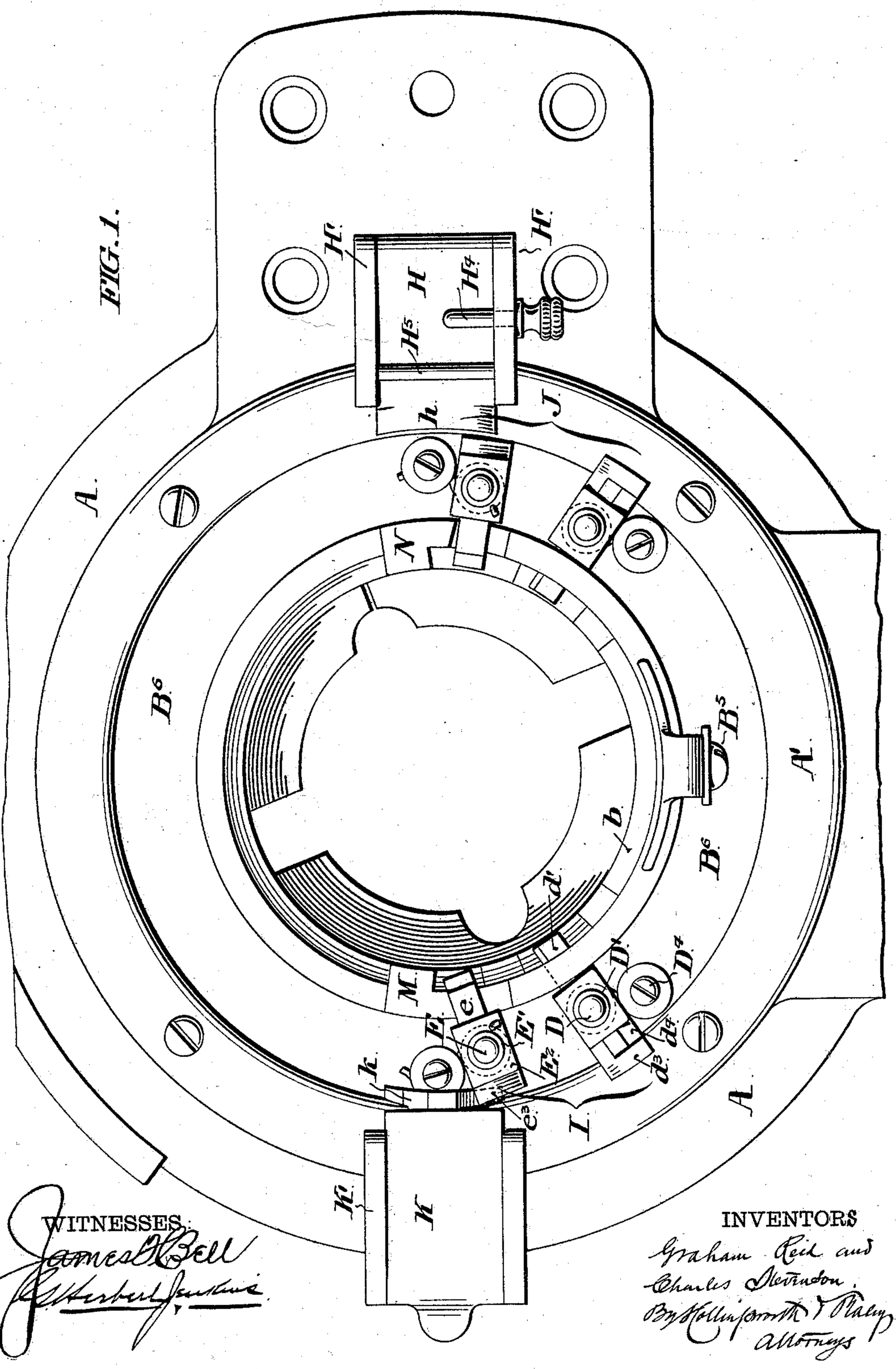
(No Model.) 3 Sheets—Sheet 1.

G. REID & C. STEVENSON.

CIRCULAR KNITTING MACHINE.

No. 544,995. Patented Aug. 20, 1895.

FIG. 1.



WITNESSES:
James A. Bell
Herbert Janvis

INVENTORS
Graham Reid and
Charles Stevenson.
By Hollingsworth & Haley
Attorneys

(No Model.) 3 Sheets—Sheet 2.

G. REID & C. STEVENSON.

CIRCULAR KNITTING MACHINE.

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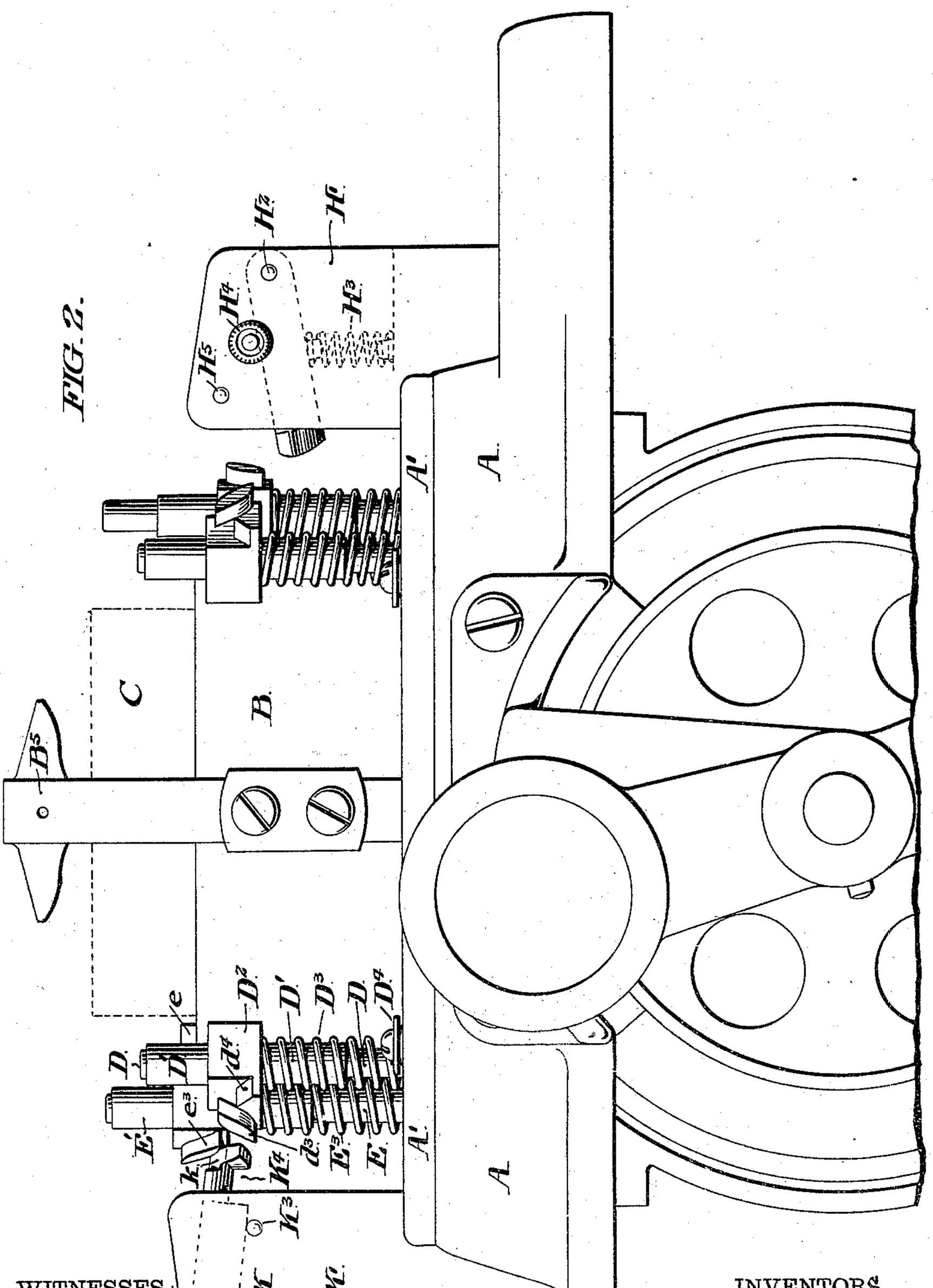
FIG. 2.



WITNESSES:

James F. Bell

R. Herbert Jenkins

INVENTORS

Graham Reid and

Charles Stevenson,

By Hollingsworth & Ridley

Attorneys.

(No Model.) 3 Sheets—Sheet 3.

G. REID & C. STEVENSON.

CIRCULAR KNITTING MACHINE.

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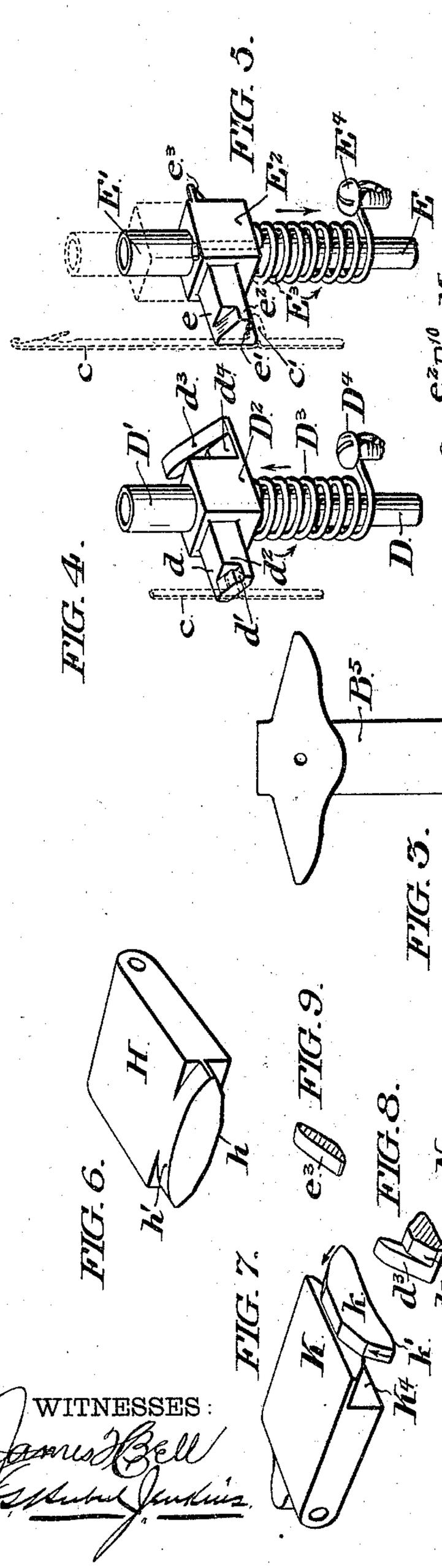

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 9.

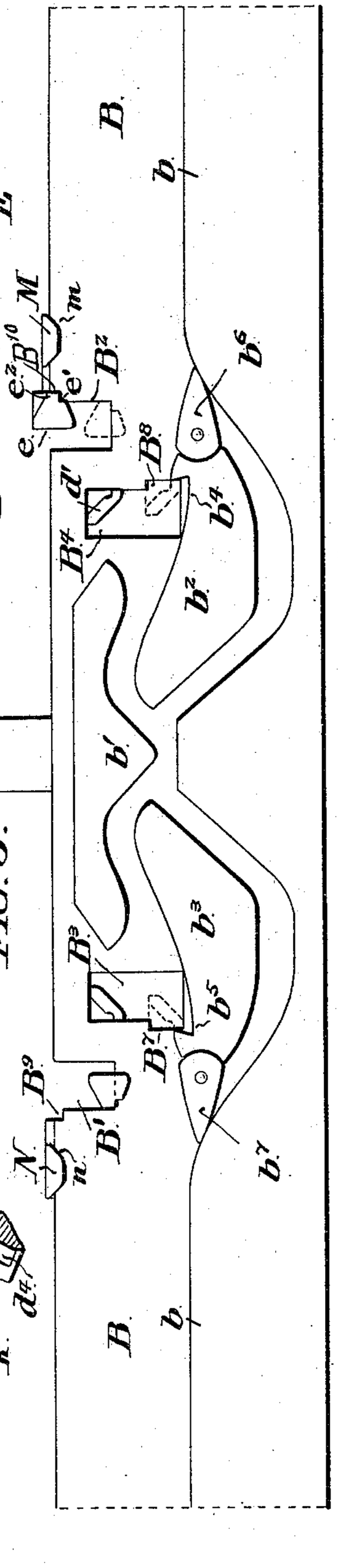

FIG. 3.

FIG. 8.

FIG. 7.

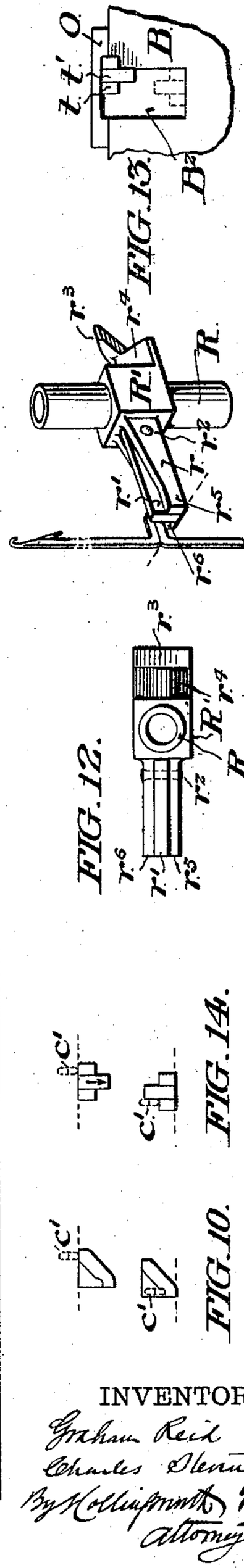

FIG. 13.

FIG. 11.

FIG. 12.

FIG. 14.

FIG. 10.

WITNESSES:

James H. Bell

Kenneth Jenkins

INVENTORS

Graham Reid and

Charles Stevenson

By Hollingsworth & Philp

Attorneys.

UNITED STATES PATENT OFFICE.

GRAHAM REID AND CHARLES STEVENSON, OF PHILADELPHIA, PENNSYLVANIA.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 544,995, dated August 20, 1895.

Application filed November 28, 1893. Serial No. 492,290. (No model.)

To all whom it may concern:

Be it known that we, GRAHAM REID and CHARLES STEVENSON, of the city of Philadelphia and 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 belongs to that class of knitting-machines wherein at certain periods individual needles are successively raised to the idle-level during a predetermined interval, and are subsequently depressed one by one into an operative position for the purposes, respectively, of narrowing and widening the fabric, as in the manufacture of stockings. Such machines embody two pairs of needle-shifting devices—viz., two needle-lifters symmetrically arranged on opposite sides of the central knitting-cam and two needle-depressors also symmetrically arranged in a similar manner. The needle-lifters and the needle-depressors, which are upon the same side of the knitting-cams, constitute a group, and as the individual members of the corresponding group upon the other side of the knitting-cams are precisely similar to those of the first-mentioned group, except in the fact that they face (or are adapted to engage the needle-hubs) in an opposite direction, only one such group will be described in detail.

In the accompanying drawings, Figure 1 represents a top or plan view of the machine embodying our invention. Fig. 2 is a side elevation thereof. Fig. 3 is a view of the interior of the cam-cylinder projected upon a plane surface. Fig. 4 is a detail view of a needle-lifter detached from its position and shown in perspective. Fig. 5 is a similar view of a needle-depressor. Fig. 6 is a view in perspective of the tripping-cam adapted to throw the needle-lifters into an operative position at each successive reciprocation. Fig. 7 is a similar view of the tripping-cam, which acts in like manner upon the needle-depressors. Figs. 8 and 9 are detail views, respectively, of the trippers or outwardly-projecting parts upon the needle-lifters and needle-depressors which engage with said last-mentioned cams. Fig. 10 is a diagrammatic view illustrating the action of the needle-lifter upon the needle-hub, showing the same in two positions. Fig. 11 is a view in perspective of a modified form of needle-lifter. Fig. 12 is a top or plan view thereof. Fig. 13 is a partial view of a needle-depressor in a similarly-modified form; and Fig. 14 is a diagrammatic view illustrating the action of such a lifter as is shown in Figs. 11 and 12, the parts being shown in two different positions.

Referring now to the general views, A represents the stationary base-plate of the machine, and A′ the stationary ring mounted thereon and overlapping the horizontal flange B^6 of the cam-cylinder B, which is actuated in the ordinary manner—*i. e.*, continuously rotated during that portion of the knitting operation which is to form the tubular fabric and reciprocated during the period when the narrowing and widening operations, respectively, occur.

The needle-cylinder is indicated by the dotted lines at C and the thread-carrier at B^5. As the construction of these parts and their method of operation are well understood, it is not deemed necessary to refer more particularly thereto.

In Fig. 3 the needle-ledge *b*, the knitting-cams b' b^2 b^3, and switch-cams b^6 b^7 are shown and the position of the two needle-shifting groups with relation thereto is indicated. On each side of the central knitting-cam b' and immediately above the knitting-cams b^2 b^3 vertical slots B^3 B^4, respectively, are formed through the wall of the cam-cylinder. Said slots are provided with offsets B^7 B^8, respectively, near their lower ends and at the side which in each instance is farthest from the central knitting-cam b'. The upper surfaces of the knitting-cams b^2 b^3 are depressed or indented, as indicated by b^4 b^5, respectively, at points adjacent to their outer ends, and the slots B^3 B^4 extend downward to a level within the depressed or indented portion of said knitting-cams, as shown, so that the outer end of each knitting-cam b^2 b^3 shall raise the needle-hub to a point slightly above the bottom of the adjacent slot. The slots B^3 B^4 admit the arms or inwardly-projecting portions of the two needle-lifters, which will be hereinafter described.

At the points adjacent to the slots B^3 B^4, re-

spectively, but farther from the central knitting-cam b', a second pair of slots B' B^2, respectively, extend downward from the upper edge of the cam-cylinder, the bottom of said slots being at a level slightly below the outer ends of the central knitting-cam b'. Said slots are formed respectively with offsets B^9 B^{10} at top and at that side which in each instance is farthest from the central knitting-cam, and adjacent to said offsets inwardly-overhanging short cams N M, respectively, may be mounted upon the top of the wall of the cam-cylinder and project downward to the level of the bottom of the offsets B^9 B^{10}, respectively. The slots B' B^2 receive the arms or inwardly-projecting portions of the needle-depressors, which will hereinafter be described in detail.

We will now proceed to describe the members of the needle-shifting group I, comprising one needle-lifter and one needle-depressor, said group being upon the left-hand side of the thread-guide in Figs. 1 and 2, and consequently upon the right-hand side thereof in Fig. 3.

First. The needle-lifter. (See Fig. 4.) A vertical post D is mounted in the horizontal flange B^6 of the cam-cylinder opposite to the slot B^4. Said post receives a sleeve D', which is adapted to slide freely thereon, and to said sleeve is rigidly attached a block D^2, which carries upon its inner face the needle-lifting arm d, and upon its outer reduced and beveled part d^4 the inclined projecting piece d^3, which we term the "tripper," since by its engagement with the proper tripping-cam the needle-lifter is thrown into an operative position, or "set," during the reciprocation which precedes its operating movement. The lifter-arm d is of rectangular cross-section, excepting at its extreme outer end, where it terminates in an inclined step d', adapted to engage beneath and temporarily hold a needle-hub. The arm d is of such length that its rectangular shoulder d^2 extends into the slot B^4, but not beyond the inner surface of the wall of the cam-cylinder, while the inclined step d' projects inward sufficiently far to be within the range of the needle-hub. A spring D^3 is coiled about the sleeve D' and post D, the upper end of said spring being secured at D^4 to the flange B^6 of the cam-cylinder and the upper end of the spring being attached to the under side of the block D^2. Said spring tends normally to throw said block upward and also to turn or rotate it, so as to throw the arm d away from the central knitting-cam b'. These two normal tendencies of the spring D^3 are indicated respectively by the small arrows adjacent to said spring in Fig. 4.

Assuming the existence of mechanism for automatically "setting" the needle-lifter at stated intervals, (which mechanism will hereinafter be described,) the operation of the needle-lifter is as follows: Normally the arm would be at the top of the slot B^4, but when the setting mechanism acts it is forced downward against the upward tension of the spring D^3 to the bottom of the slot, whereupon the torsional tension of the spring D^3 throws the arm d away from the central knitting-cam b' and in so doing causes the shoulder d^2 of the said arm to engage in the offset B^8 of the slot B^4. The upper face of said offset thus serves as a detent which prevents the rise of the arm so long as it remains seated in the offset. When, however, the knitting-cams, in moving to the right in Fig. 3, cause the needles to ride upon the switch-cam B^6, and thence onto the outer end of the knitting-cam b^2, the hub of the end needle of the then operative series will ride into the step d' upon the arm d, and as movement of the cam-cylinder continues the said arm will be turned by the hub horizontally toward the knitting-cam b' until the shoulder d^2 of the arm clears the detaining upper surface of the offset B^8. Thereupon instantly the upward tension of the spring D^3 throws the arm d (and with it the needle seated in the step) vertically upward to the extreme upper end of the slot B^4, and as movement of the cam-cylinder still continues the needle-hub rides up the inclined face of the step d', and on passing beyond the same is delivered to the upper surface of the central knitting-cam b', on which it passes to the idle-level. This action has, of course, resulted in the needle-lifter's being thrown to its extreme upward position on the post D, and in order that it may be able to engage another needle it must be returned to the bottom of the slot B^4 and detained there until at the proper moment the next succeeding end needle upon that side of the active series shall approach it. This return or setting is effected in the following manner: Upon the outwardly-projecting beveled end of the block D^2 is mounted the transversely-inclined tripper d^3. At a suitable point upon the base-plate A we mount a pair of uprights H', parallel to one another, with an interspace, as shown in Fig. 1. Said uprights carry a tripping-cam H, hinged at its rear end to the uprights by means of the transverse pin H^2, and projecting inwardly beyond said uprights to a point which is within the circle described by the tripper d^3 as the same rotates with the cam-cylinder. A spring H^3 normally tends to throw said tripping-cam H upward, the limit of its upward movement being fixed by means of the transverse pin H^5; but said cam may be depressed against the tension of the spring H^3 and held in a depressed position by means of the pin H^4, which can be withdrawn and inserted at will. When held in the depressed position shown in Fig. 2, the tripping-cam H is at such a low level that the tripper d^3 will not come in contact therewith; but when the pin H^4 is withdrawn and the tripping-cam H is permitted to rise to its extreme upward position its inner end is at such a height that the tripper d^3 will pass beneath it, and by reason of the configuration of the under cam-surface h the tripper d^3 will be depressed,

carrying downward the block D^2, and consequently the lifter-arm *d*. The extent of this depression corresponds with the depth of the slot B^4, and upon reaching this lowest position in said slot the tension of the spring D^3 will, as above stated, turn the arm *d*, so as to engage its shoulder d^2 within the detent formed by the offset B^8 in the slot. It will be observed that the inner end of the tripping-cam H is curved upon its upper surface *h'* as well as upon the lower one *h*, which latter is the operative surface for the purpose of depressing the needle-lifter. The reason for curving the upper surface *h'* is as follows: When the needle-shifting devices are first thrown into play and the tripping-cam H is in its operative position, at the first complete reciprocation of the cam-cylinder the tripping-cam H will depress one of the needle-lifters by reason of the passage of the tripper d^3 thereof beneath the under surface *h* of the cam. The same movement of the cam-cylinder will, however, also carry the other needle-lifter past the tripping-cam H, but in the wrong direction for operative engagement therewith, because the tripper d^3 upon one needle-lifter is inclined in the opposite direction from the tripper upon the needle-lifter of the other group. Hence provision must be made for the passage of the wrongly-inclined tripper by or beyond the tripping-cam H at the initial reciprocation. To this intent the under side of the tripper d^3 is inclined and the upper surface *h'* of the tripping-cam H is rounded, so that when the under side of the tripper d^3 at the initial reciprocation reaches the tripping-cam H said tripper will pass freely over the rounded upper surface *h'* of the tripping-cam H and slightly depress said cam against the tension of the spring H^3. So soon as the tripper has cleared the tripping-cam H, the tension of the spring H^3 will restore the latter to its operative position, and on the return reciprocation the upper surface of the tripper d^3 will operatively engage beneath the lower surface of the tripping-cam H. This state of affairs occurs but once during the entire period of reciprocating movement—viz., during the initial reciprocation of the cam-cylinder at the change from continuous rotary to oscillating movement.

Second. The needle-depressor. (See Fig. 5.) This instrumentality is in effect a needle-lifter reversed, and may be described in detail as follows, reference being had only to that depressor which forms part of the group I at the left-hand side of Fig. 1 and at the right-hand side of Fig. 3. A vertical post E is mounted in the flange B^6 of the cam-cylinder, and said post carries a sleeve E', capable of free movement thereon, said sleeve being rigidly connected with a block E^2, which carries the depresser-arm *e*. A coiled spring E^3 surrounds the post and lower portion of the sleeve and is secured at the lower end to the flange E^6, as shown at E^4, and at the upper end to the block E^2, the tension of the spring normally tending to depress the block E^2 and also to rotate the arm *e* away from the central knitting-cam *b'*. These normal tendencies of the spring E^3 are respectively indicated by the arrows in Fig. 5. From the inner face of the block E^2 the arm *e* projects inwardly and terminates in a step *e'*, formed upon the under surface of its front end, capable of engagement with a needle-hub from above, in the same manner as the step upon the lifter-arm *d* engages the hub from below. The length of the arm *e* is such that the step *e'* extends clear into the interior of the cam-cylinder and within the range of the needle-hubs when the same are at the idle-level, and the squared portion or shoulder e^2 of the arm *e* fits into and engages with the offset B^{10} of the slot B^2, so as to detain the arm against the downward tension of the spring E^3.

Assuming the existence of mechanism for automatically raising the block E^2 to its uppermost position against the tension of the spring E^3, and thus setting the arm in an operative position, where it is temporarily held by the detent, the action of said arm in depressing the needles is as follows: When the end needle, which is to be depressed from the idle series, is approached by its needle-depressor, the hub of the needle strikes against the step *e'* upon the end of the arm *e* and engages beneath the same from below. As movement of the cam-cylinder continues, the arm *e* is turned slightly, so as to clear the shoulder e^2 from the detent, whereupon the tension of the spring E^3 immediately throws the arm down to the bottom of the slot B^2, carrying with it the needle. On reaching the bottom of the slot B^2 the inclined under surface of the arm *e* depresses the needle-hub a slight distance farther and leaves the latter at a level within the range of the outer point of the central knitting-cam *b'*, so that said needle assumes its position in the active series.

To automatically effect the return of the needle depressor to its upward and operative position, we provide the tripping-cam K, which is pivoted at K^2 between the uprights K', mounted upon the base-plate A, said cam being free to rise upon pressure from beneath, but restrained against downward movement by means of a pin K^3. (See dotted lines of Fig. 2.) The front end of the cam K is cut away upon the under side, as indicated at K^4, for a purpose which will hereinafter be mentioned, and the operative cam-surface has the configuration shown at *k* and *k'*. Upon the outer face of the block E, which carries the needle-depressor, is mounted an inclined tripper e^3, (see Figs. 5 and 9,) whose under surface is capable of engagement, on movement in the proper direction, with the upper surface *k* of the cam K, and whose upper surface can ride upon the lower surface *k'* of said cam in the opposite direction.

By reference to Figs. 1 and 2 it will be seen that the inward projection of the tripper-cam K is considerably greater than the inward

projection of the cam H, and consequently the tripper-cam K is capable of engagement with the tripper e^3 of the needle-depressor, although said tripper has a very considerably less radial projection, and consequently describes a smaller circle than the tripper d^3 upon the needle-lifter. Hence the tripper e^3 is in operative relation to the surface k of the tripper-cam K and will be at each reciprocation acted upon thereby, so as to raise the needle-depressor to the extreme upward position, while, however, the tripper e^3 will freely pass and avoid the other tripping-cam H. In order, however, that the tripper d^3 upon the needle-lifter shall not be affected by the tripping-cam K in its passage by the latter, we provide the channel or cut-away portion K^4 on the under side of the tripping-cam K, said channel corresponding in radial distance from the center of rotation with the radial distance of the tripper d^3. Thus as the needle-lifter passes the tripping-cam K the tripper d^4 will pass under the latter, while the overhanging front end k of said cam K will be over the reduced and beveled projection d^4 of the lifter-block D^2. Whatever slight contact may take place exerts no injerious effect, by reason of the fact that the tripping-cam K is free to rise and thus accommodate itself to any trifling degree of interference, falling back into its operative position as soon as the tripper d^3 has passed by.

In using needle-depressors of the form shown in Fig. 5 we prefer to employ the guard-cams N M, adjacent to the slots B^2 B′ respectively, in order that should any needle have been accidentally raised above what may be considered as the normal idle-level, the hub thereof shall be struck by the guard-cam M or N and be forced downward by the under surface m or n thereof to the exact position for engagement with the step upon the needle-depressor. Such guard-cams, however, are adjuncts and not essential to the operation of the needle-depressors, serving merely to remedy any accidental irregularity of position in the needles. It is, of course, essential that when the needle-lifters are in operation the needle-depressors shall be idle, and vice versa and also that during the period of continuous rotary knitting both shall be idle. These conditions are obtained by permitting the needle-lifter to remain at the top of its slot and the needle-depressor to remain at the bottom of its slot, where they are of course inoperative to affect needles in normal action. During this period the tripping-cam H is depressed, as indicated in Figs. 1 and 2, and held out of range of both sets of trippers, and the tripping-cam K is raised or thrown over backward on its pivot K^2, so as in like manner to be clear of the trippers. When the needle-lifters are to be operated, the tripping-cam H is permitted to assume its uppermost position, the tripping-cam K being still thrown outward, and when the needle-depressors are to be in operation the tripping-cam K is lowered or turned inward into the position indicated in Figs. 1 and 2 and the tripping-cam H is depressed and locked by means of the pin H^4.

In Figs. 11 and 12 we have illustrated in perspective and top views, respectively, an alternative form of needle-lifter, which is also capable, of course, of serving in reverse position as a needle-depressor, it being understood that the other mechanism for automatically setting and shifting the same operates in a similar manner to that just described. The difference between the lifter-arm shown in these two figures last mentioned and the lifter-arm indicated in the general views lies in the fact that instead of providing an inclined step which engages the needle, and which also, to a certain extent operates as a cam after the throw of the arm itself has taken place, we employ a step which, upon the completion of the upward throw of the lifter, (or downward throw of the depressor), automatically disengages itself from the needle without compelling the latter to ride along its surface in frictional contact therewith. Thus in said figures R indicates the sleeve, which is capable of movement upon the post. R′ indicates the block, upon whose outer face are the reduced projection r^4 and the tripper r^3. The lifter-arm r is, however, longitudinally slotted in a vertical direction or bifurcated, and a thin strap r' is secured in the slot by a pivot r^2. The free ends r^5 r^6 of the bifurcated arm r are reduced in vertical height, so that the intermediate strip r' rises upon the upper face of the arm r, and thus forms in conjunction therewith a step, or rather a pair of steps, one on each side of the center of the arm. The range of movement of the strip r' upon its pivot r^2 is sufficient to permit said strip to drop down, so that its top may be flush with the upper surface of the reduced front end of the arm r, and the range of upward movement of the strip r' corresponds with the position shown in Fig. 11.

The method of operation of such a form of device is as follows: Assuming that the needle-lifter has been by the action of the tripping-cam H depressed to the bottom of its slot and engaged in the detent thereof, the strip r' will be raised by contact with the bottom of the slot and present a step for the needle-hub. When engagement occurs, as before described, the arm will be turned sufficiently to clear it from the detent, whereupon the spring (not shown in this figure, but similar to the spring D^3 before described) will throw the arm (still engaging the needle) to the upper part of the slot. The strip r', however, will strike against the upper surface of the slot and be knocked down upon its pivot r^2, so that the top of said strip will be flush with the upper surface of the bifurcated arm r, thereby no longer presenting any lateral obstruction to the passage of the needle-hub, which will accordingly be cleared by the arm and ride upon the upper surface of the knit-

ting-cam b' to the idle-level. This action of the bifurcated arm and strip is indicated in Fig. 14, where the lower view shows the needle-hub c' as engaging in the step formed by the strip r' in its raised position, while the upper figure shows the strip r' knocked down at the conclusion of the needle-lifting operation and clearing the hub. In Fig. 13 we have illustrated the action of a similarly-modified device, when employed as a needle-depressor. Understanding the parts to be mounted for vertical movement, under the action of a spring, in the same manner as before, the inwardly-projecting depressor-arm t is bifurcated and provided with a central strip t, pivoted thereto, in a manner similar to the pivoting of the strip in the needle-lifter. In order, however, that said strip shall be struck upon its rising movement, so as to present the proper shoulder for engaging the needle, we mount upon the upper surface of the cam-cylinder B a bridge O, which projects over the top of the slot B^2. The two positions of the needle-depressor are shown in Fig. 13, the upper one ready for engagement with the needle, being indicated in solid lines, and the lower one, after clearance of the needles, being indicated by the dotted lines. The action of this needle-depressor is, as above stated, precisely similar to the action of the similarly-constructed needle-lifter, save that the direction of its engagement with the needle-hub is from above instead of below, and the movement after engagement is downward instead of upward.

Having thus described our invention, we now point out certain conspicuous features of difference in its construction and mode of operation from devices heretofore used for the same general purpose. In these older devices, where pivoted arms or their equivalents were employed to effect the shifting of the needles, the shifting action has been the resultant of two different rotary movements—viz., the rotary movement of the cam-cylinder in one plane and the rotation in another plane of the arm itself as a radius-bar. Where the needle-shifting arm has been mounted entirely within the cam-cylinder the disadvantages are obvious, the most notable being lack of space for constructing the parts of proper rigidity, and the very limited throw which the arm is capable of obtaining. Where, on the other hand, the shifting-arms have extended through the wall of the cylinder, the operation presents the disadvantage of a thrust which must be exerted laterally upon the needle-hub and also longitudinally upon the arm itself, which thrust, in the act of raising the hub, tends to bend or distort it, sometimes rendering the grooves upon the needle-cylinder irregular and necessarily producing an undesirable wear upon the needle-groove, owing to the relatively great frictional contact with the side of the needle. If the shifting movement is to be considerable the lateral strain upon the needle and hub is excessive, because the interval of operation, considered as a fraction of the rotation of the cam-cylinder, must be very short.

Our invention obviates all the disadvantages referred to and differs radically from previous devices, so far as we are aware, in that the rotary movement of the cam-cylinder is not an operative factor in actually shifting the needle. Such shifting is accomplished by the action of the spring alone, since the freeing of the needle-shifting arm from the detent, which is accomplished by the rotation of the cam-cylinder, requires the exertion of no substantial force whatever, being merely the trifling rotation of the arm against the very slight torsional tension of the spring, and even in that form of our device, where the step is inclined, the said incline passes the needle after the conclusion of the shifting movement proper and shifts it to such an inconsiderable extent as to exert no substantial lateral pressure upon the hub. Even this feature, however, is avoided by the use of that form of needle-shifting arm which is indicated in Figs. 11 and 13. We therefore believe that we have introduced a new principle of operation in this class of devices—to wit, the shifting of the needles by the direct throw of a spring unattended by material lateral pressure upon the needle-hub and independent of the rotary movement of the cam-cylinder.

As the needle-shifting devices above described are completely operative elements, irrespective of the cams which automatically set them into operative position, we do not limit our broad claims to the use of such cams, although of course in our subordinate claims we desire to include them as proper adjuncts in an automatic machine. Furthermore, although we use the word "vertical" in our claims to indicate the direction of movement of the needle-shifters, we of course do not by so doing mean to limit ourselves to a device whose movement is exactly vertical, and the term must therefore be understood as descriptive of the general direction of the throw. In like manner we do not limit our claims to any specific form of detent for holding the shifters in their operative or "set" position, it being only necessary that when set they should be presented to the needle-hub at the proper moment.

We use the term "needle-shifter" as indicative of either the needle-lifter or the needle-depressor, as the case may be, since it is broad enough to comprehend both devices.

We are aware that the use of needle-shifting arms having a capacity for both longitudinal and rotary movement upon a post is not new, and we are also aware that springs have been used in connection with such arms to effect the return thereof to operative position for re-engagement with the needle-hubs. We, of course, do not claim any such devices,

as ours differs therefrom essentially in the particulars above described; but

We claim—

1. The combination with the cam cylinder, the needle cylinder and the needles, of a vertically movable needle-shifter capable of engagement with the needle hub; a spring normally tending to throw said shifter in the direction of its shifting movement, and permitting said needle-shifter to yield under the pressure exerted by the hub of the needle against the rotation of the cam cylinder and a detent adapted to hold said shifter against the compression of said spring before engagement with the needle hub, and releasing said shifter upon such engagment, substantially as set forth.

2. The combination with the cam cylinder, the needle-cylinder and the needles, of a vertically movable needle-shifter capable of engagement with the needle hub; a spring normally tending to throw said shifter in the direction of its shifting movement and permitting said needle shifter to yield under the pressure exerted by the hub of the needle against the rotation of the cam cylinder; a detent adapted to hold said shifter against the compression of said spring before engagement with the needle hub, and releasing said shifter upon such engagement; a tripper connected with said needle-shifter; and a tripping-cam adapted to engage with said tripper and set the needle-shifter in position against the compression of its spring, substantially as set forth.

3. The combination with the cam cylinder, the needle cylinder and needles, of a vertically movable needle-lifter; a vertically movable needle-depressor; springs normally tending respectively to throw the lifter upward and the depressor downward and for allowing said needle lifter and depressor to yield in the direction of pressure exerted by the hub of the needle against the rotation of the cam cylinder; detents capable of engaging said lifter and said depressor respectively against the compression of said springs; trippers connected respectively with said lifter and said depressor, and tripping cams arranged with reference to said trippers, substantially as set forth, whereby said tripper is permitted to engage operatively with its tripping cam and avoid operative contact with the other tripping cam, as and for the purposes specified.

4. The combination with the needle cylinder and its needles, of a cam cylinder having vertical slots symmetrically arranged with reference to the knitting cams in the manner set forth, each of said slots being provided with an off-set; needle-lifter and needle-depressors extending through said slots and adapted to engage within and be detained by said off-sets; springs normally tending to throw said lifters and said depressors, respectively, in the direction of their respective shifting movements, and also tending to throw them into engagement with the detaining off-set; and tripping devices, substantially as set forth, adapted respectively to depress the lifter against the tension of its spring and raise the depressor against the compression of its spring, substantially as set forth.

5. In combination with a herein described slotted cam cylinder and needle-cylinder, a needle shifter extending through the slotted portion of the cam cylinder and comprising a bifurcated arm, and an intermediately hinged strip of greater vertical height than the end of said arm, said strip having a range of movement which permits it, when moved in one direction to form a step, for the needle hub, and when moved in an opposite direction, to clear said hub, substantially as set forth.

6. A knitting machine comprising a cam cylinder, having vertical slots provided with off-sets near their lower ends, said cam cylinder being also provided with a needle lifter including an arm adapted to engage the vertical slot and having a shoulder adapted to engage the off-set, a single spring normally pressing the arm vertically and also tending to rotate it so that the shoulder will engage the off-set, a needle hub adapted to engage the shoulder and rotate the arm against the compression of the spring, whereby the latter is permitted vertical movement; all substantially as described.

7. A knitting machine comprising a cam cylinder, having a central knitting cam and knitting cams b^2, b^3, with suitable switch cams, a cylinder upon which the same are mounted, having vertical slots formed through its wall, said slots having off-sets near their lower ends and at the side farthest away from the central knitting cam; needle lifters, comprising a vertical post secured to the cam cylinder, a block sliding thereon, having an arm engaging said slots, and a shoulder adapted to engage the off-set, said shoulder being provided with an inclined step or surface upon which the needle heel can ride, a spring upon said post normally acting to elevate the block and to keep the arm rotated away from the central knitting cam, means for depressing said block against the compression of the spring, whereby the rotating action of said spring causes the shoulder on the arm to engage the off-set, and a needle hub adapted in its movement to carry the needle into engagement with said shoulder and force the same out of said off-set, whereby said block is raised and the needle rides on the inclined step; all substantially as described.

GRAHAM REID.
CHARLES STEVENSON.

Witnesses:
CHAS. F. MYERS,
JAMES H. BELL.