-arm B^5 is formed with a curved upper end b^9, adapted to engage with a sleeve-slide B^7, carried by a rock-shaft B^8, with which it is engaged by means of a groove $a^\times$ and feather $b^\times$, (see Fig. 10,) so that while free to slide along this rock-shaft it is compelled to turn therewith, as is well understood. The curved upper end of the controlling-arm rests in an annular recess or bearing B^9, formed between adjustable collars $b^{10}b^{10}$ of the sleeve-slide. These collars are secured in place by means of set-screws $c^\times$. The rock-shaft B^8 is supported at its opposite ends in bearings in upright frame-arms B^{10} B^{10}. A lug a^7, projecting downwardly from the sleeve-slide, engages with one or other of two supporting-slides A^8 A^9, to which the yarn-carriers D A^7 are respectively attached. Recesses in the respective supporting-slides alternately receive the lug a^7 when these slides are to be interlocked with the sleeve-slide. These supporting-slides are carried by and reciprocate along parallel guide-bars A^{10} A^{10}. These guide-bars are secured at their opposite ends to the frame-arms B^{10} B^{10}, and have a space between them.

The eyes d' d' of the yarn-carriers, through which the yarn passes to be supplied to the needles, are formed at the lower ends of pivotally-supported arms $d^\times$, constituting the yarn-carriers proper. At their upper ends these arms have hinged connection by means of the pivots c^6 c^6 with the supporting-slides A^8 A^9, respectively.

A spring a^8 acts upon each yarn-carrier with a tendency to keep it in its working position, the movement of the yarn-carrier in the direction in which its spring presses it being limited by an adjustable set-screw a^9.

A pointed inclined sided separating-horn a^{10}, secured to the right frame-upright B^{10}, acts upon the yarn-carriers at the inner ends of their strokes, so as to move them sidewise slightly against the action of their springs, in order that the yarn-carrier, which is out of operation, will be prevented from interfering with the reciprocating yarn-carrier. The yarn-carrier arms, as in this instance shown, are each composed of two sections. The lower arm $d^\times$ or yarn-carrier proper is removably connected by screws $c^\times$ with an upper section C^6, which is hinged to its supporting-slide. The upper sections C^6 of the yarn-carrier arms are of plate form adapted to bear in recesses in their respective supporting-slides, as plainly shown in Figs. 8 and 9.

The rock-shaft B^8 is automatically actuated at proper intervals to throw one yarn-carrier out of action and the other into action, in order that a yarn-carrier A^7, supplied with thick or heavy yarn, may be thrown into action, and the other yarn-carrier, D, supplied with lighter yarn, may be thrown out of action, or vice versa, according to whether the heel or the toe is being formed, requiring the heavy yarn, or the foot or leg portion of the stocking is being knitted with lighter yarn. If preferred, different-colored yarns may be used, and they may be of corresponding weight, if desired. The mechanism in this instance employed for alternating the yarn-carriers is as follows:

An elbow-lever C^7 for actuating the rock-shaft B^8 of the yarn-carrier mechanism is pivotally supported by the frame-stud c^7 and carries at the end of its lower or shorter arm a pin c^8, which may be provided with a roller, entering a cam-groove C^8 in the outer face of a ring J^2, attached to the right end of the pattern-cylinder, and hereinafter more particularly described.

At its upper end the elbow-lever has jointed connection with the right end of the rock-shaft by means of a slotted lug c^9, secured by a sleeve to the rock-shaft, and a pin on the elbow-lever entering the slot of said lug. A spring-metal star-shaped washer C^9 and a securing-pin serve to properly hold the elbow-lever upon its stud c^7.

The movement imparted to the pattern-cylinder, as farther on to be described, causes the cam-groove to act five times upon the pin of the elbow-lever for each complete revolution of the pattern-cylinder, the inclines or cam-surfaces d^6 d^7 d^8 d^9 d^{10} acting in turn upon the elbow-lever pin. During the time that portion of the cam-groove between the inclines d^{10} d^6 is acting upon the pin of the elbow-lever, the yarn-carrier D, which is supplied with heavy yarn, is in action for knitting the toe of a stocking. When the cam-incline d^6 acts upon the elbow-lever, the rock-shaft is actuated to disengage the lug of the sleeve-slide B^7 from the supporting-slide A^9, and engage it with the supporting-slide A^8, which, during the action of the yarn-carrier D, was at rest at the right end of its path of movement against the horn a^{10}.

When that portion of the cam-groove extending from the incline d^6 to the incline d^7 is acting upon the elbow-lever, the foot of the stocking is being worked. When the incline d^7 acts upon the elbow-lever, the sleeve-slide is disengaged from the supporting-slide A^9, and again engaged with the supporting-slide A^8 for knitting the heel. The action of the incline d^8 upon the elbow-lever alternates the yarn-carriers, the yarn-carrier A^7, provided

with the lighter yarn, being thrown into action for knitting the leg during the time that the elbow-lever pin is engaged with that portion of the cam-groove extending from d^8 to d^9. By the action of the incline d^9 upon the elbow-lever the yarn-carrier D is thrown out of action, the movement imparted to the rock-shaft by the action of the incline d^9 being such that the lug of the sleeve-slide is moved into a position between the supporting-slides. Both yarn-carriers remain out of action during the time that the portion of the cam-groove extending from d^9 to d^{10} is acting upon the elbow-lever, (a stocking having been completed,) and when the incline d^{10} acts upon the elbow-lever the yarn-carrier D is thrown into action for commencing to knit the toe of another stocking. The yarn-carriers are thrown into and out of action at the ends of their strokes inward or to the right.

Devices the same as shown and described in the before-mentioned application, Serial No. 165,731, are provided for shifting the position of the cam E′ for actuating the back presser-hooks relatively to the yarn-carrier in action. These devices and the cam E′ are as follows: The main slide or section e of the cam moves in a guideway e' in the upper rear channel-plate C^3, and is provided with a cam-recess e^2. The other slide or section e^3 of this cam reciprocates in its guide-groove e^4 in the back guide-bar D′, and is provided with a projection corresponding with the cam-recess e^2 of the main section. Levers or controlling arms d^4 of the back presser-hooks project between the two sections of their actuating-cam, and are of a width about corresponding with the space formed between the recess of the main section and the projection of the other section of the cam. The connecting-piece $B^\times$ has upon its under side a downwardly-projecting lug d^5, which enters a recess between upwardly-projecting lugs D^5 D^5 of the main section of the cam. The space between these lugs is of a length sufficient to allow of the necessary amount of play of the lug d^5 at the time of shifting. The small section e^3 of the cam is provided with an upwardly-projecting lug e^5, which enters a recess in the under side of the connecting-piece $B^\times$, formed between downwardly-projecting lugs $f^\times$ $f^\times$. This recess corresponds approximately with the space between the lugs on the main section of the cam. It will be understood that at the end of each stroke the presser-hook cam will be left in a position such that it will not be moved at first upon the commencement of the next stroke of the actuating-slide of the yarn-carrier, thus providing for shifting upon each stroke of the yarn-carrier and main cam-slides. The cam E for actuating the front set of presser-hooks is the same in all respects as that for operating the back set of presser-hooks, except that it has detachable rigid connection with the saddle B^6 by a bracket $e^\times$, secured to the saddle-section b^6, instead of having a shifting connection, so as to be adjustable automatically relatively to the yarn-carrier. The downwardly-projecting outer end of the bracket $e^\times$ engages a recess in the main section of the cam E, and downwardly-projecting lugs $p^\times$ $p^\times$ of this bracket embrace the lug $q^\times$ of the small cam-section C^6.

It will, of course, be understood that the presser-hooks are supported by their pivot-rods a^6 a^6 and work in guide-grooves in the respective guide-bars D′ D′ and in the needle-beds.

Rocking needle-supports F F′ for both the front and back rows of needles are dropped and elevated by means of endwise-sliding sustaining-bars D^6 D^7 beneath them, supported at their ends in guideway-slots in the ends of the main frame. These sustaining-bars project beyond the main frame at its left end, so that they may be actuated by hand as desired. They have upon their under sides, near each end, (see Fig. 30,) inclined surfaces or cams f f, by the contact of which with the bottoms of the guideway-slots in the main-frame ends the sustaining-bars are raised and lowered as they are moved endwise. When the sustaining-bars occupy their normal positions for sustaining the rocking needle-supports in their elevated positions, these bars rest with their seats f' f' upon the bottoms of their guideway-slots in the frame ends, and when lowered the notched or cut-away parts f^2 f^2 of these bars rest upon the bottoms of their guideways. The guideway-slot in the left end of the main frame for the back sustaining-bar D^7 is made of a width sufficient to permit of the left end of this bar being given a slight side-wise movement, for a purpose in turn to be explained. The ends of the needle-supports are pivotally connected with the under sides of the needle-beds.

The two series of rocking levers F^2 for supporting the jacks F^6 of those needles of the back row which are on opposite sides of the central needles of this row are provided (see Fig. 27) with the lugs f^3 f^3 for engagement with the pattern-cylinder F^3, and are the same as heretofore. Each of these levers is provided with the notch f^4 in the bottom of its jack-guideway, into which the rear end of the needle-jack descends when the lever is depressed to lower the shank or projection F^4, Fig. 26, of the jack beneath the cams, which actuate the needles by contact with the needle-jack projections. The needle-jacks F^6, which are supported by the rocking levers F^2, are cut away upon their under sides by being recessed, as at f^5. The solid portion F^5 of the rear needle-bed from its front edge backward for about half its width is made of uniform thickness, and with its top surface parallel to its under surface. The rear top surface of this solid portion is inclined to provide for the downward movement of the needle-jack when its cut-away portion extends above both the regular and the inclined surface of the solid portion of the needle-bed.

The cams G G′ are carried by the front

main cam-slide C^4, and by their reciprocation the needles of the front row are actuated. The movable cam G is carried at the end of an arm g', pivotally connected with the front cam-slide and provided with an upwardly-projecting lug G^2, having a side pin g^2, which engages with one or the other of two guide-grooves G^3 G^4 in the inner vertical wall of the lower front channel-plate C^2. The lug G^2 passes through a slot in the front main cam-slide. At the left end of the guide-grooves G^3 G^4 there is pivoted between them a switch-gate g^3. A laterally-projecting arm on this switch-gate is connected with a vertically-moving controlling-arm G^5, which passes downward through the front needle-bed and is pivotally connected at its lower end with a pivoted shoe g^4, which rides at times in a groove G^6 in the pattern-cylinder, and at times upon cams G^7 G^8 G^9, during the actuations of the pattern-cylinder. A spring g^5, bearing at its upper end against the under side of the needle-bed and pressing downward upon the vertically-moving controlling-arm G^5, acts with a tendency to keep the shoe in its lowermost position at all times. It will be seen that the switch-gate will be operated six times during each revolution of the pattern-wheel, the switch-gate being elevated every time the shoe of the controlling-arm rides up an incline of one of the cams G^7, G^8, or G^9, so as to cause the pin g^2 to travel in the lowermost one of its two guides in the channel-bar, and to continue to travel in this guide while the shoe rides upon the surface of the cam. When the shoe descends the incline of the cam upon which it has been operating, the switch-gate will be lowered and the pin g^2 will be transferred to the uppermost one of its two guideways. Changes of the switch-gate occur when the pin g^2 is in the wide groove g^6. The result of this operation is that while the upper guide-groove controls the movements of the cam G, the front row of needles will be thrown out of action, because the projections of the needle-jacks of this row of needles will remain behind the two cams G G', passing beneath the cam G, and when the lower guide-groove controls the cam G it will be depressed so that the needle-jacks will be transferred from behind the cam G to the front of the cam G' at each stroke during the reciprocations of the main cam-slides, thus causing the needles to reciprocate once during each reciprocation of these cam-slides.

The needles of the back row are actuated by cams H H', and a triangular cam H^2 between the adjacent ends of the cams H H'. The movable cam H is carried by a pivoted arm h. The cam-arm h is provided with an upwardly-projecting lug h', having a laterally-projecting pin h^2, working in guide-grooves H^4 H^5, having a switch-gate H^9 at their left ends similar to the switch-gate employed for the cams for actuating the front needles. This switch-gate is also actuated by a vertically-moving controlling-rod h^3, pivotally connected at its lower end with a pivoted shoe h^4, substantially similar to the corresponding parts employed for actuating the cams of the front needles. This shoe h^4 is acted upon by a spring h^5, mounted upon the comb-frame H^6, with a tendency to keep the shoe down upon the pattern-cylinder at all times. In this cylinder are two grooves H^7 H^8, into which the shoe is depressed to draw down the switch-gate H^9, so that the cam H will be controlled by the upper guide-groove H^4. At this time the cam H will be elevated so that the needle-jacks will be acted upon in such a manner as to cause the back needles to reciprocate once for every reciprocation of the main cam-slides. When the shoe of the controlling-rod is acted upon by the ungrooved portions of the pattern-cylinder, the switch-gate is actuated in such a manner that the cam H is controlled by the lower guide-groove H^5. At this time the cam H is depressed, and the result is that the back needles make one reciprocation for each stroke of the main cam-slides.

The left needle in the back row of needles b^2 is automatically dropped and lifted at the beginning of the formation of a stocking by mechanism such as follows: The rocking support f^6 for this needle is cut away and provided with a cam f^7 on its under side. Normally this needle-support rests with its regular or uncut under surface upon the back sustaining-bar D^7. When, however, this bar is moved sidewise, it is presented to the recessed part of the needle-support, to permit this support and its needle to rock downward, the support when down resting upon its sustaining-bar outside of its cam f^7. A spring f^8 bears upon the rocking needle-support f^6 to insure its downward movement when this movement is permitted by the sidewise movement of the sustaining-bar and the withdrawal of the needle from the ledge D^8 of guide-bar D'. A hook f^9, having its shank mounted by the side of the needle-support, bears upon the needle, so that it is compelled to move downward with its support. The shank of the hook f^9 is shown as pivoted with the needle-support and as acted upon by the spring f^8. The sustaining-bar D^7, Fig. 6, is moved laterally in one direction by a spring F^7, and in the other direction by an elbow-lever F^8, to which motion is imparted by the pattern-cylinder at the proper time for permitting of throwing the needle out of action. This elbow-lever, as shown, is provided with a cam end or incline f^{10} for acting upon the sustaining-bar D^7 to move it in a direction contrary to that in which its spring moves it, and the opposite end of this lever, Figs. 6 and 12, is provided with a wiper-cam F^{10}, acted upon by the periphery of the pattern-cylinder. This elbow-lever is pivoted by a sleeve D^9 upon a stud-shaft D^{10}, supported by and projecting inwardly from the left end of the frame. The dropping-needle is actuated in such a manner that it is held down at the time that the yarn-

carrier is supplying the yarn above it upon its first outward stroke in beginning the formation of a stocking, and then moved upward in position to engage the yarn supplied to it upon the return stroke of the yarn-carrier, this operation being well understood.

When the sustaining-bar is moved laterally by the elbow-lever, it is temporarily retained in this position by the action of a dogging-lever E^2, which dogs the sustaining-bar after the elbow-lever is released. This dogging-lever is pivotally supported about midway its length and is acted upon by a spring E^3, Fig. 4, which draws down its shouldered end E^4 when downward movement of this end is permitted. The opposite end of the dogging-lever is acted upon by a tripping-rod e^6, Figs. 1, 4, and 17, actuated by a wiper-cam E^5, Figs. 1 and 4, carried by the back main cam-slide. At the proper time for elevating the dropping-needle this tripping-rod is depressed, correspondingly raising the end of the dogging-lever which acts on the sustaining-bar, thus leaving the sustaining-bar free to be actuated by its spring to be restored to its normal position beneath the dogging-lever.

The pattern-cylinder is intermittingly actuated at the ends of strokes of the main cam-slides, by driving connections with the main actuating-gear a' in the manner next to be explained. A shaft I, suitably mounted in a sleeve-bearing i at the right end of the main frame, is geared with the cam-gear B' by means of a star-pinion I'. This star-pinion is moved twice for each revolution of the cam-gear and is fast upon the shaft I, which has imparted to it one revolution for each five revolutions of the actuating-gear and cam-gear as the mechanism is in this instance organized. A pinion i' is fast upon the shaft I for engagement with gear-teeth I^2 upon the periphery of the pattern-cylinder at its right end. A long tooth i^2 is provided upon this pinion i' for engagement at proper intervals with sliding segment-gears I^3 I^4, adapted to move at times independently of the pattern-cylinder. These segment-gears have adjustable connection with the pattern-cylinder, so that their teeth, no matter in what positions they may be adjusted for action, will form continuations of or register with the teeth of the pattern-cylinder gear I^2. The adjustable segment-gears I^3 I^4 are of similar formation, one of them being of greater extent than the other, and each adapted to be slid and held in position in an annular guideway J' of the pattern-cylinder. The segment-gear I^3 has a segmental guide-flange J, shouldered at $j^\times$, and fitting so as to slide freely in the guideway J', formed at the right end of the pattern-cylinder, partly by a groove in the cylinder end and partly by the ring J^2, riveted or otherwise suitably attached to the end of the cylinder. The shoulder j of the segment-gear projects beneath the toothed end of the pattern-cylinder, so that the segment-gear teeth and the teeth of the pattern-gear will be flush with each other, and the segment-gear be prevented from displacement. A cross-pin j', together with a series of pin-holes j in the pattern-cylinder, serve to limit the movement of the segment-gear I^3 independently of the pattern-cylinder, in a forward direction, or that in which the cylinder rotates, and another series of pin-holes j^2 and a pin j^3, behind the segment-gear, provide for adjusting the segment-gear in position relatively to the pattern-cylinder and to prevent backward movement of the segment-gear I^3. This last-named pin and the openings in which it is secured in adjusting the segment-gear may be threaded to prevent accidental displacement of the adjusting-pin, or any equivalent means for adjusting may be provided. Premature forward movement of the segment-gear I^3 is prevented by a yielding stop K. The forward portion of the segment-gear is borne sidewise against by the stop, which is shown as formed by a spring-bar secured at one end to the inner surface of the main frame at its right end, bent sidewise, so as to bear at $K^\times$ against the frame and having a cam projection or incline k, Fig. 2, against which the forward end of the segment-gear bears, and along in frictional contact with which this segment-gear is forced when positively operated, as will be obvious. A screw $k^\times$, passing through the frame and engaging a screw-tap in the thickened end of the stop, Figs. 5 and 5^a, serves to adjust the stop and causes it to act with greater or less force in its resistance to the movement of the segment-gear to insure proper action by preventing accidental movement of the gear.

It will be seen that when, during the actuation of the pattern-cylinder, this cylinder has been brought to a position such that the cross-pin j^3 abuts against the rear end of the segment-gear, this gear is forced to partake of the forward movement of the pattern-cylinder, and is thus moved into position to be acted upon by the long tooth of the pinion i', with the result that as this segment-gear is intermittingly operated by this long tooth, and during a period of rest of the pattern-cylinder caused as presently to be explained, it will be moved forward the distance of one of its teeth every time the pinion makes one revolution until it has been fed forward a distance such as to cause its forward end to strike the stop-pin j'. During the time or more or less of the latter portion of the time that the long tooth of the pinion i' is acting upon the segment-gear I^3 to feed it independently of the pattern-cylinder an untoothed space L of the pattern-cylinder is occupied by the pinion, the pattern-cylinder gear being mutilated by the omission of one tooth at this space. At this time the pattern-cylinder is at rest, the period of rest of the pattern-cylinder, which occurs during the occupancy of the space L by the pinion, depending upon the adjustment of the segment-gear.

The shorter the distance between the pins j' j^3 the shorter the period of rest. When the forward end of the segment-gear has been brought into contact with its stop-pin, motion is first imparted to the pattern-cylinder by way of this segment-gear, as will be obvious, and after this the pinion acts upon the gear of the pattern-cylinder while the heel of a stocking is being formed and until an untoothed space L′ of the cylinder-gear is occupied by the pinion, when the cylinder comes to rest again and the ankle and gradually-enlarged leg portions of the stocking are formed during this interval of rest by the actuations of mechanism such as soon to be described.

The long segment-gear I^4 is of construction similar to that of the segment-gear I^3, and is adjustably mounted in the pattern-cylinder in a corresponding manner, there being provided for this segment-gear I^4 a front stop-pin l' in one of the series of holes j^2, and a rear stop-pin l in one of the series of holes j. The brake-stop K acts upon the segment-gear I^4 in the same manner as upon the segment I^3.

When, upon the contact with the rear end of the segment-gear I^4 of its adjusting-pin l', carried by the pattern-cylinder, this gear has been brought into position for engagement by the long tooth of the pinion i', the pinion occupies an untoothed space L^2 of the pattern-cylinder which had been presented to it at the completion of the actuations of the mechanism which control the widening of the stocking. The pinion will continue to rotate in this space without actuating the pattern-cylinder until the segment-gear becomes engaged with the pattern-cylinder by abutting against the front stop-pin l', after which the cylinder continues to move step by step and the segment-gear becomes inoperative until it is again acted upon by its rear pin.

In order to provide for controlling the widening of the work independently of the pattern-cylinder, I have devised auxiliary mechanism, such as soon to be described, by means of which any desired number of needles, which are not dependent upon the pattern-cylinder for their action, may be thrown into and out of operation. As shown, widening-needles are provided in series of corresponding numbers, respectively, at each end of both main rows of needles, there being in this instance nine needles in each series, or thirty-six in all. The widening-needles M′, at the opposite ends of the front row of main needles b', and the widening-needles N′, at the opposite ends of the rear row of needles b^2, are shown as supported and actuated in the following way: Rocking levers O O′ for the respective series M′ of the front widening-needles are pivotally connected with the front needle-bed by means of pivot-rods O^2, Fig. 15, passing through holes o' in them, and through corresponding holes in brackets O^3 O^3, secured to the needle-bed, Fig. 14. Jacks P for the respective series of front widening-needles are supported by the rocking levers O O′. These jacks are provided with shanks or upward projections p', to be operated by the cams G G′ when these shanks are elevated to bring them under the control of the cams. Reciprocating needle-controlling cam-bars Q Q′ have corresponding inclines q^2 q^2 upon their upper and under surfaces to constitute their cams, and, as in this instance shown, have actuating connection with the respective rocking levers O′ by means of links Q^2 Q^3, which are pivotally connected at their lower ends with the rocking levers, and have slots q q' endwise through which the controlling cam-bars work. The slots q q' are formed in the edges of the links of the respective series Q^2 Q^3, near their upper ends. The rocking levers will be moved up or down, (they would be actuated in the same way were the controlling cam-bars passed through slots made directly in the levers,) according to the direction in which the cam-bars are moved in the desired order for throwing the widening-needles into and out of action by bringing the shanks of their jacks into positions to be operated upon by the cams or withdrawing them from such positions, as will be obvious.

The reciprocating cam-bars Q Q′ work in a guideway-groove Q^4, formed in the lower front channel-plate C^2, and are retained therein by a suitable number of cross-pieces q^3, secured to the channel-plate above and below the guide-groove, which they span. The controlling-links Q^2 Q^3 of the rocking levers reciprocate in guide-grooves formed in the channel-plate C^2, as plainly shown by the drawings.

The adjacent or inner ends of the reciprocating cam-bars Q Q′ are connected with each other by reversing mechanism. As shown, they have secured to them rack-bars Q^5 Q^6, one above the other. Between these rack-bars a pinion q^4, gearing with both of them, is loosely mounted upon a stud q^5, fixed to the channel-plate and projecting forwardly therefrom. This pinion is secured against displacement in suitable well-known way, and by means of it, when one of the cam-bars is moved in its guideway-slot, motion is imparted by the reversing mechanism to the other cam-bar to cause it to move in the opposite direction. In this way it will be seen that both cam-bars are moved inward simultaneously or outward simultaneously throughout the reciprocations imparted to them, as presently to be explained.

The rocking levers O^4 O^5 for supporting the jacks of the respective series N′ of rear widening-needles are of construction precisely similar to that of the rocking levers of the front widening-needles, and like them are provided with slotted controlling-links o^2, to be actuated by the needle-controlling cam-bars O^6 O^7, in construction similar to Q Q′, provided with reversing mechanism, such as the rack-bars

Q^5 Q^6, with a pinion similar to q^4, supported between them by a stud secured to the rear lower channel-plate C^2.

It will be seen that the rear widening-needles and their actuating cam-bars are similar to the corresponding parts employed in connection with the front widening-needles. The rocking levers O^4 O^5 for the rear widening-needles are supported upon the same pivot-pin that supports the rocking levers of the needles of the back row which are on opposite sides of the central needles of this row. Each of the rocking levers for supporting the jacks of the widening-needles is provided with a slot widened toward its rear to provide for the dropping of the jacks, as in the above-referred-to application, Serial No. 165,731.

The auxiliary mechanism, by which the needles for widening and narrowing the work are operated independently of the pattern-cylinder, is in this instance operated from the driving-shaft by way of the main actuating-gear and the shaft I. This shaft extends across from end to end of the main frame, and is mounted at its outer or left end in a suitable bearing. Two teeth i^3 i^3 are provided diametrically opposite each other upon this shaft, near its outer end, for engagement with a segment-gear I^5 upon the periphery of a wheel I^6 of the auxiliary mechanism for controlling the widening and narrowing operations. This wheel I^6 is mounted upon the shaft of the pattern-cylinder against or close to the left end of the pattern-cylinder, and is acted upon by a yielding shoe or spring-brake i^4, to prevent its accidental movement. As shown, this brake acts upon the face of the wheel, but obviously, by twisting it, it might be caused to act upon the inner surface of the wheel. The auxiliary wheel I^6 is provided with two stop-lugs i^5 i^6 for engagement at proper times with a coöperating stop i^7 upon the pattern-cylinder. A cam-groove I^7 is formed in an adjustable peripheral portion or tire I^8 of the auxiliary wheel. A series of holes in the auxiliary wheel, and an adjustable stop-pin i^8, engaging with the desired one of these holes, and with a hole in the tire, serve to secure the tire in the desired position.

By the movement of the pattern-cylinder, when it is being actuated to form the heel of a stocking, it imparts motion to the auxiliary wheel by contact of the pattern-cylinder stop i^7 with the front stop i^5 of the auxiliary wheel, and by the time the untoothed space L′ of the pattern-cylinder is presented to the pinion i' the segment-gear of the auxiliary wheel will have been brought into position such that its front tooth will be under control of the teeth i^3 i^3 of the shaft I, so that the auxiliary wheel will be fed forward by the actuation of the shaft, preparatory to the operations of the widening-needles, and during the formation of the ankle portion of the stocking. The length of this ankle portion depends upon the adjustment of the cam-grooved tire I^8 relatively to the segment-gear I^5 of the auxiliary wheel. When, by the feed of this segment-gear independently of the pattern-cylinder by means of the teeth i^3 of the shaft I, the auxiliary wheel has been moved a distance sufficient to bring the cam portion of the groove I^7 into position to operate upon the pin i^9, carried by one end of a lever I^9, the reciprocating cam-bars, which actuate the widening-needles, will be operated by mechanism connecting them with this lever.

The cam-actuated lever I^9 of the auxiliary mechanism for throwing the widening-needles into action has the pin i^9 (or it may be a roller) attached to its rear end, and is pivoted midway its length upon a stud i^{10} at the inner side of the left end of the main frame beneath the needle-beds.

Upwardly-projecting levers R R′ connect, respectively, at their lower ends with the cam-actuated lever, at or near its front and rear ends. These levers R R′ are shown as pivotally supported about midway their lengths by brackets r r', respectively secured to the left front corner of the front needle-bed and the left rear corner of the rear needle-bed, the upper ends of the levers lying close to the front and rear surfaces of the respective channel-plates C^2 C^2, and spanning the guide-grooves for the cam-bars which are formed in these channel-plates. Each of the levers has pivoted to its upper end an actuating-pawl R^2, projecting to the left and adapted to vibrate up and down in slots formed, respectively, in the front and rear channel-plates C^2 C^2. These actuating-pawls, Fig. 16, have each a downwardly-projecting tooth for engagement with ratchet-teeth r^2, formed upon the left front and rear cam-bars Q O^6, respectively. Each actuating-pawl is borne downward upon by a spring R^3 acting upon a side lug r^4 of the pawl. Stop-pawls R^4 R^5, one for coöperating with each actuating-pawl, are borne upon by springs r^5 r^6. These springs act upon side lugs of the stop-pawls, and these pawls serve to hold the cam-bars while their actuating-pawls are being retracted preparatory to feeding the cam-bars, as will readily be understood.

The stop-pawls are pivoted at their heel ends to plates R^6 R^7, secured to the respective channel-plates, and provided with lugs r^8 r^8, which serve in connection with the slots in these channel-plates to guide and retain the actuating-pawls in proper position.

A rocking arm S, supported upon an arm s, attached to the inner surface of the right end of the main frame, is acted upon by a spring S′, with a tendency to sway it inward or toward the left. At its upper end this rocking arm is slotted and has connection with a pin s', secured to the right end of the cam-bar Q′. It will be seen that this rocking arm, when permitted to act, serves to move the cam-bar Q′ inward, or to the left, which results in moving the cam-bar Q also inward but to the right because of the pinion-and-rack connection between the adjacent ends

of these cam-bars. A coil-spring S^2 upon the stud of the pinion o^5, which connects the rack-bars of the cam-bars O^6 O^7, acts upon this pinion with a tendency to rotate it in a direction such as to move the two cam-bars inward.

As the mechanism is in this instance organized, the widening-needles are thrown into action in the following order: When the first cam-incline T of the cam-groove I^7 acts upon the actuating-lever I^9, the inner needle of the right series of back widening-needles N′ will be thrown into action by the movement outward (to the right) imparted to the cam-bar O^7. The relation of the cam-inclines upon the bars O^6 O^7 is such that, although movement to a corresponding extent is imparted to both cam-bars by this first actuation of the lever I^9, the cam-inclines only of the bar O^7 are presented to a link connected with a lever of a widening-needle. During the above-described operation of the back cam-bars by their lever-and-pawl connections with the actuating-lever, this lever moves the lever R, connected with its front end, into position to actuate the front cam-bars upon the succeeding operation of the actuating-lever. Upon the presentation of the second cam-incline t to the pin or roller of the actuating-lever, this lever will be moved in a direction opposite to that in which it was moved by the first cam-incline, and the front cam-bars Q Q′ will be operated by means of the lever R and the actuating-pawl secured thereto in such manner as to throw into action two front widening-needles. These needles so thrown into action are the inner one of the right series M′, and the inner one of the left series M. During this action a return stroke of the actuating-pawl of the lever R′ takes place, so that upon the presentation of the cam-incline T′ to the actuating-lever two rear widening-needles will be thrown into action, these needles being the inner one of the left series N, and next to the inner one of the right series N′. At this time a return stroke of the actuating-pawl carried by the lever R takes place.

Upon successive movements imparted to the actuating-lever by the series of cam-inclines, repetitions in the order named of the above-described operations take place, there being thrown into action two widening-needles, either at the front or at the rear, until there remains out of action a single widening-needle, which is that at the outside of the left series of back widening-needles. This needle is thrown into action by itself upon the next operation of the actuating-lever after that occurring when the outer needles of the right and left series of front widening-needles were thrown into action. After this the last cam-incline t' restores the pin or roller of the actuating-lever to that side of the cam-groove from which it started at the beginning of the above-described operations of throwing the widening-needles into action. A spring t^3 acts upon the front end of the actuating-lever with a tendency to pull it inward and keep its cam-traveling roller in proper position.

The cam-inclines of the groove I^7 extend somewhat nearer to the center of the cam-groove at their front ends than elsewhere, being formed at these ends each with a slight inclined lug or shoulder t^2. In this way sufficient movement is imparted to the respective cam-bars to insure proper action of the pawls upon the cam-bars, lost motion being taken up by the action of the springs S′ S^2, as will readily be understood.

After all the widening-needles have been thrown into action, the rear stop i^6 of the auxiliary wheel is brought into contact with the stop i^7 of the pattern-cylinder during the actuation of the segment-gear I^5 by the shaft I, and the pattern-cylinder has motion imparted to it, so as to present its single tooth between the untoothed spaces L′ L^2 to the pinion i', and this pinion rides into and comes to rest in the space L^2. While this pinion is in this space L^2, all the widening-needles continue to operate. Movement is again imparted to the pattern-cylinder by the long segment-gear I^4, in manner already explained, and the cylinder begins its step-by-step motion again upon the completion of a stocking.

All the widening-needles are simultaneously thrown out of action, upon the completion of a stocking, by mechanism such as follows: An arm U, upon the end of the sleeve D^9 opposite that carrying elbow-lever F^8, acts upon the rear end of a lever U′, pivoted near its front end to the inner surface of the left end of the main frame, beneath the needle-beds. The front end of this lever is slotted and engaged by a pin u, carried by the rear end of a corresponding lever U^2, pivoted to the frame at u'. The rear and front ends of these levers U′ U^2, respectively, are provided with side lugs for engaging with the lower ends of rods U^3 U^4, adapted to move up and down in guide-holes formed in the main frame, and in the front and rear needle-beds and lower channel-plates C^2 C^2. At their upper ends these rods are formed with cross-heads to come in contact with the under surfaces of the lugs which project from the actuating and holding pawls of the cam-bars Q O^6, respectively. When, upon the actuation of the rocking arm U, by the operation of the pattern-cylinder upon the shoe F^9, the rear lever U′ is lifted, a corresponding movement will be imparted to the front lever U^2, and the pawls of both the front and back cam-bars will be tripped or lifted to free them from the ratchets, thus leaving these cam-bars free to be operated in such manner as to move them in proper way to throw all the widening-needles out of operation, as will next be described.

A lever V, pivoted at its right end to the under side of the front needle-bed, engages at its left end with a trip-arm V′, pivoted upon the outer surface of the left end of the main frame. A rod v, secured to the lever V be-

tween its ends, is jointed at its lower end to the shoe g^4, which actuates the cam-controlling arm G^5. When this shoe descends into the short portion v' of the divided cam-groove G^6, the front end of the trip-arm V′ will be depressed, and by the elevation of the rear end of this trip-arm the nose end of a rocking pawl V^2 will be lifted, Fig. 19. This rocking pawl is pivoted beneath the lower rear channel-plate C^2 upon a stud projecting forwardly from a bracket v^2, secured to the cam-bar O^6. A lever V^3, supported by a pivot v^3, Fig. 18, projecting downwardly from the upper rear channel-plate C^3, has self-adjusting pivotal connection at its rear end with the bracket v^2 by means of a pin v^4, secured to the bracket and a slot in the lever. At its forward end and right edge this lever is provided with a rounded surface. Another lever V^4, similar to the lever V^3, has adjustable connection at its forward end with a bracket V^5, secured to cam-bar Q. This lever V^4 is pivotally supported beneath the upper front channel-plate C^3, and at its rear rounded end comes in contact with the corresponding end of the lever V^3.

Upon the final portion of the outward stroke of the main cam-slides, at the completion of a stocking, the arm U and the lever V are actuated to trip the pawls of the cam-bars Q O^6 and elevate the nose end of the pawl V^2, so that upon the final portion of the succeeding or last stroke of the main cam-slides an engaging lug W upon the under surface and left end of the back main cam-slide will actuate the pawl and move inward the cam-bar O^6, and at the same time correspondingly move the cam-bar Q by the action of the levers V^3 V^4. In this way the rocking levers of all the widening-needles are lowered and these needles thrown out of action, as will readily be understood. This throwing out of action of the widening-needles is assisted by the force of the springs S′ S^2.

In order that more or less widening-needles may be operated according to the size which it is desired to make the leg of the stocking, the cam-inclines T t T′ t', &c., are rendered detachable, being shown as formed of blocks, Fig. 24, each removably secured in place by means of a dowel-pin Y entering a hole y in one or other of the side walls of the cam-groove I^7, Fig. 23, and by a screw Y′ passing through a screw-threaded hole y' in the wall of the cam-groove and engaging a hole in the cam-block. It will be seen that by removing any desired number of the cam-blocks at either end of the series of these cam-blocks, fewer widening-needles will be actuated, and that by restoring the cam-blocks more of the widening-needles may be caused to operate, according to the number of cam-blocks in place.

In the operation of the machine when about to begin to knit a stocking the positions of various parts of the mechanism are as follows, the operation of mechanism which is similar to that of the before-mentioned John Nelson machines being the same as in said machines: All the needles except the widening-needles are in their advanced positions. The widening-needles are in their retracted and inoperative positions. The cams for operating the needles of the back row are set to cause these needles to retract and advance at each stroke of the main cam-slides, and so make two reciprocations at each reciprocation of these slides to knit the toe of a stocking. The dogging-lever which acts upon the sustaining-bar of the dropping needle at the left end of the back row of main needles is in its operative position ready to cause this needle to drop when it has been partially retracted upon the first outward stroke of the main cam-slides, and neither yarn-carrier is engaged with its actuating-slide. Now, upon the beginning of the advance or outward stroke of the first reciprocation of the main cam-slides, the yarn-carrier D is engaged for action, and after this both sets of needles are retracted or moved downward, the needles of the back row being advanced also after being retracted on this stroke. The yarn is laid by the yarn-carrier across the needles preparatory to their downward movement, the horns which move with the yarn-carrier having opened the latches of the needles, if closed, so that the yarn lies upon the latches. The presser-hooks are actuated in such manner as to be first moved upward in time to come above the yarn as it is carried downward by the needles, so that upon the subsequent advance of the needles the presser-hooks move downward and retain the yarn that slips out of the open latches of the needles, the yarn so retained serving to close the latches upon the next downward movement of the needles of the back row in the well-known manner of knitting in this class of machines. The dropping needle, (that at the left of the back row of needles,) as it is retracted on this first stroke of the main cam-slides, passes beneath the yarn so as not to engage it; but before the completion of this outward stroke the tripping mechanism which operates upon the dogging-lever of the sustaining-bar of the dropping needle is actuated, and this needle is lifted, so that it occupies the same inclined plane as that occupied by the other needles of its row. This needle therefore advances in line with the other needles of the back row during the latter part of the outward stroke of the main cam-slides, but passes above instead of beneath the yarn, as it did on its downward stroke. At the end of the first stroke of the main cam-slides the switch mechanism of the cam for actuating the front row of needles is operated to throw these needles out of action in their retracted positions, in which positions they remain during the knitting of the toe of a stocking, and the yarn-carrier is shifted relatively to the cams for actuating the presser-hooks and the cams for actuating the needles, and upon the inward stroke of the first reciprocation the above-described actions of the

yarn-carrier, its horns, the needles of the back row, and their coöperating presser-hooks are repeated. The step-by-step motion imparted to the pattern-cylinder during the knitting of the toe and at the end of each stroke of the main cam-slides causes the needles first on one flank and then on the other of the back row of needles to be successively thrown out of action one at a time, then in part thrown into action again, and so on, thus narrowing and widening the row of stitches in the formation of the toe, as heretofore and as well understood. Upon the completion of the toe the yarn-carrier D is disengaged from its actuating-slide and the yarn-carrier A^7 thrown into action by engagement with this slide, and the switches of the cams for actuating both the front and rear needles are actuated in order to throw the needles of the front row into action, and to cause the needles of the back row to operate once during each complete reciprocation of the main cam-slides, instead of operating twice at each reciprocation, as they did when forming the toe. Circular knitting now goes on, while the cylinder remains at rest, to form the foot or that portion of the stocking between the toe and heel. During the time that this portion of the stocking is being formed the pinion i' occupies the untoothed space L of the pattern-cylinder, and the long tooth of the pinion acts upon the segment-gear I^3 to feed it independently of the pattern-cylinder. The length of the foot of a stocking depends upon the adjustment of this segment-gear, the pinion continuing to act in the untoothed space of the pattern-cylinder during the time that the segment-gear is being fed forward to bring it against its front stop-pin. When so brought against this stop-pin, the foot portion of the stocking is finished, and intermittent motion is imparted to the pattern-cylinder by the pinion, and the above-described operations which took place for forming the toe are repeated to knit the heel, it being understood that the yarn-carrier which is supplied with heavy yarn is brought into operation in place of the yarn-carrier A^7. After the formation of the heel and during the knitting of the ankle or lower portion of the leg of the stocking, (at which time it will of course be understood that both sets of needles are acting as when the foot portion of the stocking was being knit,) the pinion i' acts in the space L' of the pattern-cylinder gear, and the teeth i^3 i^3 of the shaft I operate upon the segment-gear of the auxiliary wheel, moving it independently of the pattern-cylinder. When this segment-gear has been fed forward until the ankle portion of the stocking has been completed, the widening-needles a reactuated, and while they are all in operation the pattern-cylinder is actuated to present its untoothed space L^3 to the pinion i', and the work of completing the stocking goes on, as already fully explained.

As the mechanism is timed, in this instance, there are seven and a half rounds or rows of stitches knitted after throwing the first widening-needle into action before the next two widening-needles are thrown into action, and a corresponding number of rounds of stitches are knitted between the times of successively throwing into action other widening-needles.

It will be understood that the length of that portion of the stocking which is knitted after the last widening-needle has been thrown into action, and the stocking thus gradually enlarged, and during the time that all the widening-needles are acting, will depend upon the adjustment of the front stop-pin for the segment-gear I^4.

When the cylinder has motion imparted to it at the time that the segment-gear I^4 comes in contact with its front stop-pin, the yarn-carrier A^7 is thrown out of action, at this time both yarn-carriers being inoperative. Next, upon an outward stroke of the main cam-slides, the mechanism for actuating the switch mechanism of the cams for operating the front needles is actuated to throw these needles out of operation, leaving them in their retracted positions for several strokes of the main cam-slides, and during the strokes made without laying the yarn in the needles a completed stocking is thrown off. At the same time the tripping-arm V' is actuated to set the rocking pawl V^2 for subsequent engagement by the lug W of the back main cam-slide. Simultaneously the shoe F^9 of the elbow-lever F^8 is acted upon by the pattern-cylinder cam X, and the arm U acts upon the lever U', and the pawls of the cam-bars for actuating the widening-needles are lifted. Upon the return stroke of the main cam-slides taking place next after the last-mentioned operations, all the widening-needles are thrown out of action, as already fully explained.

During the final portion of the next outward stroke of the main cam-slides, the switch mechanisms of the cams for actuating both the front and rear needles are operated to throw the front needles into action, and to set the back needles for making two reciprocations for each reciprocation of the main cam-slides, thus adapting them for knitting a toe. The result of this actuation of the needle-operating cams is that both sets of needles are in their advanced positions to receive the yarn at the beginning of a new stocking.

Upon the final portion of the inward stroke of the main cam-slides occurring next before that stroke which takes place at the commencement of forming a new stocking, the wiper-cam F^{10} acts upon the elbow-lever F^8, moving the sustaining-bar D^7 into position such that during the first outward stroke of the main cam-slides the dropping needle will be operated, as already fully explained, a yarn-carrier being thrown into action at the beginning of this stroke also, as before stated.

I claim as of my own invention—

1. The combination substantially as set forth of the two alternating yarn-carriers, means for reciprocating them alternately, and the horn for deflecting one of the yarn-carriers out of the path of the other while it is operating.

2. The combination of the alternating yarn-carriers, the supporting-slides to which they are jointed, springs acting on the yarn-carriers, the separating-horn, the sleeve-slide alternately engaging with the respective supporting-slides, the rock-shaft with which the sleeve-slide turns and along which it reciprocates, means for actuating the rock-shaft, and mechanism for reciprocating the sleeve-slide, substantially as and for the purpose set forth.

3. The combination substantially as set forth of the two alternating yarn-carriers having the eyes d' at their lower ends arranged to travel in the same vertical plane, means for reciprocating the yarn-carriers alternately, and a device for deflecting one yarn-carrier out of the path of the other while it is in operation.

4. The combination of the rotating pattern-cylinder, the needles, means for actuating them, the cam-grooved ring J^2 on the pattern-cylinder, the lever actuated by said grooved ring, the rock-shaft operated by the lever, the sleeve-slide of the rock-shaft, the reciprocating yarn-carriers, their supporting-slides, means for alternately connecting the supporting-slides of the yarn-carriers with the sleeve-slide, the saddle connected with the yarn-carrier-actuating devices, and the horns carried by the saddle for opening the latches of the needles.

5. The combination of the sidewise-moving sustaining-bar, the dropping needle, the rocking support with which the dropping needle rises and falls provided with the cam and resting upon the sustaining-bar, the spring acting on the sustaining-bar and against the force of which the sustaining-bar is moved to admit of the descent of the dropping needle, the spring-actuated dogging-lever for temporarily retaining the sustaining-bar in its adjusted position, the tripping-rod acting on the dogging-lever, the main cam-slides, and the wiper-cam actuating the tripping-rod, substantially as and for the purpose set forth.

6. The combination of the sidewise-moving spring-actuated sustaining-bar, the dropping needle, the rocking support with which the dropping needle rises and falls provided with the cam and resting upon the sustaining-bar, the elbow-lever acting on the sustaining-bar, the pattern-cylinder, the cam of the elbow-lever acted upon by the pattern-cylinder, the spring-actuated dogging-lever acting upon the sustaining-bar, the trip-rod of the dogging-lever, the main cam-slides, and the wiper-cam thereof for actuating the tripping-rod, substantially as and for the purpose set forth.

7. A knitting-machine comprising front and rear needle-controlling cam-bars having the corresponding inclines upon their upper and under surfaces, the needles controlled by said cam-bars, actuating devices for the needle-controlling cam-bars, the jacks, the front and rear jack-supporting rocking levers and the slotted links pivoted to said levers and actuated by the cam-bars.

8. The combination, substantially as set forth, of the driving-shaft, needle-controlling cam-bars having the corresponding inclines upon their upper and under surfaces, auxiliary mechanism, substantially as set forth, for actuating the cam-bars, mechanism, substantially as set forth, for operating the auxiliary mechanism from the driving-shaft, the jack-supporting rocking levers, and their pivotally-attached slotted links actuated by the cam-bars, for the purpose set forth.

9. The combination of needle-controlling cam-bars having the corresponding inclines upon their upper and under surfaces, their rack-bars and the intermediate pinion, mechanism, substantially as set forth, for actuating the cam-bars and the jack-supporting rocking levers with which the cam-bars have actuating connection by way of their slotted pivotally-attached links, substantially as and for the purpose set forth.

10. The combination of the rocking lever O' for supporting a needle-jack, and its slotted pivoted controlling-link, substantially as and for the purpose set forth.

11. The combination of a rocking lever O' for supporting a needle-jack, a slotted controlling-link pivoted to the rocking lever, and a needle-controlling cam-bar reciprocating in the link-slot, substantially as and for the purpose set forth.

12. The combination of the needle-controlling cam-bars, the racks and pinion connecting them at their inner ends, means, substantially as set forth, for actuating the cam-bars, the jack-supporting levers, their pivotally-attached slotted links, and a spring acting upon the cam-bars with a tendency to move them inward, substantially as and for the purpose set forth.

13. The combination of the driving-shaft, the shaft I gearing connected therewith by which it is actuated from the driving-shaft, the auxiliary wheel, its segment-gear the shaft I by which it is actuated, the cam-grooved tire of the auxiliary wheel, the needle-controlling cam-bars and mechanism, substantially as set forth, operated from the cam-grooved tire by which the said cam-bars are actuated, substantially as and for the purpose set forth.

14. The combination of the auxiliary wheel, its segment-gear, the shaft having teeth for engaging the segment-gear, mechanism, substantially as set forth, for actuating this shaft, the pattern-cylinder, its actuating mechanism, substantially as set forth, the stops of the auxiliary wheel, the pattern-cylinder stop, and the cam-grooved tire of the auxiliary wheel, substantially as and for the purpose set forth.

15. The combination of the intermittingly-

actuated pattern-cylinder means for actuating it, its stop, the auxiliary wheel having stop-pins for engagement with the pattern-cylinder stop, mechanism, substantially as set forth, for actuating the auxiliary wheel, the cam-grooved tire of the auxiliary wheel, and means, substantially as set forth, for adjustably securing it in position, substantially as and for the purpose set forth.

16. The combination of front and rear needle-controlling cam-bars having ratchet-teeth, jack-supporting rocking levers the actuating connecting-links, actuating-pawls engaging the ratchet-teeth on the cam-bars, levers carrying the actuating-pawls, stop-pawls acting on the cam-bar ratchets, springs acting on the pawls, the lever by connection, substantially as set forth, with which the pawl-carrying levers are actuated, mechanism, substantially as set forth, for actuating this lever, and the pawl-tripping mechanism substantially as set forth, for the purpose described.

17. The combination of the front and rear needle-controlling cam-bars having ratchets, the actuating and stop pawls engaging the ratchets, springs acting on the pawls, mechanism, substantially as set forth, for operating the actuating-pawls, the rods for lifting the pawls, the levers acting upon the rods, the rocking arm for actuating the levers, and mechanism, substantially as set forth, for actuating the rocking arm, for the purpose set forth.

18. The combination of the front and rear needle-controlling cam-bars, the rocking pawl V^2 carried by one of the cam-bars, the trip-arm acting on the rocking pawl, mechanism, substantially as set forth, for actuating the trip-arm, the main cam-slides, the engaging lug for actuating the rocking pawl, and the pivoted levers V^3 V^4 engaging the cam-bars, substantially as and for the purpose set forth.

19. The combination of front and rear needle-controlling cam-bars having ratchet-teeth, jack-supporting rocking levers the actuating connecting-links, actuating and stop pawls engaging the ratchets on the cam-bars, springs acting on the pawls, mechanism, substantially as set forth, for operating the actuating-pawls, mechanism, substantially as set forth for tripping the pawls, the main cam-slides, their engaging lug W, the rocking pawl V^2 carried by one of the cam-bars, mechanism, substantially as set forth, for tripping said rocking pawl, and the pivoted levers acting one upon the other and engaging with the front and rear cam-bars, respectively, substantially as and for the purpose described.

20. The combination of the yarn-carrier supporting-slides, means for actuating them, the yarn-carriers hinged to their respective slides, springs for holding the yarn-carriers in proper position, and a horn at one end of the machine operating upon the yarn-carriers to deflect them, substantially as described.

In testimony whereof I have hereunto subscribed my name.

ALFRED NELSON.

Witnesses:
S. G. BRONSON,
H. D. EASTMAN.