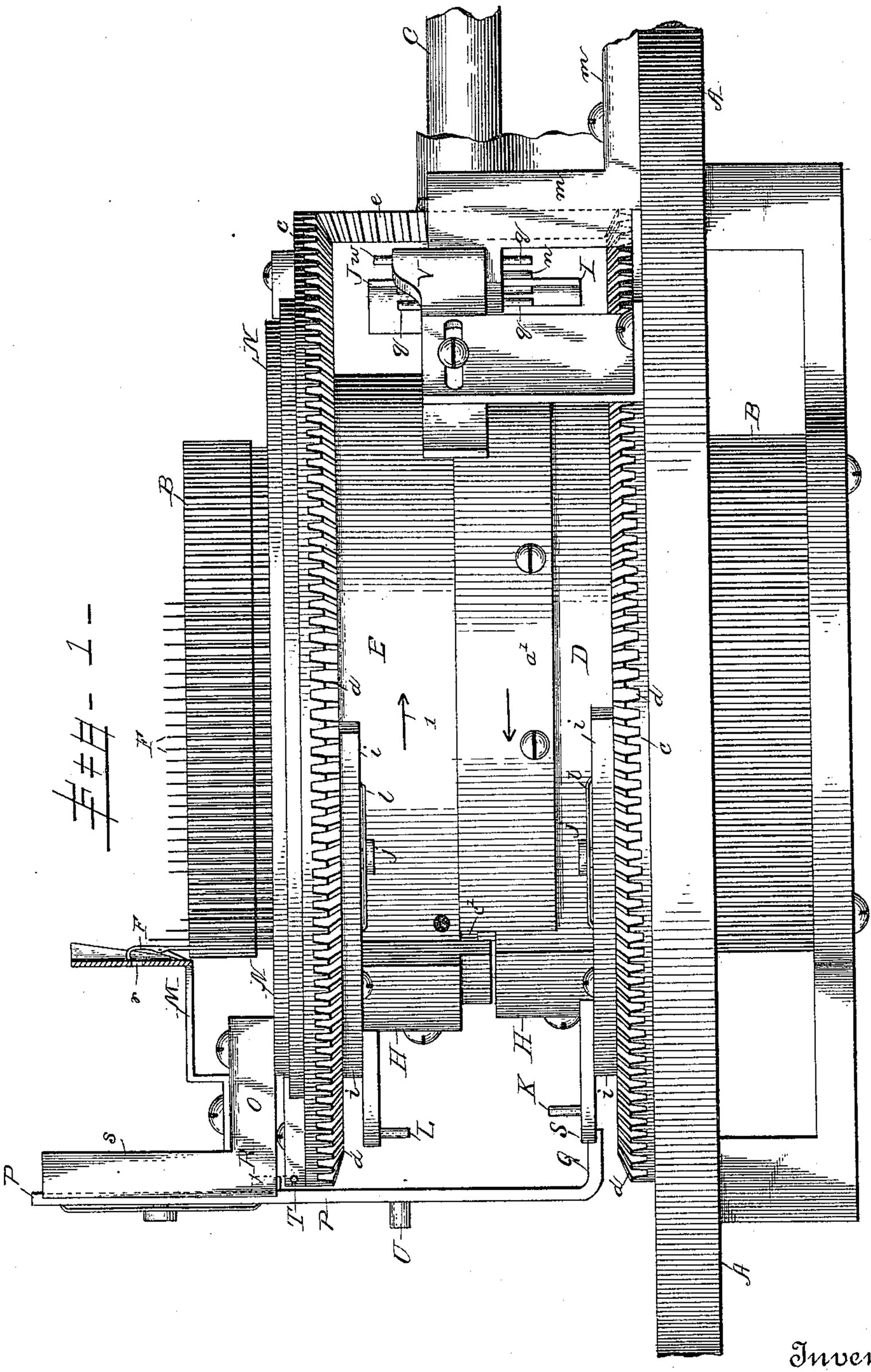
(No Model.) 6 Sheets—Sheet 1.

A. T. L. DAVIS.

CIRCULAR KNITTING MACHINE.

No. 438,346. Patented Oct. 14, 1890.



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his Attorney

(No Model.) 6 Sheets—Sheet 2.

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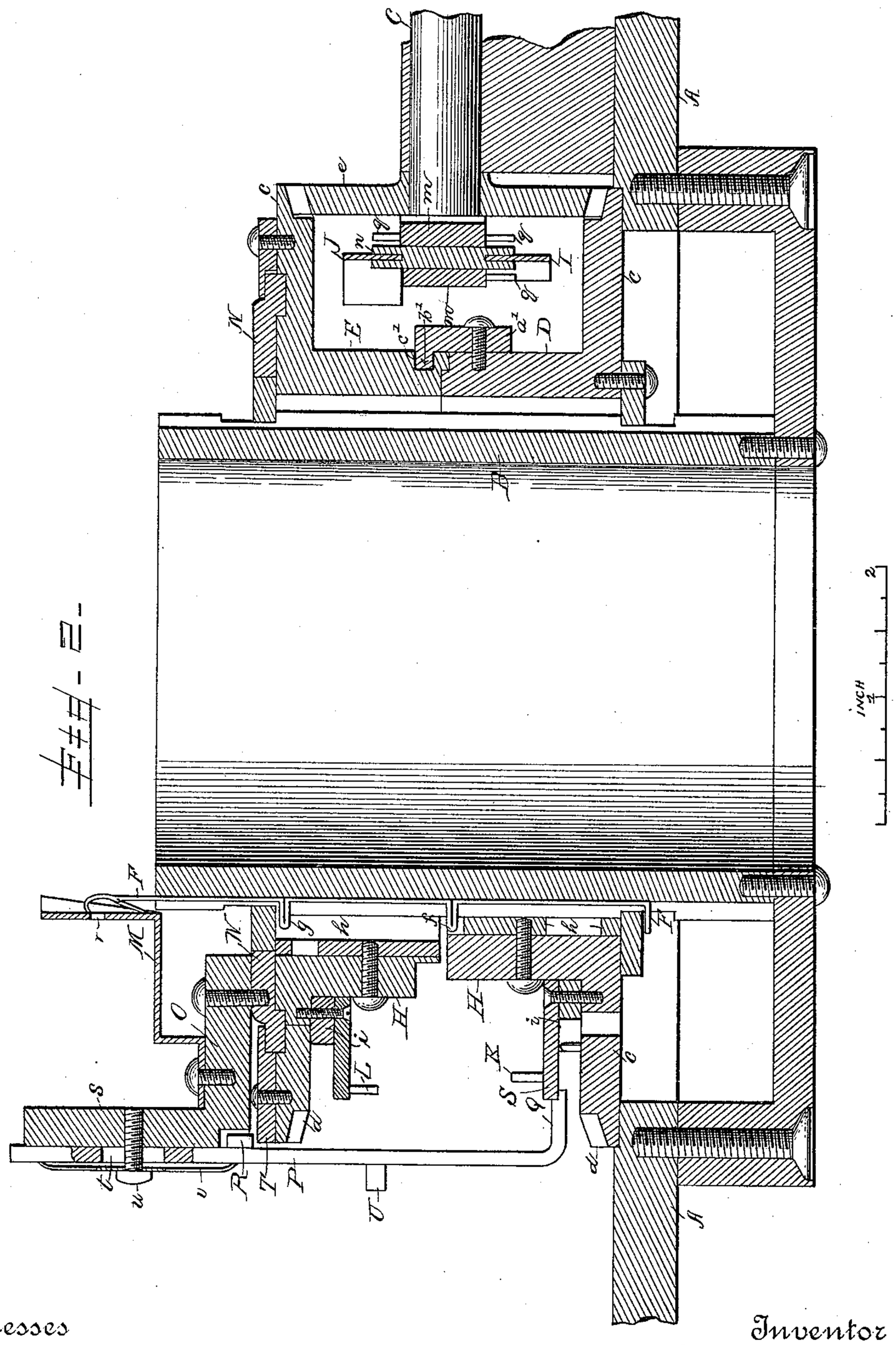
CIRCULAR KNITTING MACHINE.

No. 438,346. Patented Oct. 14, 1890.



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(No Model.)

6 Sheets—Sheet 3.

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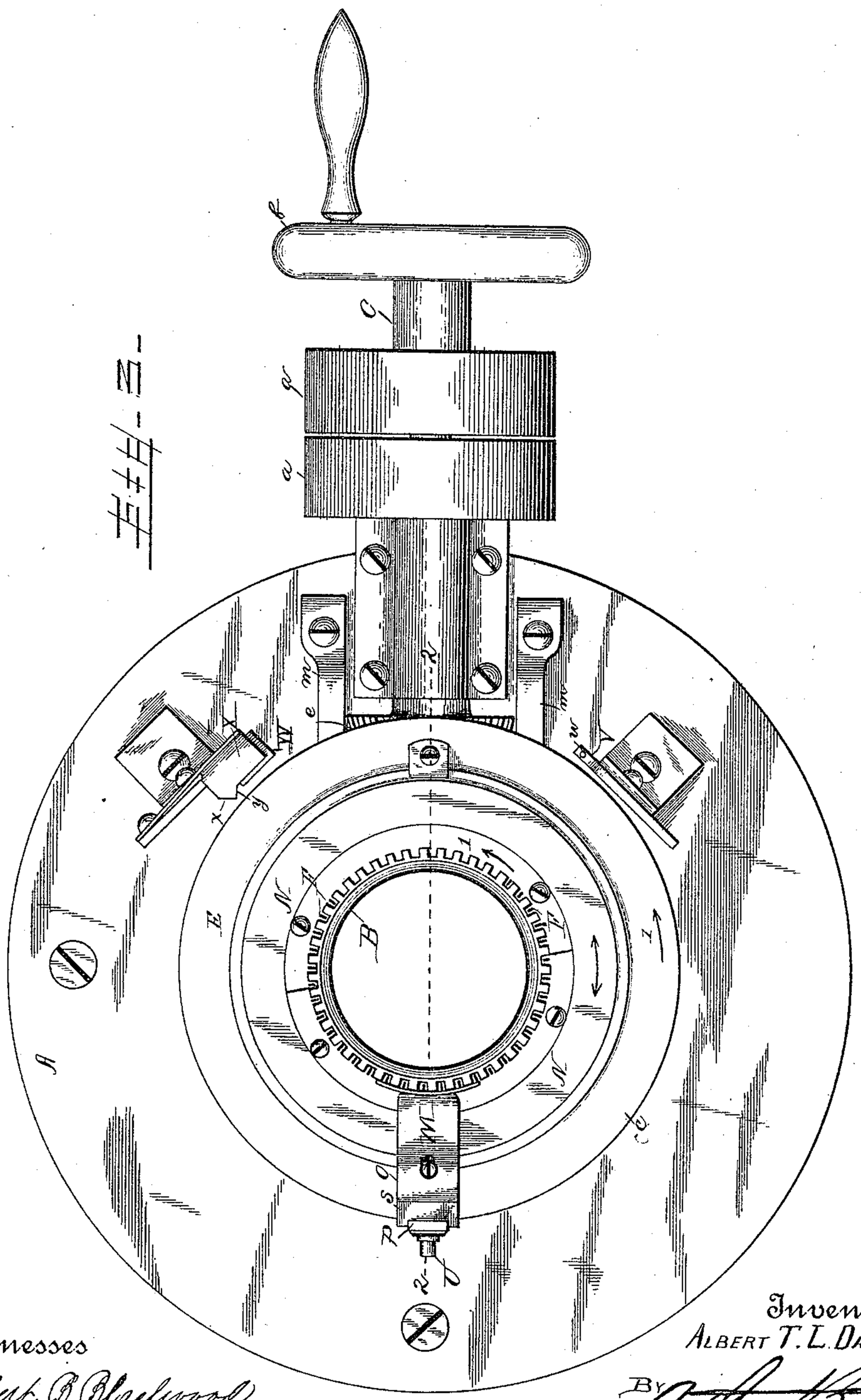
CIRCULAR KNITTING MACHINE.

No. 438,346. Patented Oct. 14, 1890.



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(No Model.) 6 Sheets—Sheet 4.

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CIRCULAR KNITTING MACHINE.

No. 438,346. Patented Oct. 14, 1890.

Fig. 4.

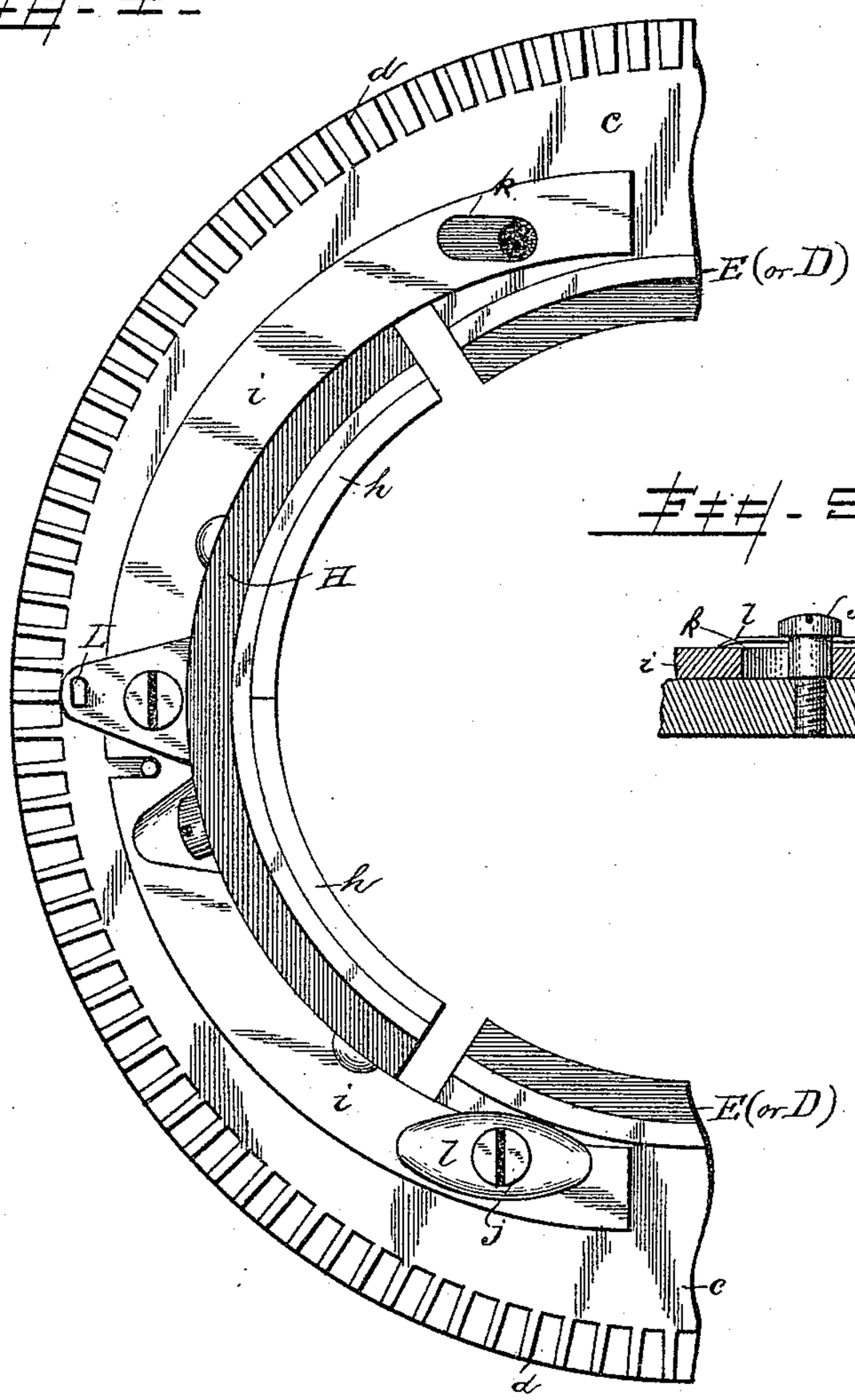

Fig. 5.

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(No Model.) 6 Sheets—Sheet 5.

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CIRCULAR KNITTING MACHINE.

No. 438,346. Patented Oct. 14, 1890.

FIG. 1.

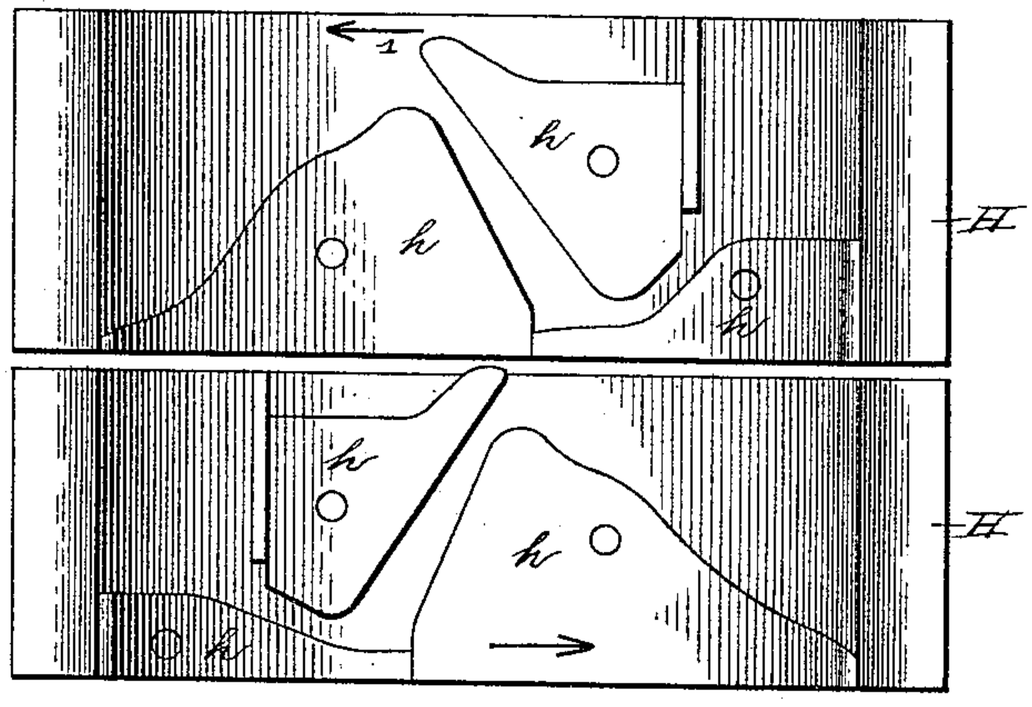


FIG. 7.

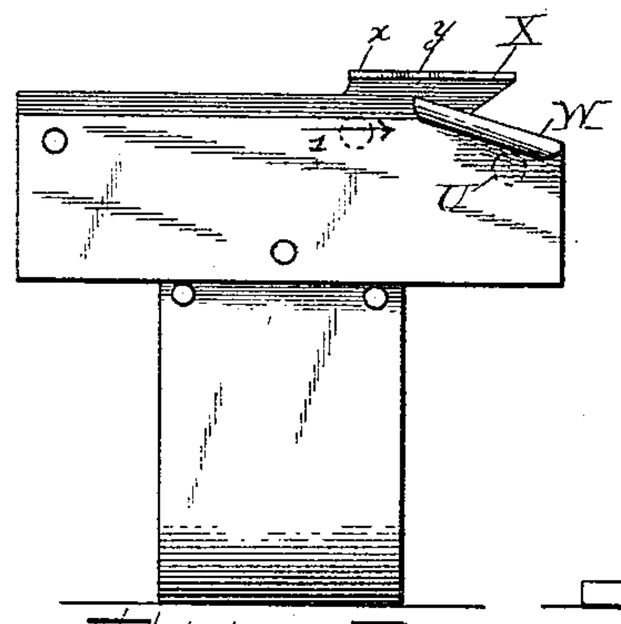


FIG. 8.

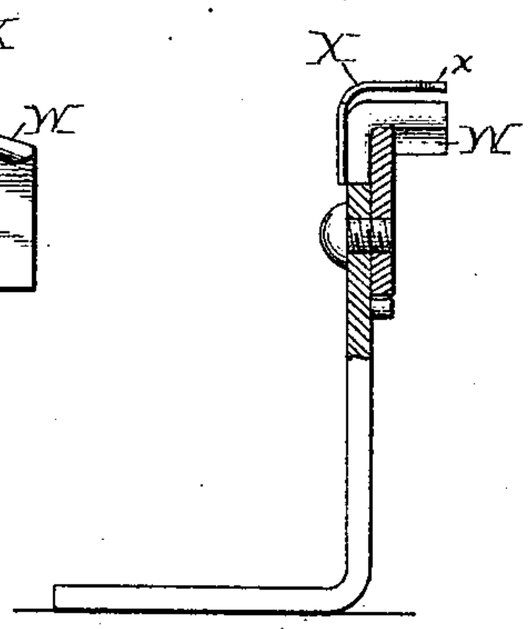


FIG. 9.

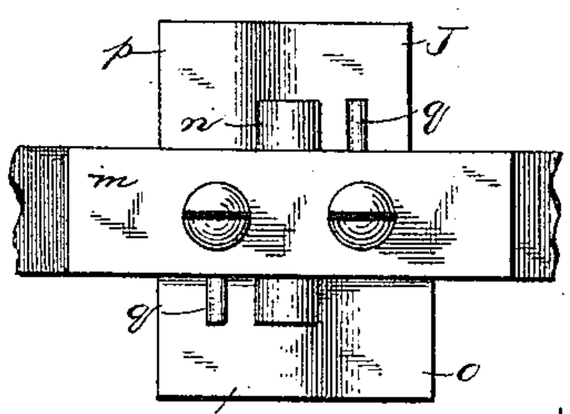
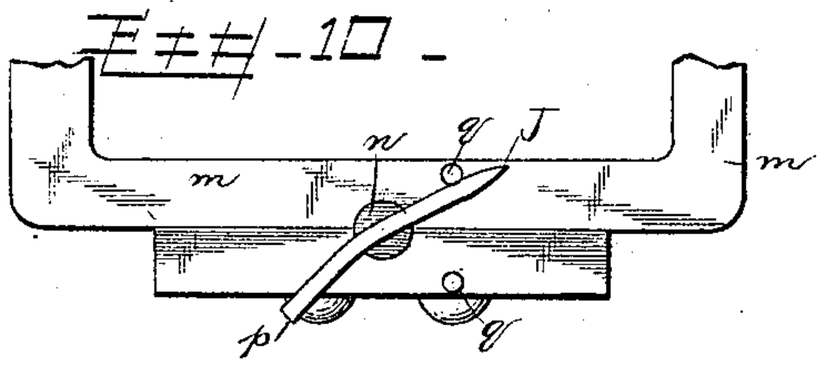


FIG. 10.



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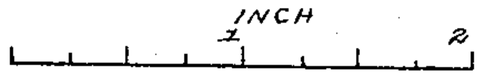

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(No Model.) 6 Sheets—Sheet 6.

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CIRCULAR KNITTING MACHINE.

No. 438,346. Patented Oct. 14, 1890.

Fig. 11.

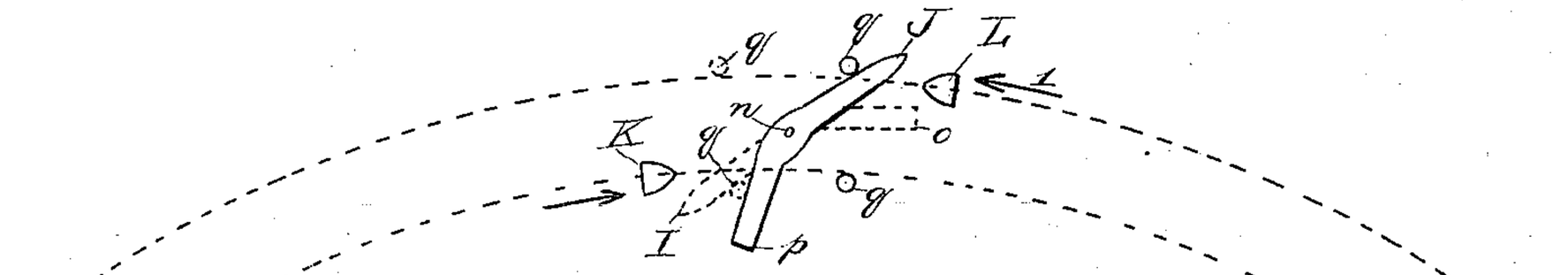
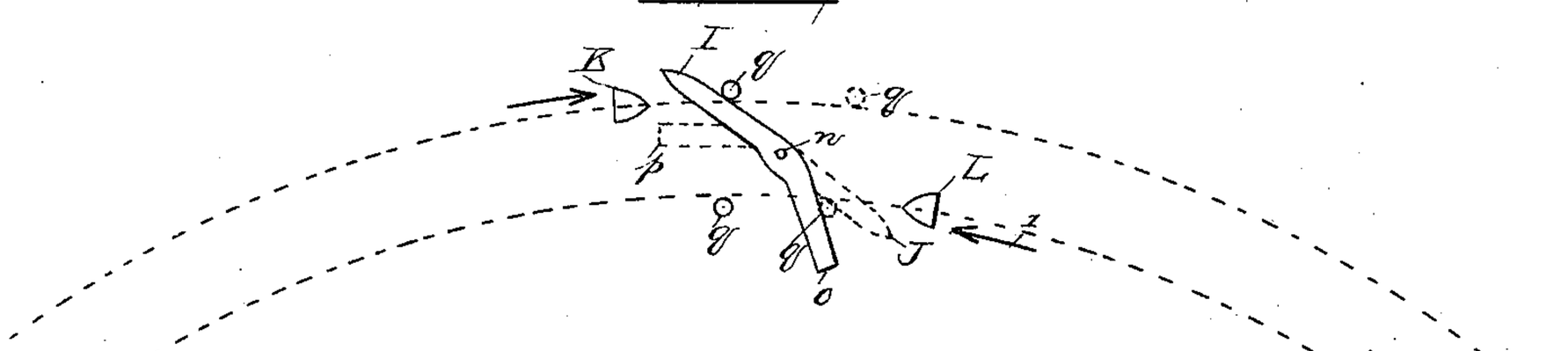
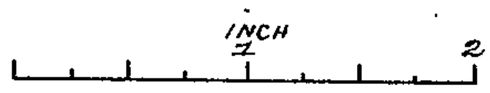


Fig. 12.





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UNITED STATES PATENT OFFICE.

ALBERT T. L. DAVIS, OF LAKE VILLAGE, NEW HAMPSHIRE.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 438,346, dated October 14, 1890.

Application filed January 22, 1890. Serial No. 337,680. (No model.)

To all whom it may concern:

Be it known that I, ALBERT T. L. DAVIS, of Lake Village, in the county of Belknap and State of New Hampshire, have invented certain new and useful Improvements in Circular-Knitting Machines, of which the following is a specification.

The present invention relates to that class of circular-knitting machines which is adapted to knit a flat web. Such machines have hitherto comprised as their essential characteristics a stationary needle-cylinder, a rotary needle-operator, consisting of a rotary cam-cylinder which actuates the needles, and a rotary thread-carrier, which feeds the thread into the needles. Flat webs have been formed on such machines by rotating the needle-operator or cam-cylinder and the thread-carrier first in one direction and then in the other, the extent of movement in each direction being less than the circumference of the needle-cylinder. The needle-operator and thread-carrier have been suitably geared to a handle, and in order to rotate them alternately in opposite directions it has been necessary to turn the actuating-handle first in one direction and then in the other. This method has been attended with many serious disadvantages. It has been necessary to have such machines hand-operated only, since in power-machines the prime mover must move constantly in a given direction. The alternate reversals of the movement of the handle has rendered the operation slow, and owing to the necessity of turning the handle a predetermined limited distance in each direction very close attention is demanded on the part of the attendant to operate the machine properly.

The object of the present invention is to furnish a circular-knitting machine for knitting flat webs which can be operated by power and in which there is no alternate reversal of the actuating mechanisms.

To this end the invention consists, primarily, in two needle-operators moving in opposite directions and alternately actuating the needles, one needle-operator being in operative relation to the needles when the other is inactive, and vice versa. These needle-operators consist of two rotary carriers, which are constantly rotated in opposite directions, and each carrier carries a radially-movable cam-slide having the needle-actuating cams, the cam-slide on one carrier being moved into operative relation with the needles when the cam-slide on the other carrier is moved out of such operative relation. In connection with these needle-operators is employed a thread-carrier, which is alternately moved in opposite directions through the instrumentality of the needle-operators.

The principle and mode of operation of the invention are illustrated in the accompanying drawings, wherein is shown a simple embodiment of the improvements. As far as the essential features of the invention are concerned, the drawings show the best and most convenient mechanism for carrying out the principle and mode of operation which have been devised; but the invention is not limited or restricted to the precise mechanical constructions shown, since the details thereof are susceptible of various modifications and changes.

In the drawings, Figure 1 is a side view of the main parts of the head portion of a circular-knitting machine embodying the present invention. Fig. 2 is a central vertical section of the same in a plane indicated by the line 2 2 in Fig. 3. Fig. 3 is a complete plan of the head of the machine on a smaller scale than that employed in the other figures. Fig. 4 is a plan of a portion of one of the rotary needle-operators, the figure illustrating more particularly the upper operator. Fig. 5 is a vertical section of a portion of the same. Fig. 6 is an inner view of the two cam-slides, showing the relative positions of the needle-actuating cams. Figs. 7 and 8 are views of the lowering-cam for depressing the shifting-bar of the thread-carrier. Figs. 9 and 10 are views of the mechanism for shifting the cam-slides; and Figs. 11 and 12 are diagrams illustrating the operation of the mechanism for shifting the cam-slides, the upper wing and tail being shown in full lines in Fig. 11 and in dotted lines in Fig. 12, and the lower wing and tail being shown in dotted lines in Fig. 11 and in full lines in Fig. 12.

A is the head-plate of the knitting-machine, which supports the knitting mechanism.

B is the stationary needle-cylinder, and C

is the drive-shaft carrying fast and loose pulleys *a a*, and having also a hand-wheel *b* for rotating the same by hand when desired.

The two needle-operators consist of two cylinders or rings D E, one of which, as E, turns above the other. These rings are concentric with the axis of the needle-cylinder, around which axis both rotate. The lower needle-actuating cylinder or ring has on its lower portion an outwardly-extending horizontal peripheral flange *c*, having rack-teeth *d* on its upper surface throughout its entire periphery, and the upper needle-actuating cylinder has on its upper portion a similar outwardly-extending horizontal peripheral flange having similar rack-teeth on its lower surface throughout its entire periphery, so that the teeth of the two circular racks thus provided on the two needle-actuating cylinders or rings face each other. Both of these circular racks engage diametrically-opposite teeth of a gear wheel or pinion *e* on the inner end of the drive-shaft C, so that the rotation of the shaft in one direction drives the two needle-actuating cylinders or rings in opposite directions.

The lower cylinder or ring D turns in suitable ways formed in the head-plate A, and the upper cylinder or ring E turns on the lower cylinder or ring, the two rings being provided with reciprocal guides. As shown in the drawings, these reciprocal guides consist of circular plates *a'*, bolted to the lower ring D, having inwardly-projecting flanges *b'*, which enter an annular groove *c'* in the exterior of the upper ring E.

Each needle F used in the machine is formed with two projecting butts *f* and *g* in different horizontal planes when in operative position in the needle-cylinder. The lower needle-actuating cylinder or ring D co-operates with the lower butts *f* on the several needles, and the upper needle-actuating cylinder or ring E co-operates with the upper butts *g* on the several needles. With the exception of having two butts, each needle is in other structural respects similar to the ordinary latch-needles.

It is obvious that the two needle-operators cannot act simultaneously on the needles, and consequently provision is necessary to render one needle-operator inactive and out of operative relation with the needles when the other is in action. The constructions of the two needle-operators in respect to this provision are in the main identical, so that a description of one will suffice for both.

Each cylinder or ring D and E constitutes a carrier which carries a cam-slide H, which is provided with needle-actuating cams *h*, (co-operating with the needle-butts,) of usual construction and possessing in themselves no novelty. The only change in the needle-actuating cams over those usually employed lies in the relative arrangements of the cams on the two rings or cylinders D E, the opposite rotations of which render it necessary that the cams on the upper cylinder or ring E should be arranged oppositely to those on the lower cylinder or ring D, since the cams on the upper cylinder or ring travel in the opposite direction to those on the lower ring or cylinder. Aside from this reverse position of the needle-actuating cams on the two cylinders or rings, they possess in themselves no novelty. The cam-slide H, thus provided with needle-actuating cams on each cylinder or ring, is capable of a radial movement—that is, a movement to and from the axis of the knitting mechanism. Consequently when the cam-slides are moved to their inward positions their cams are brought into operative relation with the proper butts on the needles; but when the cam-slides are moved to their outward positions their cams no longer co-operate with the needle-butts, the extent of outward movement being sufficient to carry the cams beyond the reach of the needle-butts.

Referring now to one only of the cam-slides, its inner portion (which is provided on its inner face with the needle-actuating cams *h*) constitutes a separate segmental section of the cylindrical part of the cylinder or ring D or E, the body of the cylinder being cut away to receive the cam-slide. To allow for the radial movement of the cam-slide, the projecting flange *c* is also partly cut away on its inner side. The cam-slide is provided with an outwardly-extending projecting flange *i*, which rests and slides on the cylinder-flange *c*. The cam-slide is held to the flange *c* by means of two headed screws *j*, which tap into the flange *c* and pass through slots *k k*, near opposite ends of the cam-slide flange *i*. Since the cam-slide extends through a considerable arc, only its central portion moves in a true radial line, and the longitudinal axes of the slots *k k* are parallel with this radial line, in which the center of the cam-slide moves, and the length of the slots determines the extent of movement of the cam-slide. Preferably the heads of the screws *j* seat against spring friction-plates *l l* on the cam-slide flange *i*, so that the cam-slide will be maintained by their friction in either position to which it may be moved. The friction due to these friction-plates, however, is not sufficient to prevent the easy back-and-forth movement of the cam-slide.

It is essential that when the cam-slides on both cylinders or rings D and E are moved in or out neither cam-slide should be in connection with any of the needles. Accordingly the needles are omitted on the needle-cylinder through an arc at least equal to the arc occupied by each cam-slide, and each cam-slide is in turn operated when it is opposite this unfilled portion of the needle-cylinder. Preferably this unfilled portion of the needle-cylinder is adjacent the pinion *e* on the drive-shaft.

The instrumentality for the operation of the two cam-slides is very simple. In a bracket *m*, fixed to the head-plate A and straddling

the pinion *e*, is journaled a small vertical rock-shaft *n*, carrying on its opposite ends oppositely-extending wings I J. The lower wing I is in the path of an upward-projecting tappet-pin K on the lower cam-slide, (preferably on its flange *i*,) and the upper wing J is in the path of a downward-extending tappet-pin L on the upper cam-slide, (preferably on its flange *i*.) If now the rock-shaft is turned with the outer edge of the lower wing I at its innermost position, the outer edge of the upper wing J will occupy its outermost position. Then when in the rotation of the lower cylinder or ring D the tappet-pin K on its cam-slide approaches the rock-shaft it comes in contact with the outer face of the lower wing I, and consequently in the further movement of the cylinder or ring D the tappet-pin K travels along the outer surface of wing I, and since the wing I occupies a plane at an angle with a radius of the needle-cylinder the tappet-pin K is forced radially outward, and with it its cam-slide. The lower cam-slide is thus moved outward, so that its cams are carried outward beyond the reach of the lower butts *f* on the needles, and the immediately subsequent rotation of the lower cylinder or ring D is ineffective to move the needles. The relative positions of the two cylinders or rings D and E is such that when the lower tappet-pin K encounters the lower wing I the oppositely-moving tappet-pin L on the upper cam-slide simultaneously encounters the outer edge of the upper wing J. Since, however, the wing J then occupies its outermost position, the tappet-pin L encounters and travels on the inner face of the wing J, and consequently is thereby forced inward. This inward movement of the tappet-pin L causes the inward movement of the upper cam-slide on the upper cylinder or ring E, whereby the upper cam-slide is moved into its inner position with its cams occupying their operative relation to the upper butts *g* of the needles. In the immediately subsequent movement of the upper cylinder or ring E the needles are consequently operated by the upper cams. It consequently follows that after the two cam-slides have thus been operated the upper cylinder or ring E will actuate the needles during one rotation, and the lower cylinder or ring D will have during one rotation no effect upon the needles. In order therefore that during the next following rotation of the two cylinders or rings D E the lower cylinder or ring D may actuate the needles and the upper cylinder or ring E shall have no effect thereon, it is essential that the lower cam-slide should be moved inward and that the upper cam-slide should be moved outward. This is conveniently effected by simply rocking the shaft *n* and so reversing the position of the wings I J, so that when the lower tappet-pin K encounters the wing I it will travel on the inner surface thereof, thus moving the lower cam-slide inward into operative position in relation to the needles, and so that when the upper tappet-pin L encounters the upper wing J it will travel on the outer surface thereof, thus moving the upper cam-slide out of operative relation to the needles. This rocking of the shaft *n* is conveniently and automatically effected by means of two projecting tails *o* *p*, carried by the shaft. The lower projecting tail *o* extends on the opposite side of the shaft *n* from the lower wing I. As a convenient construction, the tail *o* and wing I are formed of a single plate bent at the center, where it is attached to the shaft, so that the tail *o* extends at an angle from the wing I. Likewise the upper projecting tail *p* extends on the opposite side of the shaft *n* from the upper wing J, and is formed of a single plate with the upper wing, which plate is bent at an angle at its center, where attached to the shaft. The angles of the two plates both face the axis of the machine. The movement of the rock-shaft in either direction is limited by stop-pins *q q*, against which the wings I J abut. Assume now that the wings and tails stand in such a position that the upper tappet-pin L encounters the inner face of upper wing J and the lower tappet-pin K encounters the outer face of the lower wing I. Then, after passing the rock-shaft, the upper pin L encounters the inner face of the upper tail *p*, which stands at an angle across its path. Further movement of tappet-pin L (which cannot be pushed further inward) causes the said pin to push the tail *p* out of its path, the tail *p* swinging on the center of the rock-shaft *n* and causing the shaft *n* to rock in its bearing. This oscillation of the shaft causes the upper wing J to swing inward, so that when the upper pin L next encounters it the pin travels on its outer surface, and at the same time the lower wing I is swung outward, so that when the lower tappet-pin K next encounters it the pin travels on its inner surface. While the upper pin L is thus operating the lower tappet-pin K encounters the outer surface of the lower wing I, passing the rock-shaft *n* simultaneously with the upper tappet-pin. After passing the shaft, however, the lower tappet-pin K does not touch the lower tail *o*, since it is bent inwardly and is not in the outer path of the tappet-pin. Consequently the lower tappet-pin has no effect on the rock-shaft. The oscillation of the rock-shaft by the upper tappet-pin shifts the positions of the two tails as well as the positions of the two wings, so that when on the next rotation the tappet-pins approach the rock-shaft the upper tail *p* is no longer in the path of the upper tappet-pin L, but the lower tail *o* is in the path of the lower tappet-pin K. Consequently the rock-shaft is oscillated in the opposite direction by the lower tappet-pin K. The result is that the two tappet-pins automatically and alternately oscillate the rock-shaft in opposite directions, and so alternately reverse the positions of the cam-slide-operating wings. In this manner one

cam-slide co-operates with the needles during one rotation and the other cam-slide co-operates with the needles during the succeeding rotation. Each cam-slide is hence alternately operative and inactive.

It is hence evident that the maximum number of needles which can be used simultaneously on the needle-cylinder is limited by the length of one of the cam-slides and the space required for their shifting. Any number of needles less than the maximum can, however, be employed, so that webs of varying widths can be knit.

It is necessary that the thread-carrier should feed in the thread to the needles during the operative rotations of each of the needle-operators, and consequently it is necessary that the thread-carrier should first move with one needle-operator, and should then move in the opposite direction with the other needle-operator. Provision is therefore made for automatically reversing the movement of the thread-carrier. The construction and arrangement which have been adopted as effective and proper for this purpose are as follows: The thread-carrier as a whole comprises a thread-guide plate M, having the thread-eye *r*, and an annular ring N, to which the thread-guide plate is secured by means of an intervening outwardly-extending bracket O. This thread-carrier ring rests and rotates upon the upper needle-operating cylinder or ring E concentrically therewith, and is held and turns in proper ways or guides on said ring. When the thread-carrier co-operates with the upper cylinder or ring E—that is, when the thread-carrier feeds the thread to the needles while the upper cylinder or ring E is actuating the needles—the carrier is simply turned with the upper cylinder or ring and has no movement of its own relatively thereto. When, however, the thread-carrier co-operates with the lower needle-actuating cylinder or ring D, it turns therewith, so that it turns upon the upper cylinder or ring E and in a direction opposite to that in which said upper cylinder or ring is moving. To move the thread-carrier in each direction, it is only necessary to cause it to be alternately acted upon by the two needle-operators. To accomplish this, the outwardly-extending bracket O is formed with a vertically-extending arm *s*, the outer face of which is beyond the periphery of the flanges *c c* on the two needle-actuating cylinders or rings D E, and this arm *s* is formed with suitable vertical guides or ways, in which is held and slides a vertically-movable shifting-bar P. This shifting-bar is provided with a longitudinal slot *t*, through which extends a headed screw *u*, which taps into the bracket-arm *s*, whereby the shifting-bar is held to the bracket-arm. The length of the slot *t* permits and limits the vertical movement of the shifting-bar. A spring friction-plate *v* is interposed between the head of screw *u* and the outer surface of the shifting-bar, the friction of which maintains the shifting-bar in any position to which it may be moved. The shifting-bar is provided with two inward-projecting stops Q and R. The lower of these stops Q is located above the flange *c* on the lower needle-operating cylinder or ring D and the upper stop R is located above the flange *c* on the upper needle-operating cylinder or ring E. Co-operating with the lower stop Q is an outward-projecting stud S, which is fixed to the lower needle-operating cylinder or ring D, preferably to the flange *i* of its cam-slide and in close proximity to the tappet-pin K. As a convenience of construction, the tappet-pin K is mounted, as shown, upon the stud S. When the shifting-bar occupies its lowermost position, the stop Q is below the plane of the path of the stud S, so that the stud does not come in contact therewith. When, however, the shifting-bar is elevated to its uppermost position, then the stop Q is lifted into the plane of the path of stud S, so that as the stud is carried around by the movement of the lower needle-operating cylinder or ring it comes in contact with stop Q, thus causing the stop Q, and with it the thread-carrier, to move with the lower needle-operating cylinder or ring. Co-operating with the upper stop R is an outward-projecting stud T, fixed to the upper outer edge of the flange *c* on the upper needle-operating cylinder or ring E in approximately the same vertical plane as the tappet-pin L. When the shifting-bar is in its elevated position, (with the lower stud Q and stud S co-operating,) the upper stop R is elevated above the plane of the path of the upper stud T, so that the stud in its rotation does not encounter the stop R. When, however, the shifting-bar is lowered, (thus lowering the lower stop Q below the path of the lower stud S,) the upper stop R is lowered into the plane of the path of the upper stud T, so that as the stud is carried around by the movement of the upper needle-operating cylinder or ring E it encounters the upper stop R, thus causing the stop R, and with it the thread-carrier, to move with the upper needle-operating cylinder or ring.

The thread-carrier can therefore be caused to move with the two needle-operating cylinders or rings alternately by raising and lowering the shifting-bar P. This is done automatically and at the proper intervals by the following described means: The shifting-bar is provided with an outwardly-projecting boss U, which is alternately raised and lowered by coming in contact with lifting and lowering cams V W, secured to the head-plate A on opposite sides of the drive-shaft C. The object of the lifting-cam V is to raise the shifting-bar and so disconnect the upper stop R and the upper stud T, and thereby stop the conjoint movement of the thread-carrier and the upper needle-operating cylinder or ring. Assuming therefore that the upper cylinder or ring rotates in the direction of the arrow 1, the cam-surface of the lifting-cam V is arranged so as

to elevate the boss U as it rides above it when moving in this direction. In locating this lifting-cam it should be arranged so as to lift the shifting-bar after the upper needle-operating cylinder or ring has ceased to operate the needles, and preferably before the upper needle-actuating cam-slide is moved outwardly. Consequently the lifting-cam should, as shown, be located to the left of the drive-shaft and near thereto. Then in the operation of the machine the movement of the thread-carrier will be stopped before the upper needle-actuating cam-slide is moved outward to its inoperative position and before the lower needle-actuating cam-slide is moved inward to its operative position. To prevent the yarn-carrier being carried around with the upper cylinder or ring E by reason of frictional contact therewith after the shifting-bar P is raised, an upwardly-projecting stop-pin *w* is carried by the lifting-cam V, against which the boss U abuts after being lifted, so that the further movement of the thread-carrier in the direction of arrow 1 is prevented. The thread-carrier is thus held stationary for a brief interval with the lower stop Q elevated into the path of the lower stud S, ready to be encountered thereby. When the lower stud S, which moves constantly in a direction opposite to that indicated by the arrow 1, encounters the lower stop Q, it carries with it the thread-carrier until the boss U on the shifting-bar P encounters the lowering-cam W. The cam-surface of this cam W is its lower surface, beneath which the boss U travels, being depressed thereby, whereby the shifting-bar P is lowered, the coaction between lower stop Q and lower stud S is destroyed, and the upper stop R is lowered into the path of the upper stud T in readiness to be encountered thereby. The lowering-cam W is located on the right of the drive-shaft C in such position that it stops the movement of the thread-carrier after the lower needle-actuating cam-slide has ceased to operate the needles and before it is moved outward out of operative position in relation to the needles.

A brief interval occurs after the shifting-bar has been lowered by cam W and before its upper stop R is encountered by the upper stud T on the upper needle-operating cylinder or ring, and it is desirable that the thread-carrier should remain stationary during this interval. Prior to the lowering of the shifting-bar P by cam W, the thread-carrier moves with the lower cylinder or ring D and in a direction opposite to that of the upper cylinder or ring E, on which it rests and moves. Consequently when the thread-carrier is disconnected from the lower cylinder or ring D there is little danger of its further movement in that direction, which, however, could be easily guarded against by providing a stop on the end of the cam W; but, owing to the frictional contact which necessarily exists more or less between the thread-carrier and the upper cylinder or ring, the thread-carrier would start to move around with the upper cylinder or ring unless prevented immediately after the thread-carrier was disengaged from the lower cylinder or ring and before the proper moment, which occurs when the upper stud T reaches the lowering-cam W. Such early starting of the thread-carrier would spoil the knitting, since the thread-carrier would then be carried past the needles in advance of their operation by the cam-slide. Provision is therefore necessary for maintaining the thread-carrier in a stationary position until it is moved by the engagement of the upper stud T with the upper stop R. This provision consists in a spring-plate X, secured to the lowering-cam W, and properly beveled on its inner face, having a beveled edge *x*, which the shifting-bar P encounters as the boss U approaches the cam, whereby the spring-plate is pushed aside to permit the shifting-bar to pass, and having a beveled shoulder or catch *y*, which prevents the shifting-bar P, and consequently the thread-carrier, from being moved by the frictional contact between the upper cylinder or ring E and the thread-carrier. The abruptness of the shoulder *y* and the tension of the spring-plate are sufficient to retain the thread-carrier in a stationary position against movement by frictional contact with the cylinder or ring E; but the power exerted by the driving-force is amply sufficient to cause the shifting-bar P, through the action of the stud T upon stop R, to easily push aside the spring-plate, the shifting-bar pressing against the bevel of the shoulder *y*.

The machine as described is thus seen to comprise two needle-operators constantly moving in opposite directions, two needle-actuating mechanisms acting alternately and carried by said needle-operators, respectively, and a thread-carrier, which moves alternately in opposite directions, co-operating first with one needle-operator and then with the other. The machine can be driven by power as rapidly as any circular-knitting machine and knits a flat web.

I claim as my invention—

1. Two movable needle-operators of a knitting-machine which move in opposite directions and alternately control the needles, substantially as set forth.

2. Two rotary needle-operators of a circular-knitting machine which rotate in opposite directions and alternately control the needles, substantially as set forth.

3. Two rotary needle-operators of a circular-knitting machine which rotate constantly in opposite directions and alternately control the needles, substantially as set forth.

4. Two movable needle-operators of a knitting-machine which move in opposite directions and alternately control the needles, in combination with a thread-carrier, which moves alternately in opposite directions, substantially as set forth.

5. Two rotary needle-operators of a circular-knitting machine which rotate in opposite directions and alternately control the needles, in combination with a rotary thread-carrier, which rotates alternately in opposite directions, substantially as set forth.

6. Two rotary needle-operators of a circular-knitting machine which rotate constantly in opposite directions and alternately control the needles, in combination with a rotary thread-carrier, which rotates alternately in opposite directions, substantially as set forth.

7. Two rotary needle-operators of a circular-knitting machine which rotate constantly in opposite directions, each of said needle-operators being composed of a rotary cylinder or ring, and a needle-actuating mechanism carried thereby and movable to and from the needles, substantially as set forth.

8. A needle-operator of a circular-knitting machine, consisting of a cylinder or ring, which rotates constantly in one direction, and of a cam-slide having needle-actuating cams, said cam-slide being carried by said cylinder or ring and movable thereon to and from the needles, in combination with a second needle-operator consisting of a cylinder or ring, which rotates constantly in a direction opposite to that of the other cylinder or ring and of a second cam-slide having needle-actuating cams, said second cam-slide being carried by said second cylinder or ring and movable thereon to and from the needles, substantially as set forth.

9. The combination, with two rotary cam-slides, of a circular-knitting machine having needle-actuating cams and the carriers in which said cam-slides are mounted, said cam-slides rotating constantly in opposite directions and being movable to and from the needles, substantially as set forth.

10. The combination, with two rotary cam-slides, of a circular-knitting machine having needle-actuating cams and the carriers in which said cam-slides are mounted, said cam-slides rotating constantly in opposite directions and being movable to and from the needles, one cam-slide being moved in when the other is moved out, substantially as set forth.

11. The needle-cylinder of a knitting-machine and the needles thereof, each needle having two butts in different horizontal planes, in combination with two rotary cam-slides, one above the other, having needle-actuating cams, and the carriers in which said cam-slides are mounted, the cams on the lower cam-slide co-operating with the lower butts of said needles and the cams on the upper cam-slide co-operating with the upper butts of said needles, substantially as set forth.

12. The needle-cylinder of a knitting-machine and the needles thereof, each needle having two butts in different horizontal planes, in combination with two cylinders or rings, one above the other concentric with said needle-cylinder and constantly rotating in opposite directions, a cam-slide on each of said cylinders or rings movable to and from said needles, the lower of said cam-slides having cams co-operating with the lower butts of said needles and the upper cam-slide having cams co-operating with the upper butts of said needles, one cam-slide being moved in toward said needles when the other is moved out from said needles, and means, substantially as set forth, for moving said cam-slides.

13. Two rotary cam-slides rotating in opposite directions and movable to and from the needles, each cam-slide having an actuating tappet-pin, the two pins being in different planes, and the carriers in which said cam-slides are mounted, in combination with a rock-shaft and oppositely-projecting wings on said shaft, said wings being arranged in the paths of said tappet-pins, respectively, one tappet-pin encountering the outer face of its wing when the other tappet-pin encounters the inner face of its wing, substantially as set forth.

14. Two rotary cam-slides rotating in opposite directions and movable to and from the needles, each cam-slide having an actuating tappet-pin, the two pins being in different planes and the carriers in which said cam-slides are mounted, in combination with a rock-shaft, oppositely-projecting wings on said shaft, said wings being arranged in the paths of said tappet-pins, respectively, one tappet-pin encountering the outer face of its wing when the other tappet-pin encounters the inner face of its wing, and two projecting tails carried by said shaft and located in the paths of said tappet-pins, respectively, only after said pins have encountered the inner faces of their respective wings, substantially as set forth.

15. The needle-cylinder of a knitting-machine, the needles thereof, each needle having two butts in different horizontal planes, two rotary needle-actuating cylinders or rings, one being located above the other, and the two cylinders or rings rotating constantly in opposite directions, a drive-shaft, a pinion thereon, and circular racks carried by said cylinders or rings and engaging said pinion, respectively, above and below said shaft, in combination with two cam-slides on said two cylinders or rings, respectively, each of said cam-slides being movable to and from the needle-cylinder, the upper of said cam-slides having cams co-operating with the upper butts of the needles, and the lower of said cam-slides having cams co-operating with the lower butts of said needles, an upwardly-projecting tappet-pin on the lower cam-slide, a downwardly-projecting tappet-pin on the upper cam-slide, a rock-shaft, two oppositely-projecting wings on said rock-shaft in different horizontal planes, the upper of said wings being located in the path of said upper tappet-pin, and the lower of said wings being located in the path of said lower tappet-pin, one tappet-pin encountering the outer face of its wing when the other tappet-pin encounters

the inner face of its wing, and vice versa, and two projecting tails in different horizontal planes carried by said rock-shaft and located in the paths of said tappet-pins, respectively, only after said pins have encountered the inner faces of their respective wings, substantially as set forth.

16. Two needle-actuating cylinders or rings constantly rotating in opposite directions, in combination with a thread-carrier and means for connecting said thread-carrier with each of said cylinders or rings alternately, substantially as set forth.

17. Two needle-actuating cylinders or rings constantly rotating in opposite directions, in combination with a thread-carrier and a shifting-bar which alternately connects said thread-carrier with said cylinders or rings, respectively, substantially as set forth.

18. Two needle-actuating cylinders or rings, one above the other, constantly rotating in opposite directions, each of said cylinders or rings having a projecting stud, in combination with a thread-carrier, a movable shifting-bar thereon, and two stops carried by said shifting-bar, the upper stop being in the path of the stud on the upper of said cylinders or rings when the shifting-bar is lowered and the lower of said stops being in the path of the stud on the lower of said cylinders or rings when said shifting-bar is raised, substantially as set forth.

19. Two needle-actuating cylinders or rings, one above the other, constantly rotating in opposite directions, each of said cylinders or rings having a projecting stud, in combination with a thread-carrier, a movable shifting-bar thereon, and two stops carried by said shifting-bar, the upper of said stops being in the path of the stud on the upper of said cylinders or rings when the shifting-bar is lowered, and the lower of said stops being in the path of the stud on the lower of said cylinders or rings when said shifting-bar is raised, and stationary lifting and lowering cams which alternately raise and lower said shifting-bar, substantially as set forth.

20. Two needle-actuating cylinders or rings, one above the other, constantly rotating in opposite directions, each of said cylinders or rings having a projecting stud, in combination with a thread-carrier resting and turning on the upper of said cylinders or rings in contact therewith, a movable shifting-bar on said thread-carrier, two stops carried by said shifting-bar, the upper of said stops being in the path of the stud on the upper of said cylinders or rings when the shifting-bar is lowered, and the lower of said stops being in the path of the stud on the lower of said cylinders when said shifting-bar is raised, stationary lifting and lowering cams which alternately raise and lower said shifting-bar, and a spring plate or catch engaging said thread-carrier and holding it stationary after said shifting-bar has been lowered, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ALBERT T. L. DAVIS.

Witnesses:

JOHN ALDRICH,

THOMAS HAM.