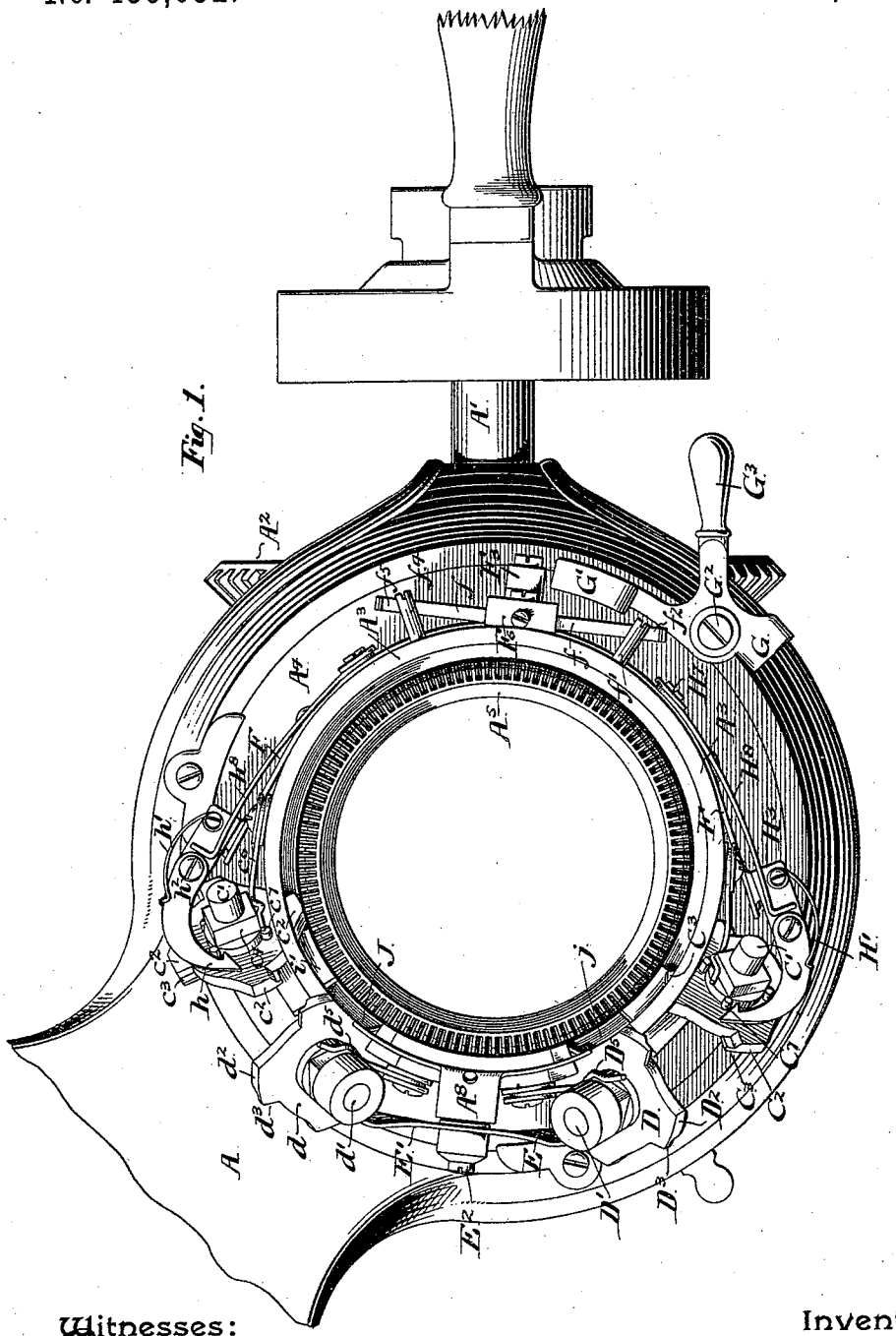
(No Model.) 4 Sheets—Sheet 1.

J. B. PAXTON & E. I. O'NEILL.

CIRCULAR KNITTING MACHINE.

No. 455,052. Patented June 30, 1891.

Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

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CIRCULAR KNITTING MACHINE.

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Fig. 2.

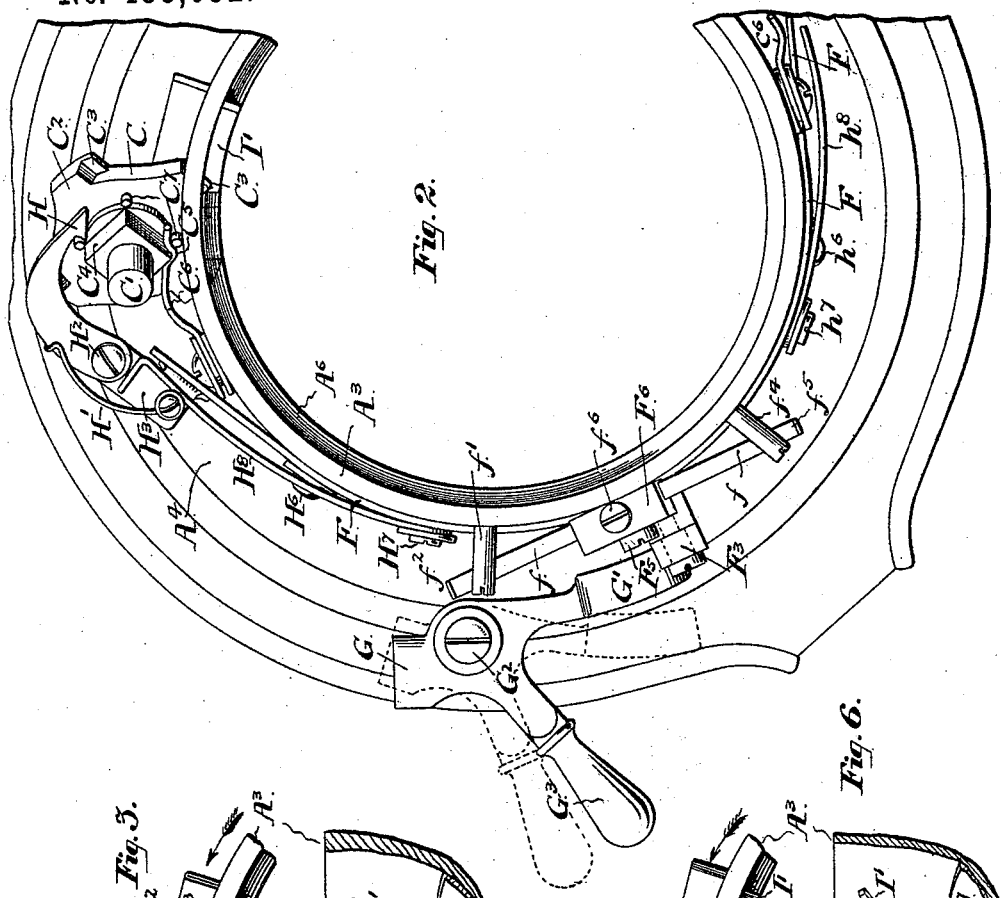

Fig. 3.

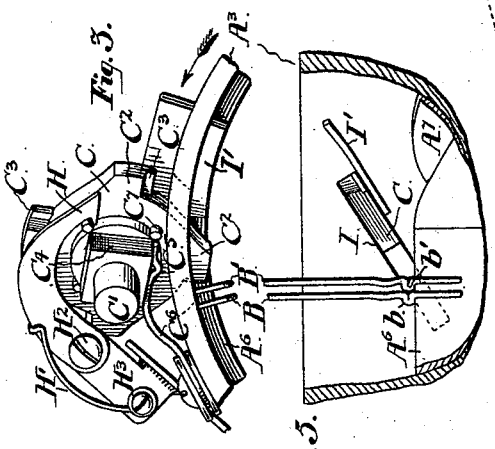

Fig. 5.

Fig. 6.

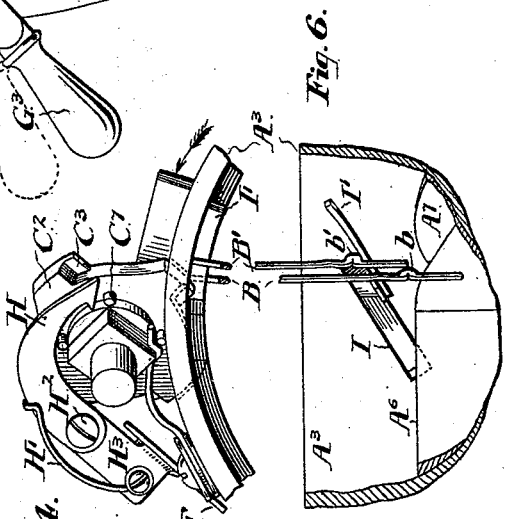

Fig. 4.

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CIRCULAR KNITTING MACHINE.

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Fig. 7.

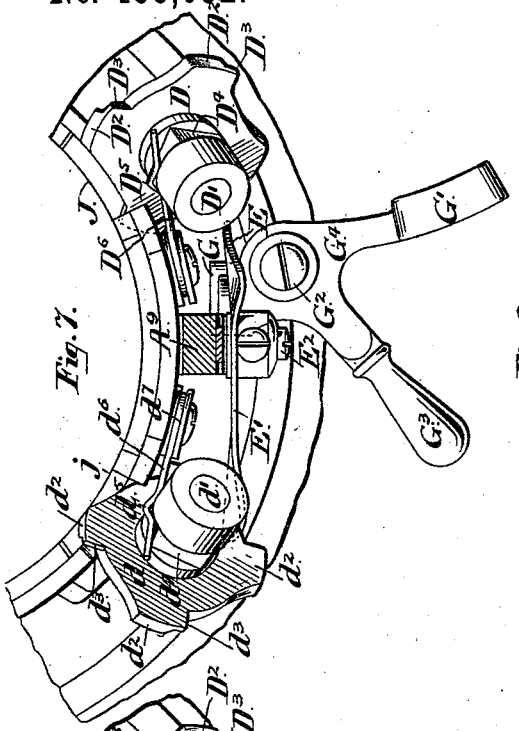


Fig. 8.

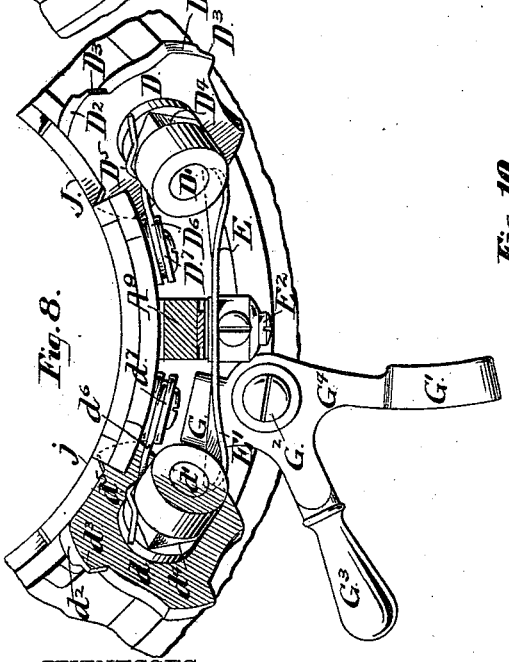


Fig. 9.

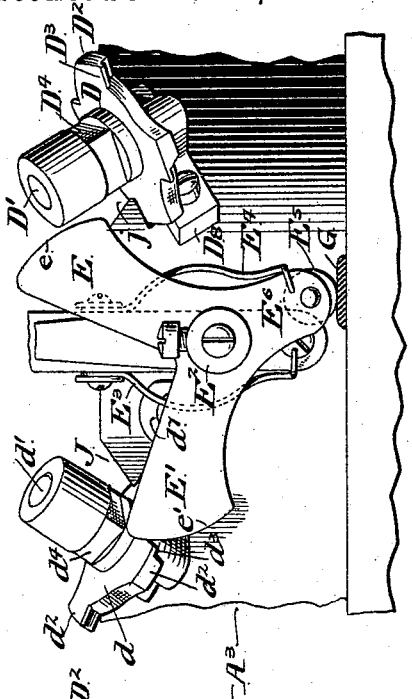
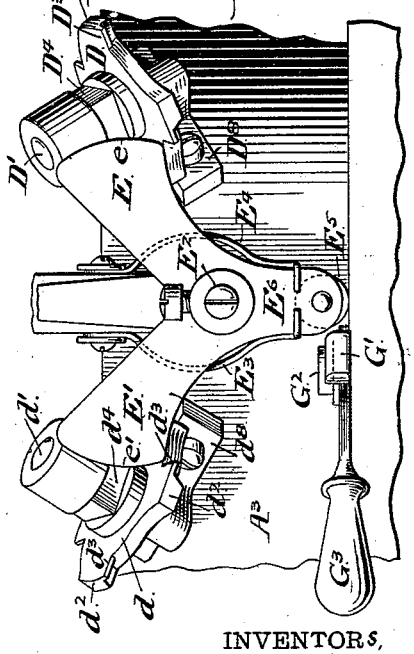


Fig. 10.



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CIRCULAR KNITTING MACHINE.

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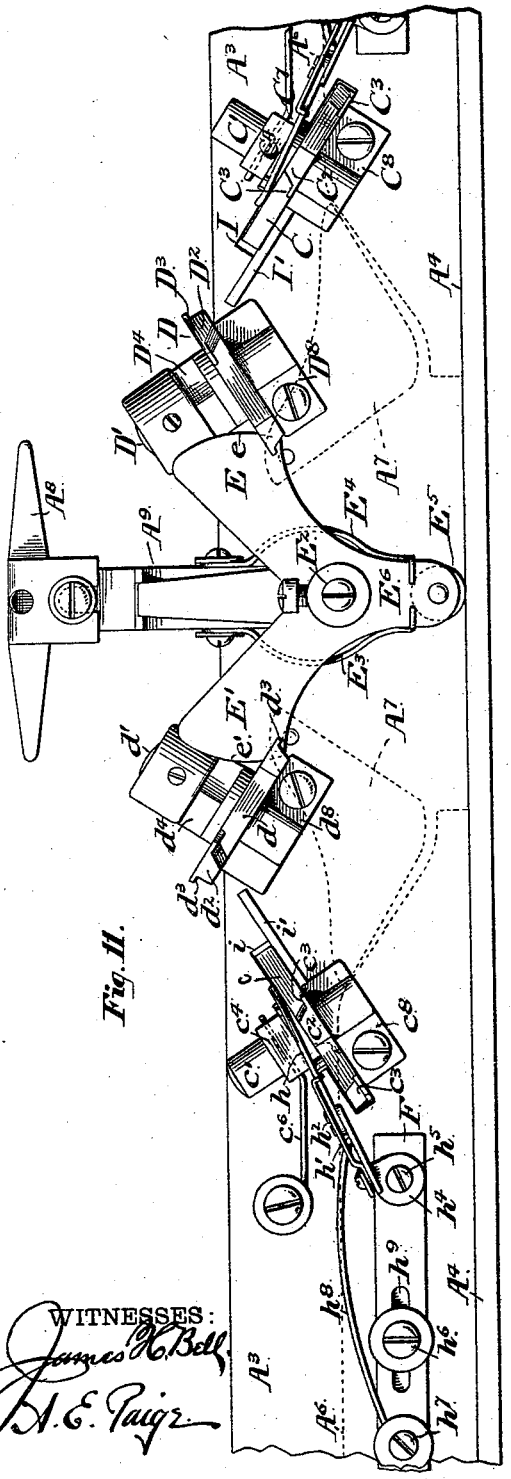

Fig. 11.

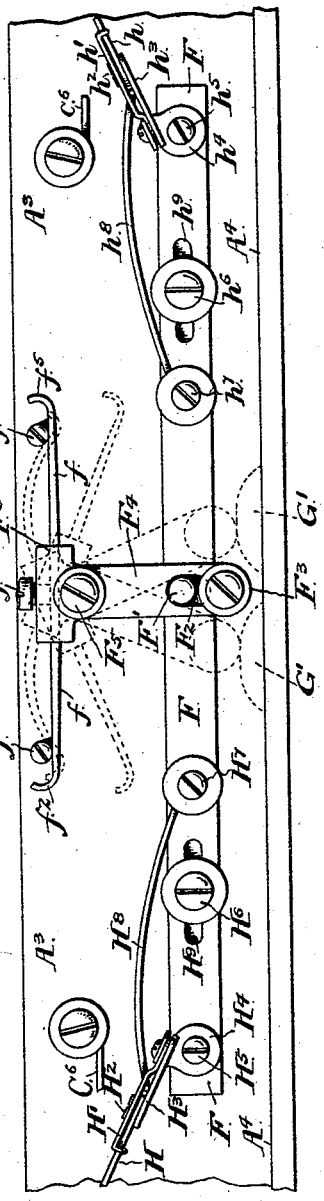

Fig. 12.

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UNITED STATES PATENT OFFICE.

JOHN B. PAXTON AND ELLIS I. O'NEILL, OF PHILADELPHIA, PENNSYLVANIA.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 455,052, dated June 30, 1891.

Application filed October 8, 1890. Serial No. 367,464. (No model.)

To all whom it may concern:

Be it known that we, JOHN B. PAXTON and ELLIS I. O'NEILL, both of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Circular-Knitting Machines, whereof the following is a specification, reference being had to the accompanying drawings.

Our invention relates to the manufacture of stockings upon such machines by the well-known process of knitting the tubular portion of the leg by the continuous rotation of the cylinder, and then, after throwing one-half of the needles up to the idle-level, narrowing and widening the web at the heel by reciprocating movement of the cylinder, accompanied by the raising of individual needles successively to the idle-level, and again returning them successively to the range of the knitting-cams, the tubular portion of the foot and the narrowed toe portion being respectively knit by similar methods. In automatic machines for accomplishing this purpose it has been usual to raise the needles by means of pivoted pawls, sometimes in conjunction with cam-surfaces arranged above the range of the knitting-cams and sometimes without such adjuncts. The arrangement of such pawls within the periphery of the cam-cylinder requires nice adjustment and a somewhat complicated mechanism for their actuation.

The object of our present invention is to dispense with the use of the pawls or similar devices and to effect the raising and lowering of the individual needles by means of devices mounted outside of the cam-cylinder and operated therethrough.

In the accompanying drawings, Figure 1 represents a partial top or plan view of a knitting-machine to which our invention has been applied. Fig. 2 is a partial plan view of certain of the parts shown in Fig. 1 on a somewhat enlarged scale and with the needle-cylinder removed to more clearly show the relation of the needle-lifting device to the cam-cylinder. Figs. 3 and 4 are detail views of one of the needle-lifting devices in two of its operative positions—viz., at the commencement and termination, respectively, of the lifting movement. Figs. 5 and 6 are interior views in elevation of the same portion of the cam-cylinder with the parts in the position indicated in Figs. 3 and 4, respectively. Figs. 7 and 8 are plan views of a portion of the periphery of the cam-cylinder, showing the needle-depressing devices and their actuating mechanism in two operative positions. Figs. 9 and 10 are respectively views in elevation of certain of the same parts in the positions shown in Figs. 7 and 8, other parts being omitted for the sake of clearness. Fig. 11 is a view in elevation of one half of the exterior of the cam-cylinder projected upon a plane surface. Fig. 12 is a similar view of the remaining half of the cam-cylinder.

Referring to the general view of the machine in Fig. 1, A represents the base-plate; A′, the driving-shaft; A^2, the bevel-gear for driving the cam-cylinder A^3, and A^4 the horizontal arm of the flange thereof, resting upon the base-plate; A^5, the needle-cylinder, whose needles are not in this instance shown.

As the needle-lifting and needle-lowering devices occur in pairs, the construction of the members of each pair being similar, but arranged in converse relation to the cam-cylinder, we shall only describe in detail one member of each pair, and have indicated in the drawings by capital letters the parts of the one which is described in detail, the corresponding parts of the other one being indicated by corresponding small letters, so that the description of one can readily be applied to the other without repetition.

Taking first the needle-lifting devices: On each side of the knitting-cams A^7 we form inclined slots I and *i* (see Fig. 11) through the wall of the cam-cylinder, commencing in the vicinity of the needle-track A^6, and thence inclining up toward the knitting-cams A^7. Adjacent to these slots we mount upon the exterior of the cam-cylinder the shafts C′ *c*′ of two rotatable disks C *c*, respectively. The axes of the disks are inclined substantially at right angles to the lines of the slots I *i*, to which they are respectively adjacent. The periphery of the disk C has projecting portions or teeth C^2, each of which has at the under side of one edge a short projecting flange or step C^3. These teeth are of such radial length and the disk is so mounted with relation to the slot I that in rotating the tooth shall enter the slot with its step just at the

level of the needle-track and shall leave the slot at a height which of course depends upon the inclination of the axis and the diameter of the disk. The limitations are that while the tooth in rotating shall overhang the needle-track it must not, however, extend inward far enough to strike the exterior surface of the needle-cylinder. The peripheral portions of the disk intermediate between the teeth are of such short radius as not to extend within the cam-cylinder.

To permit the use of small disks, we prefer to arrange cam-inclines I′ and *i′* upon the inside of the cam-cylinder and leading upward from the upper ends of the slots I and *i*.

The remaining features of the needle-disk relate to devices for automatically bringing it into proper position to act upon the needles, as will hereinafter be described; but assuming that it has been set in the position shown in Fig. 3, its operation in raising the needles is as follows: Only two needles B B′ are shown, the needle B′ being that one which is at one end of the active series and which is now to be raised to the idle-level. It will be seen that one of the teeth C^2 is now within the slot I, with its projecting step or flange C^3 just at the level of the needle-track A^6. As the cam-cylinder A^3 moves in the direction of the arrow, the tooth C^2 will strike under the hub *b′* of the needle B′, so that the latter will rest upon the step thereof. As the cylinder continues to move the disk C will be rotated by the resistance of the needle; but in rotating it must, owing to the inclination of its axis, cause the tooth which is within the slot I to rise along the edge of the slot, and as the needle-hub *b′* continues to rest upon the step of the tooth it must rise correspondingly. By the time that the tooth has rotated sufficiently to withdraw from the slot I the needle will have been raised so as to bring its hub above the edge of the inclined cam I′, and as the cylinder continues to rotate the needle will be thrown up to the idle-level by its hub riding upon said cam. The position of the parts corresponding to the moment when the tooth of the disk C is rotated out of the slot are shown in Figs. 4 and 6, where it will be seen that the needle B′ is riding up the cam I′, while the needle B (now the end one of the active series) remains in position. As the needle-lifting disk, when once the needle is lifted out, must necessarily remain in an inoperative position until the proper moment for acting upon the next needle, and must then be turned so as to bring a tooth into proper relation to the needle-ledge, we provide actuating mechanism automatically operated, and of which the following is one type.

Upon the upper surface of the disk C is a square head C^4, rigidly connected therewith, opposite to the corners of which are four studs C^7. A spring C^6, having a flat portion provided with a right-angled notch or bend C^5, is mounted upon the outside of the cam-cylinder in such relation to the disk that the flat portion of the spring shall bear upon the flat side of the square head C^4 when the tooth is in the position proper for the commencement of the needle-lifting operation.

The notch or right-angled bend C^5 of the spring is in such relation to the corners of the square head C^4 as to engage with one of said corners immediately upon the termination of the needle-lifting operation. These two positions of the spring in relation to the head are shown, respectively, in Figs. 3 and 4, and it will there be seen that the disk C is secured in each of said positions by the flat and notched portion of the spring, respectively, with sufficient firmness to prevent accidental displacement, while yet allowing the rotation of the disk under proper pressure. This rotation is effected partly by the needle itself, as has just been described; but in order to again bring the disk into operative relation to the needle we provide the following mechanism:

A curved hook H rests upon the upper surface of the disk C in such relation to the studs C^7 as to be capable of successive engagement therewith. This hook is pivoted at H^2 to a bracket H^3, which is pivoted in turn to the flat curved strip F, embracing not quite one-half of the periphery of the cam-cylinder upon the outside thereof. The pivot H^5, whereby the piece H^3 is secured to the strip F, is substantially horizontal, while the pivot H^2, whereby the hook H is secured to the bracket H^3, is parallel, or nearly so, to the axis C′ of the needle-lifting disk C. A curved spring H′, secured to the bracket H^3, bears against the back of the hook H, tending to throw it inward or toward the axis C′. A second spring H^8, secured at H^7 to the strip F, bears down upon the top of the bracket H^3, so as to keep the hook H flat upon the surface of the disk C, while permitting the necessary amount of play occasioned by the movement of the hook upward and forward upon the inclined surface of the disk. The strip F is provided with slots H^9 *h*^{9}, respectively, through which guide-studs H^6 *h*^{6} extend, thus holding it in proximity to the outer surface of the cam-cylinder, but permitting it to move around the same in either direction to a limited distance. This movement is automatically produced by means of devices which will presently be described, but its relation to the needle-disks is as follows: Taking the position of the parts shown in Fig. 4, it will be seen that the hook H is not in engagement with any of the studs C^7, but is between two of them. If now the strip F be shifted toward the disk C, the hub of the hook H will slip over the stud C^7, which is immediately in front of it, and thereupon the pressure of the spring H′ will throw the hub inward, so as to engage with said stud. A reverse movement of the strip F will then retract the hook H, bearing upon the stud C^7, and turn the disk C so as to bring another tooth C^2 into the slot I, where it will be held until the arrival of the needle by the pressure of the flat spring C^6 against the square

side of the hub C^4. A similar arrangement of hooks and springs is provided for the other needle-disk *c*, and the same is operated alternately with the disk C by the movement of the strip F in opposite directions. To produce these movements automatically by the reciprocation of the cam-cylinder, we provide the following devices: At or near the longitudinal center of the strip F is a stud F′, which projects radially outward. A swinging arm F^4, pivoted to the exterior of the needle-cylinder at F^5, is provided near its lower end with a slot F^2 to receive said stud F′, allowing the same some vertical play therein. Upon the extreme lower end of said arm is mounted a radially-projecting stud carrying a friction-roller F^3. The upper end of the swinging arm F^4 is provided with a transverse head F^6, transversely slotted from its inner face to receive and hold by means of a set-screw f^6 a horizontal spring-piece *f*, which projects on each side thereof, and whose ends are outwardly curved, as shown at f^2 f^5, respectively, in order to engage in extreme positions of oscillations of the swinging arm with the studs f' f^4, respectively. (See dotted lines, Fig. 12.)

Obviously oscillation of the swinging arm F^4 in one direction or the other will cause a shifting of the strip F, and thus produce the series of movements before described for the actuation of the disks C and *c*.

Upon the outer periphery of the base-plate A is mounted upon a vertical pivot G^2 a horizontally-swinging cam-piece comprising two radially-projecting arms, whose respective ends G and G′ constitute the cam-surfaces. The vertical height of the former of said cam-surfaces G is about one-half and the extent of its radial projection from the pivot G^2 is about one-third of the height and radial projection, respectively, of the latter cam-surface G′. A handle G^3 is provided, by means of which the operator can turn said cam-piece upon its pivot, so as to throw either one of the cams G or G′ within range of the proper rotating parts. In the present instance the cam G′ is the operative portion whereby the movements of the swinging arm F^4 are produced.

By reference to the plan view of Fig. 1 and the dotted lines in Fig. 12 it will be seen that the projection of the stud and friction-roller F^3 is such that when the cam G′ is turned in the position shown in Fig. 1 the friction-roller will engage therewith, and by riding upon the inclined surface of said cam will, as the cylinder in rotating passes by in one direction or the other, swing the arm accordingly. The movement of the arm, however, is against the tension of the spring *f*, and accordingly, as soon as the roller F^3 has left the cam G′, the spring will cause the return of the swinging arm to a vertical position, ready for re-engagement on the return movement of the cylinder. It will also be seen that the elevation of the stud F^3 above the level of the base-plate is sufficient for it to clear the lower cam G, when, as will hereinafter be described, the latter is turned inward to effect its function. Furthermore, by swinging the cam-piece G′ into the position indicated by the dotted lines in Fig. 2 the cam-piece G′ will be retracted out of the range of the friction-roller F^3. Thus it will be seen that when the cam-piece G′ is operative the needle-disks C *c* will be alternatively at each reciprocation of the cylinder thrown into a position ready for engagement with the end needle of the active series, and will, when the return reciprocating movement takes place, carry their respective needles within the range of the cams I′ *i*′, whereby they are raised to the idle-level as the movement of the cylinder continues.

The mechanism for lowering the needles successively consists of a pair of lowering-disks, which are in some respects the counterparts of the raising-disks, and which are shown at D *d*. A similar method of description—viz., by the use of capitals and smaller letters for corresponding parts—will be employed to describe this pair of devices, the members of each pair being like those of the other, but their arrangement being in converse relation to the cam-cylinder, as will be readily understood.

Near the uppermost part of the needle-cams we form inclined slots J *j*, which extend down from the upper periphery of the cam-cylinder to a point within the range of the knitting-cams A^7. Adjacent to each of these slots we mount upon the exterior of the cam-cylinder, the needle-depressing disks D *d* upon inclined axes at right angles to the respective slots. The disk *d* has four radial teeth d^2, each of which has, as shown, a short overhanging flange d^3 upon the upper side of its front edge. As in the case of the raising disks, the teeth are of such length and the disk is so mounted in relation to its slot, that in rotating they shall project inward sufficiently to overhang the needle-ledge, without, however, striking the periphery of the needle-cylinder. The disk *d* is also provided with a square head d^4 and a bearing-spring d^6, secured at d^7 to the exterior of the cam-cylinder and provided with a square notch or bend d^5, so that said spring can engage with either of the flat surfaces of the head d' or one of its corners and hold the disk *d* against accidental rotation. When the spring d^6 is bearing upon the flat side of the head, the disk is in such a position that one of its teeth d^2 is just within the inner surface of the cam-cylinder and at the top of the incline J, this position corresponding with the hubs of the needles in the idle-level. As in rotating the end one of said needles strikes against said tooth it engages beneath the overhanging flange d^3 thereof, and in a manner similar to that described for the lifting operation the disk will be rotated by the resistance of the needle, but in rotating it must, owing to the inclination of its axis, cause the needle-hub, which has engaged beneath the flange upon the tooth, to descend

until the tooth withdraws from the slot. This descent is sufficient to bring the needle from the idle-level down to the range of the knitting-cams, and thus render it active.

The position of the disk ready for engagement is shown at the left-hand side of Fig. 7, and the position of the disk after the tooth has withdrawn from the slot is shown on the left-hand side of Fig. 8.

To automatically set the disks D d into position ready for engagement, we provide the following devices: Intermediate between the two disks, and preferably upon the rear face of the thread-guide standard A^9, we mount upon a pivot E^2 a swing-plate formed of two radially-projecting wings E E′, terminating laterally in curved edges e e', respectively, and a downwardly-depending arm E^6, terminating in a friction-roller E^5, which is in contact with or immediately above the bottom flange A^4 of the cam-cylinder. Springs E^3 E^4 are secured upon each side of said arm E^6 and bear against the same in opposite directions, so as to hold it normally in a vertical position, as shown in Fig. 10. The radial projection outward of the friction-roller E^5 is about one-third of that of the friction-roller F^3, (before referred to in connection with the lifting devices,) and therefore in rotation said friction-roller E^5 will not strike against the cam G′. When, however, the other cam G is turned inwardly, (see Figs. 7 to 10, inclusive,) it will strike thereon, and in riding over the same the swing-plate will be turned, so as to throw one of the wings E′ or E, as the case may be, downward. This movement of the wing E′ causes its curved edge e' to bear against the outwardly-projecting edge of the tooth upon the disk d and to turn said disk about forty-five degrees, so that, assuming that the disk has been stopped by its spring d^6 after depressing a needle, the rotation thus occasioned will bring the edge of the next tooth in the proper relation for engaging with the next needle on the following reciprocation. As soon as the friction-roller E^5 has cleared the cam G the spring E^4 will cause the return of the swing-plate to a vertical position and upon the reverse movement of the cylinder the roller will again strike the cam G, and the plate will be swung in an opposite direction, with a corresponding effect upon the other needle-depressing disk. Thus at each reciprocation a needle at one end of the idle row will be depressed, and the disk opposite to that one which has depressed it will be shifted in position for engagement upon the return movement with the needle at the other end of the idle row.

It is not deemed necessary to describe the knitting operation with its features of widening and narrowing, since the applicability of our invention to this well-known process will be readily understood from the description above given.

During the period of knitting by continuous rotation the needle-lifting and needle-depressing devices must of course remain inoperative, and to this end we withdraw the cams G G′ from the range of the parts upon which they are respectively intended to act, such withdrawal being accomplished by turning the handle G^3 into the position indicated by the dotted lines in Fig. 2. During such period of rotation of the cam-cylinder the disks C c and D d are held in inoperative positions by means of their respective springs C^6 c^6 D^6 d^6.

Having thus described our invention, we wish it to be understood that we do not intend by the use of the word "disk" in describing the needle-lifters and needle-depressors to limit ourselves to parts having the form thus indicated. The essence of our invention in this respect lies in the fact that we employ a rotatable member mounted exterior to the cam-cylinder and having a part or parts of its periphery adapted to extend through the wall thereof, said part or parts having surfaces capable of engagement above or below the needle-hubs and so arranged that the path traveled by said surfaces as they rotate shall be inclined, respectively, to the needle-track and to the plane of the idle-level. Furthermore, although we have specified the use of a cam-incline to receive the needle-hub and carry it upward after the tooth has withdrawn from contact it is obvious that such device is merely an adjunct and that the needle might be raised to the idle-level by the action of the tooth alone in many cases. So, also, we have specified particular mechanism for rotating the needle-lifting and needle-depressing disks into their operative positions; but we do not thereby mean to limit ourselves to the use of such mechanism, the object of our description being merely to give a typical form which is capable of use in connection with the fundamental features of our invention and which is to a certain extent automatic.

We claim—

1. The combination, with the needle-cylinder and its needles and with the cam-cylinder provided with a slot extending upward from the vicinity of the needle-track, of a rotatable needle-lifter mounted exterior to the cam-cylinder, said needle-lifter having peripheral portions of different radii, the portion of lesser radius being clear of the needle-hubs and the portion of greater radius extending through said slot into the needle-track, said last-mentioned portion being provided with an edge capable of engagement with the needle-hub from below and traveling in rotation in a plane inclined upward from the needle-track, substantially as and for the purposes set forth.

2. The combination, with the needle-cylinder and its needles and with the cam-cylinder provided with an opening which extends downward from the idle-level, of a rotatable needle-depressor mounted exterior to the cam-cylinder and at said opening said needle-depressor having peripheral portions of differ-

ent radii, the portion of lesser radius being clear of the needle-hubs and the portion of greater radius extending through said opening and into the cam-cylinder at the idle-level, said last-mentioned portion being provided with an edge capable of engagement with the needle-hub from above and traveling in rotation in a plane inclined downward from the idle-level, substantially as and for the purposes set forth.

3. The combination, with the needle-cylinder and its needles and with the cam-cylinder, said cam-cylinder being provided with a pair of slots extending upward from the needle-track and with openings extending downward from the idle-level, said slots and openings being symmetrically arranged with relation to the knitting-cams, substantially as set forth, of a pair of rotatable needle-lifters mounted exterior to the cam-cylinder, said needle-lifters having peripheral portions of different radii, the portions of lesser radius being clear of the needle-hubs and the portions of greater radius extending through said first-mentioned slots respectively into the needle-track, said last-mentioned portions being provided with edges capable of engagement with the needle-hubs from below and traveling in rotation in planes inclined upward from the needle-track in opposite directions, and a pair of rotatable needle-depressors mounted exterior to the cam-cylinder, said needle-depressors having peripheral portions of different radii, the portions of lesser radius being clear of the needle-hubs and the portion of greater radius extending through said openings and into the cam-cylinder above the idle-level, said last-mentioned portions being provided with edges capable of engagement with the needle-hubs from and traveling in rotation in planes inclined downward in opposite directions from the idle-level, substantially as set forth.

4. The combination, with the needle-cylinder and its needles and with the cam-cylinder provided with a slot extending upward from the vicinity of the needle-track, of a needle-lifting disk freely mounted upon an axis of rotation exterior to the cam-cylinder, said axis being inclined to the axis of rotation of the cam-cylinder, substantially in the manner set forth, said disk being provided at intervals with peripheral teeth capable of engagement with the needle-hubs from below and of sufficient radius to extend in rotating into the needle-track, the intermediate peripheral portions of said disk being of sufficiently short radius to clear the needle-hubs, and means, substantially as set forth, for independently rotating said disk to bring its teeth successively into position for engagement with the needle-hubs, substantially as set forth.

5. The combination, with the needle-cylinder and its needles and with the cam-cylinder provided with an opening extending downward from the vicinity of the idle-level, of a needle-depressing disk freely mounted upon an axis of rotation exterior to the cam-cylinder, said axis being inclined to the axis of rotation of the cam-cylinder, substantially in the manner set forth, said disk being provided at intervals with peripheral teeth capable of engagement with the needle-hubs from above and of sufficient radius to extend in rotating through said opening and into the cam-cylinder at a point above the idle-level, the intermediate peripheral portions of said disk being of sufficiently short radius to clear the needle-hubs, and means, substantially as set forth, for independently rotating said disk to bring its teeth successively into position for engagement with the needle-hubs, substantially as set forth.

6. The combination, with the needle-cylinder and its needles, the cam-cylinder provided with slots extending upward from the vicinity of the needle-track, and the pair of rotatable needle-lifters arranged with relation to said cam-cylinder substantially in the manner set forth, of a longitudinally-movable strip mounted in guides upon the exterior of the cam-cylinder and connected at each end, substantially in the manner set forth, with a needle-lifter, a spring-actuated swinging arm pivoted to the cam-cylinder and operatively connected with said strip, and an adjustable stationary cam mounted within the range of motion of the lower end of said arm as the same reciprocates with the cam-cylinder, whereby at each reciprocation of the cam-cylinder said strip is actuated to shift a needle-lifter into an operative position, substantially in the manner set forth.

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