No. 768,279. PATENTED AUG. 23, 1904.

E. A. HIRNER.

THREAD CHANGING MECHANISM FOR CIRCULAR KNITTING MACHINES.

APPLICATION FILED SEPT. 12, 1901.

NO MODEL. 4 SHEETS—SHEET 1.

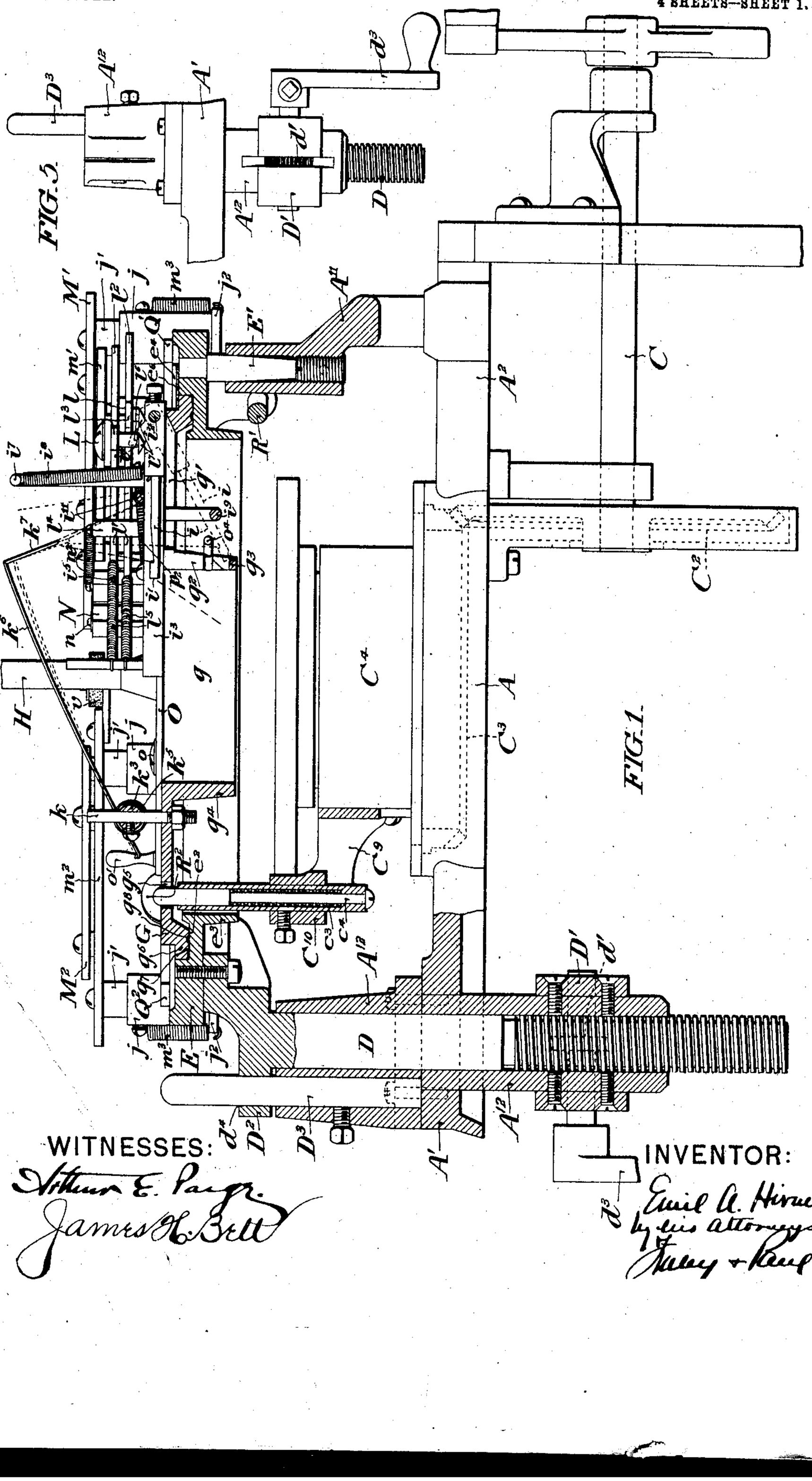

FIG. 1.

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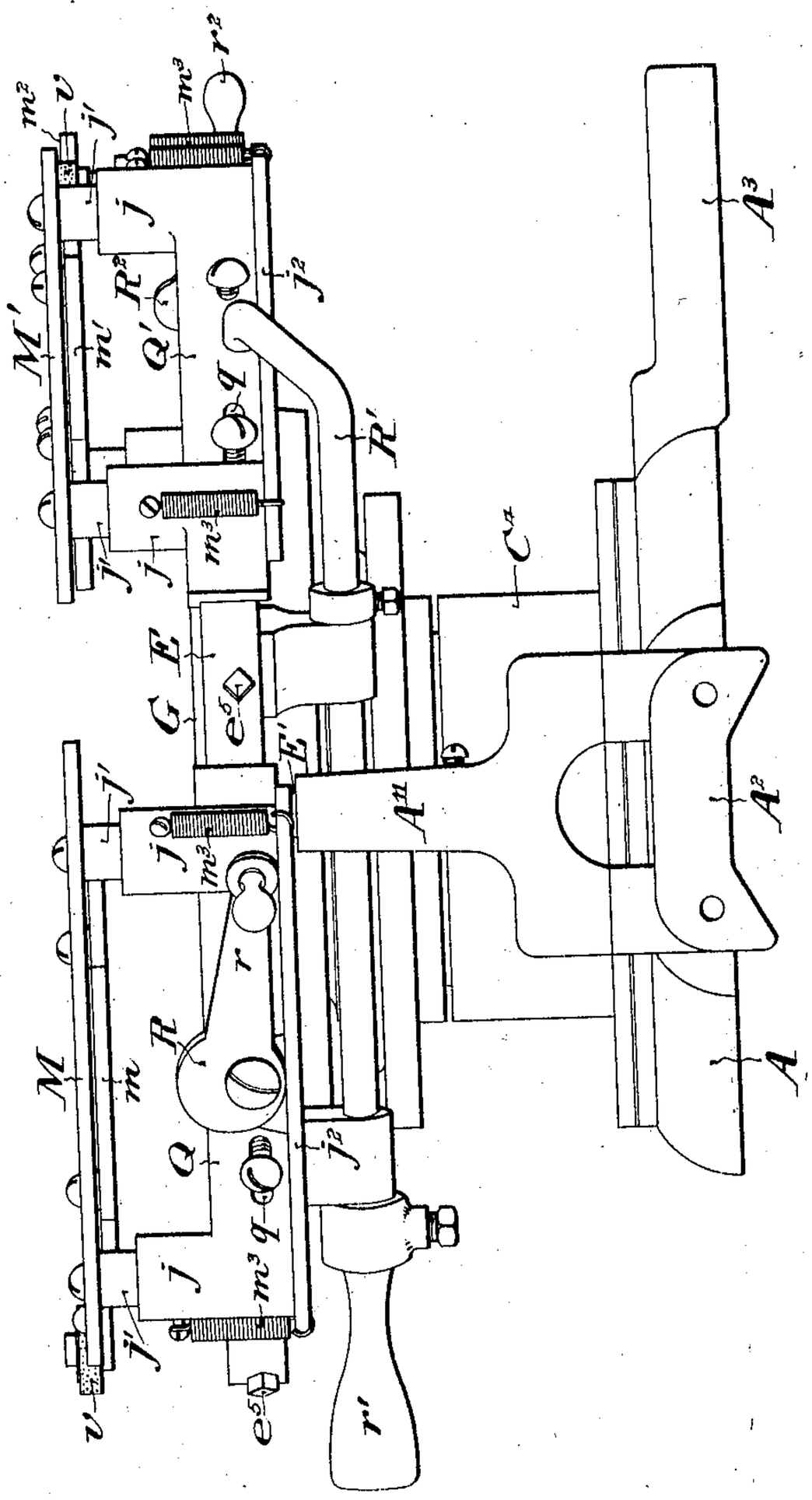
NO MODEL. 4 SHEETS—SHEET 2.

FIG. 2.



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NO MODEL. 4 SHEETS—SHEET 3.

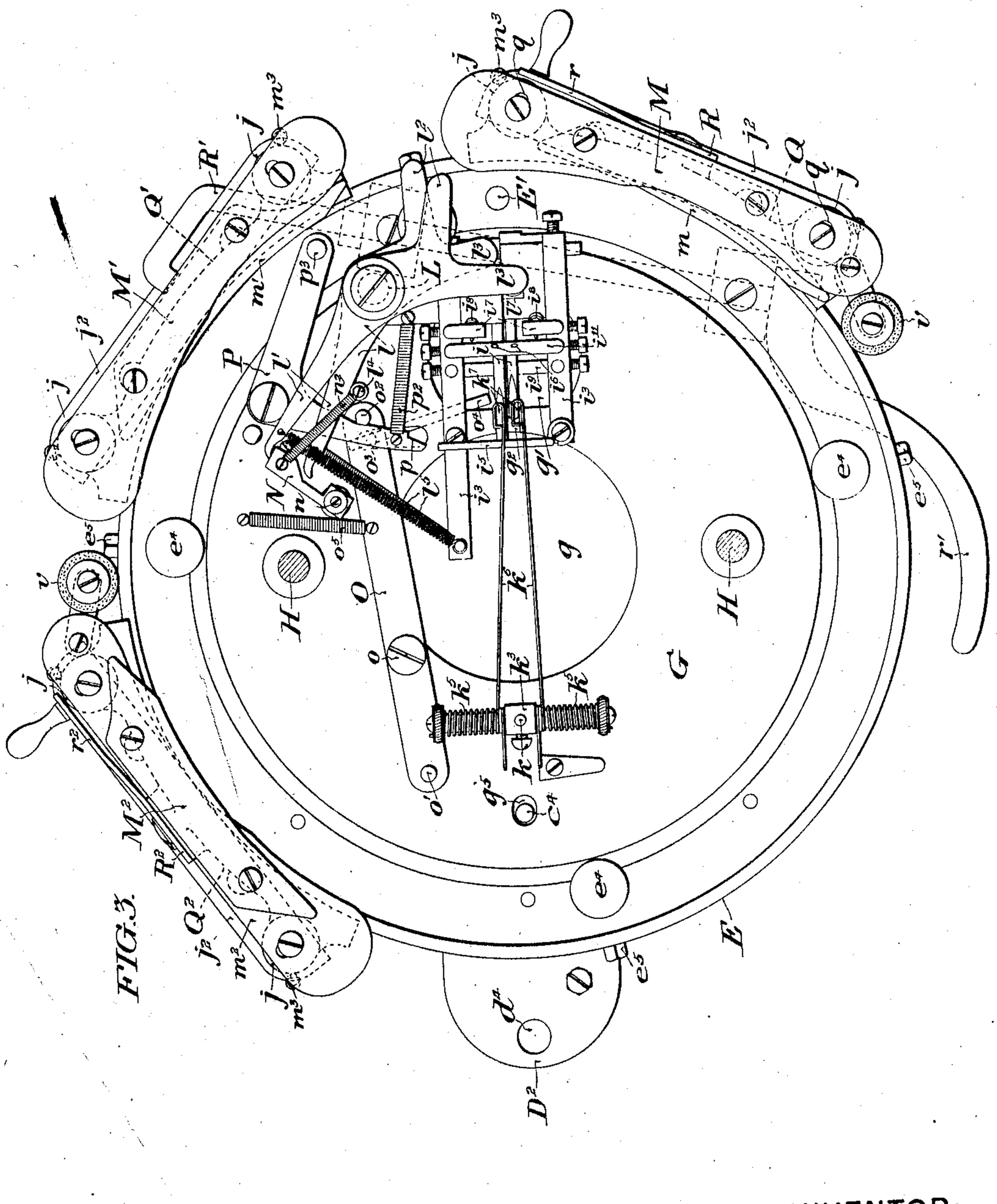

FIG. 3.

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No. 768,279. PATENTED AUG. 23, 1904.

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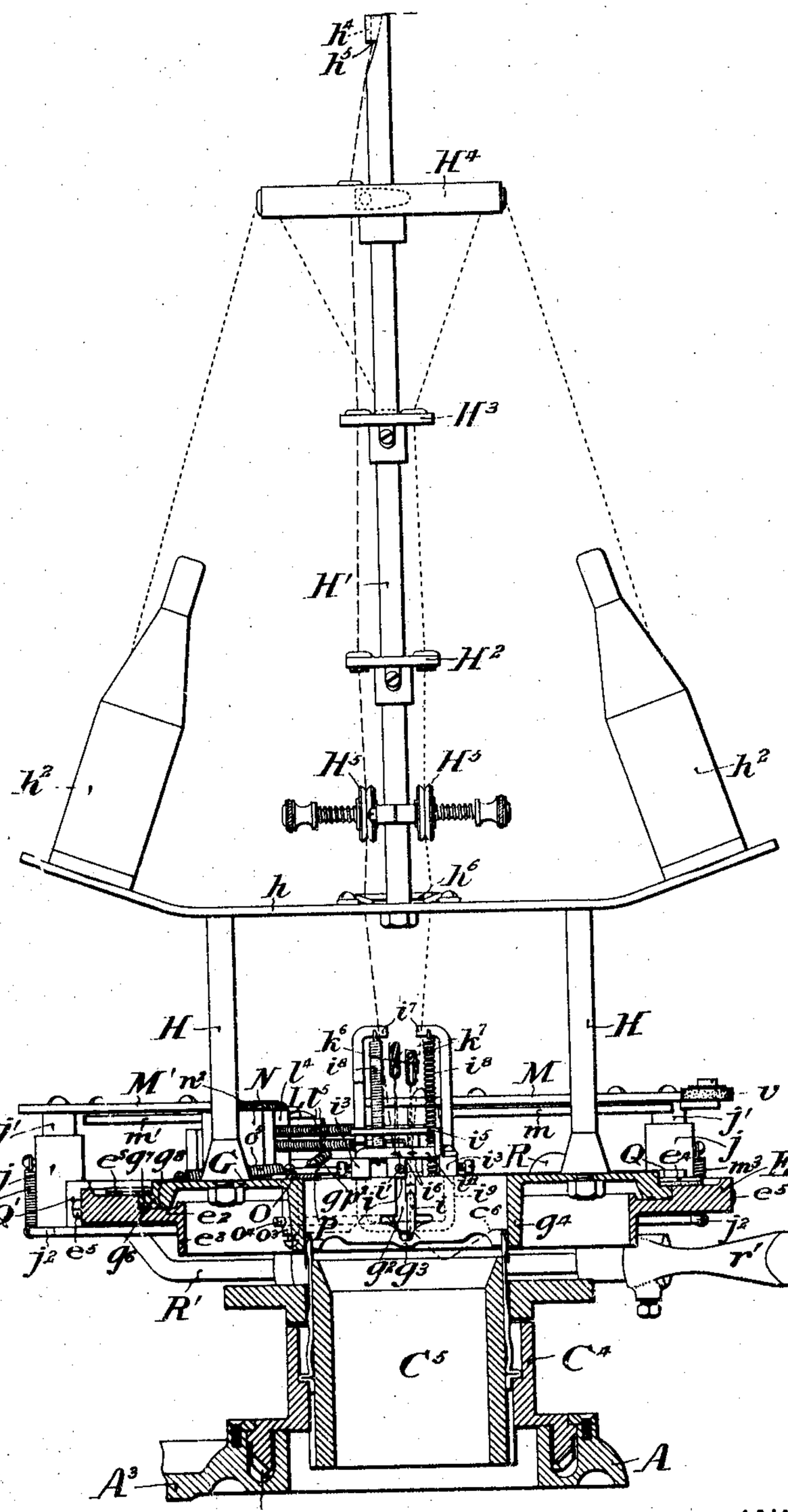
THREAD CHANGING MECHANISM FOR CIRCULAR KNITTING MACHINES.

APPLICATION FILED SEPT. 12, 1901.

NO MODEL. 4 SHEETS—SHEET 4.

FIG. 4.



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No. 768,279. Patented August 23, 1904.

UNITED STATES PATENT OFFICE.

EMIL A. HIRNER, OF ALLENTOWN, PENNSYLVANIA.

THREAD-CHANGING MECHANISM FOR CIRCULAR-KNITTING MACHINES.

SPECIFICATION forming part of Letters Patent No. 768,279, dated August 23, 1904.

Application filed September 12, 1901. Serial No. 75,149. (No model.)

To all whom it may concern:

Be it known that I, EMIL A. HIRNER, a citizen of the United States, residing at Allentown, in the county of Lehigh and State of Pennsylvania, have invented certain new and useful Improvements in Thread-Changing Mechanism for Circular-Knitting Machines, of which the following is a specification, reference being had to the accompanying drawings.

My invention has relation to thread-changing mechanism for circular-knitting machines whereby at predetermined intervals a new thread is fed into the needles and the old thread removed therefrom. Such mechanism is useful where it is desired to knit different parts of a tubular fabric, such as a stocking, from threads of different color, weight, or material. For example, such changes may occur during the knitting of a tubular fabric at intervals separated by several courses of knitting, thereby producing horizontal stripes upon the fabric, or in the manufacture of a stocking the changes may occur at the point of transition from the knitting of the leg or foot to the knitting of the heel or toe pockets in order that the pockets may differ in color or material from the rest of the stocking. The machine which I am about to describe is capable of effecting such change, or the change of thread may occur at a plurality of shorter intervals during each course of knitting, and by the similar repetition of such short interval changes for a number of successive courses longitudinal stripes or patterns may be produced, as has been described by me in an application filed by me April 23, 1901, Serial No. 57,041. The machine which I am about to describe is capable by increasing the number of the thread-changing cams of manufacturing such longitudinally-striped stockings.

In an application filed by me in the Patent Office April 15, 1901, Serial No. 55,904, I have described a split-foot stocking, of which the upper portion of the foot is knit from threads of one color and the lower portion from threads of another color, the changes being effected in similar succession twice for each course of the foot, first on one side and then on the other. The machine which I am about to describe is designed to manufacture such a split-foot stocking.

Without further multiplying instances it will be understood that the machine can be adapted to perform the operation of changing the knitting-thread wherever and however it may be desired to do so in the course of knitting either a tubular fabric or stocking.

I have shown in the drawings and will proceed to describe a particular and typical embodiment of my invention in a knitting-machine adapted for the manufacture of the split-foot stocking described in application Serial No. 55,904, to which I have referred, premising, however, that this is only one of many different products to the manufacture of which my invention is capable of being applied.

In the accompanying drawings, Figure 1 is a front elevation of the knitting-machine above referred to, the bobbin-carrier being cut off. Fig. 2 is a side elevation of the same with the parts underlying the bed-plate and the bobbin-carrier removed. Fig. 3 is a plan of the swinging table which overlies the knitting-cylinders, with the bobbin-carrier removed. Fig. 4 is a vertical central section of the machine on a reduced scale. Fig. 5 is a reduced elevation, seen from the rear, of sleeve A^{12}.

A is the bed-plate which carries the knitting-cylinders. It is of a circular outline, with a left-hand wing-plate A′, a right-hand wing-plate A^2, and the rearwardly-projecting ledge A^3, through which it may be supported. On top of wing-plate A^2 is an upright standard A^{11}. Wing-plate A′ carries centrally a large sleeve A^{12}, which passes through it, projecting both above and below it.

The main shaft C of the machine runs transversely beneath the wing-plate A^2. The left-hand extremity of this shaft carries the vertical beveled gear-wheel C^2, which meshes with a corresponding horizontal circular rack C^3, which constitutes a flange on the lower edge of the cam-cylinder C^4, which rotates centrally within bed-plate A. The corresponding needle-cylinder C^5 is sustained fixedly within the cam-cylinder. It will be understood that shaft C may have fitted to it suitable mechanism, automatic or otherwise,

for controlling the proper succession of the periods of rotation and periods of reciprocation, as usual in stocking-knitters.

Thus far the parts described are those common to all circular stocking-knitters.

The comprehension of the special mechanism of my invention will be facilitated by dividing its description into sections, as follows:

I. The swinging table and its rotating plate.

II. The thread-changing mechanism mounted on the rotating plate, comprising (*a*) the bobbin-carrier and the take-ups, (*b*) the thread-changers, (*c*) the control-levers which impart motion to the thread-changers, and (*d*) the automatic gate.

III. The cam-plates which actuate the levers.

I. The Swinging Table and its Rotating Plate.

Within sleeve A^{12} fits a rotating and sliding rod D, having a screw-thread formed upon its lower portion, which, however, operates not as a screw but as a rack. A second sleeve D′ surrounds sleeve A^{12} near its lower end and carries within it a vertical pinion d', which reaches through a slot in the side of sleeve A^{12} and engages the threaded portion of the rod D as a rack. When rotated by hand-lever d^3, it moves rod D up and down, the screw-thread allowing a coincident rotary movement. The upper end of rod D, which projects above the sleeve A^{12}, is expanded into an irregular horizontal head D^2.

D^3 is a vertical guide-rod set at its lower end in sleeve A^{12}. The head D^2 contains a circular aperture d^4, corresponding to and fitting around the guide-rod D^3, which thereby maintains rod D from rotating within the sleeve until the head has been raised far enough to clear the upper end of the guide-rod, after which it is free to swing in either direction upon the rod D as a pivot.

An annular table E is made fast at one side to the head D^2. This table, directly opposite the head D^2, carries a downwardly-projecting centering-pin E′, which, as the table is lowered in place, enters and rests within the hollow upper end of standard A^{11}. By rotating lever d^3 the parts described enable the operator to raise the swinging table until the aperture d^4 leaves the guide-rod D^3, in which position, the centering-pin having also cleared the standard A^{11}, the whole table is free to swing to one side or the other, giving the operator access to the knitting-cylinders which are beneath the table when it is in its central or operative position. The annular swinging table E has its central portion entirely removed, the circular aperture thus formed being finished off with a depending flange e^3, around the upper edge of which runs a circular groove e^2, within which is supported concentrically to the table an annular rotating plate G, upon which the thread-changing mechanism is mounted. The rotating plate G is similarly provided with a depending peripheral flange g^6, which fits with great accuracy in the annular groove e^2. To further insure ease and accuracy of rotation of the plate within the table, flange g^6 has the outer part of its opposing surface beveled off at g^7 and is also provided with an oiling-groove g^8, thereby reducing the grinding-surfaces to a minimum. The plate G is held to its place in the table by the overlapping heads of the pins e^4, protected by the washers e^6, each having its positon fixed by a set-screw e^5.

One side of the cam-cylinder C^4 carries a bracket C^9, which supports a vertical sleeve C^{10}, within which plays a vertical pin c^4. A spiral spring c^3 surrounds the pin within the sleeve, abutting against a shoulder of the pin, thereby tending to thrust it up as far as the extended head at its lower end will permit. When thus thrust up, the upper end of this pin engages a circular aperture g^5 of the rotating plate. By reason of this engagement (which, no matter what may be the position of the plate when the swinging table is adjusted in place, must take place in the course of the first rotation of the plate) coincident rotation of plate G with cam-cylinder C^4 is insured.

Rotating plate G has a central circular aperture g slightly larger than the needle-cylinder and is fitted with an internally-depending flange g^4, which, as will be seen in Fig. 4, immediately surrounds the heads of the needles in the needle-cylinder and is therefore capable of performing the function of a latch-guard. Plate G also contains a second aperture g' to one side of the central aperture. Where the central aperture g and the second aperture g' are contiguous, they open into each other, and the flange g^4 is partially cut away at this point, forming a vertical slot g^2, which reaches almost, but not quite, to the bottom of the flange. At the bottom of this slot the flange is left intact and forms the thread-carrier g^3 of the knitting-machine. (See Fig. 4.) In the same figure the dotted line e^6 represents the position of the tops of the needles as they respond to the influence of the knitting-cams, thereby showing the constant relation which always exists between the thread-carrier g^3 and the line of the top of the needles, as both the knitting-cams and the rotating plate revolve simultaneously.

Reference is here made to my copending application for improvements in thread-changing mechanism for circular-knitting machines, filed December 20, 1900, Serial No. 40,483, for a more full description of certain parts of the swinging table and its rotating plate, which I have just described.

II. The Thread-Changing Mechanism Mounted on the Rotating Plate.

(*a*) *The bobbin-carrier and the take-ups.*—

Two upright standards H H, made fast to plate G, sustain a cross-piece h. The extremities of this cross-piece are bent slightly upward, and each carries a bobbin h^2. From the middle of the cross-piece h, directly over the axis of the machine, rises a single upright standard H'. This standard carries three horizontal thread-guiding disks H^2 H^3 H^4 and also the adjustable tension-disks H^5 H^5. The thread from one of the bobbins h^2 is passed successively through thread-guiding apertures in the disks H^4 H^3 H^2, between one of the tension-disks H^5, and through an eye in the thread-guiding wire h^6. The thread from the other bobbin h^2 passes through similar thread-guiding apertures; but being used only as a reinforcing-thread it does not pass between the tension-disks. In addition to the bobbins thus carried upon the rotating plate I mount an additional bobbin (not shown) on any suitable adjacent support and lead the thread therefrom through a central aperture h^4 at the top of the standard H', through which it descends and passes out to one side at h^5, whence it is led successively through appropriate apertures in the disks H^4 H^3 H^2, as are the other threads. On the side of the aperture g opposite from the aperture g' is mounted an upright post k, carrying a horizontal arm k^3, upon the extremities of which are milled tension-screws forming attachments in which are set the coiled tension-springs k^5, which after spirally incasing part of the arm-spring over the aperture g form the take-ups k^6, which are parallel with each other and terminate in vertical elongated eyes k^7. A horizontal stop-wire i^5 bridges over the top of the slot g^2 and limits the descent of the take-ups.

(*b*) *The thread-changers.*—Over the aperture g' are mounted two pivoted thread-changers i i. They are of equal length, and each consists of a lever pivoted near one end and pierced at its swinging end with a thread-eye i'. Their pivoted ends are squared, so as to insure the more accurate parallelism of their motion as they swing vertically upon their common pivot i^2. This pivot is mounted between two parallel bars i^3, which bridge the aperture g'. When these parallel thread-changers are in their horizontal position, their swinging ends carrying the thread-eyes are over that part of the aperture g' which is nearest to the aperture g and are consequently in close proximity to the vertical slot g^2, in the line of which the movement occurs. When the swinging end of either of the thread-changers is depressed, it is contiguous with the thread-carrier g^3 at the bottom of the slot g^2.

The bars i^3 carry between them three parallel yokes—a depending wire yoke i^9, the cross-piece of which limits the downward movement of the thread-changers, a second yoke i^{11}, which bridges the bars about midway between the two extremities of the thread-changers and is pierced by thread-guiding apertures i^6, and a third yoke i^7, which rises considerably above the bars and serves as the point of support for coiled springs i^8, the lower ends of which are attached to the squared portions of each of the thread-changers, which by their tension are always maintained in uppermost position except as they are depressed against the action of the springs by the controlling-levers, which are about to be described. Yoke i^7 may, as shown, be cut away in the middle for better access to the levers.

The thread from each of the bobbins after passing through the thread-guiding wire h^6 proceeds, as may be seen in Fig. 1, through one of the thread-eyes i^6, thence to the elongated eye k^7 of the take-up, and thence through the thread-eye i' at the end of one of the thread-changers. Consequently when a thread-changer is depressed its thread is laid in the thread-carrier g^3.

(*c*) *The control-levers.*—The upright post L, set in plate G in proximity to the aperture g', has pivoted upon it two horizontal levers l l, one above the other. Each of these levers has three arms—a long arm l', a cam-arm l^2, and a short arm l^3. An upright post l^4, set in plate G, serves as a stop for these levers in one direction. Their motion in the opposite direction is opposed by springs l^5, one for each lever, which find their support in an upright post set at the extended end of the nearer one of the bars i^3. These levers are of similar shape, except their short arms l^3, of which that of the uppermost lever is longer than that of the other, the extremities of these arms thus corresponding in position to the pivoted ends of the two thread-changers and each thread-changer having the extremity of one of the arms l^3 playing over its pivot. In the extremity of each of these arms l^3 is set a depending post l^6, terminating in a shoe l^7. The length of the post is in each case such that its shoe reaches to the top of the squared end of the thread-changer to which it corresponds. The position of the levers l is such that their motion within the limits about to be described causes the shoe of their short arm to ride over the top of the corresponding thread-changers from a point over the pivot to a point considerably in front of it, so that when either arm l^3 is in its outermost position its thread-changer is raised by the tension of spring i^8 to its horizontal position, while when the same arm is in its innermost position its thread-changer is depressed by the pressure of the shoe against the top of a pivoted incline i^{10}, formed on top of the squared end of the thread-changer sufficiently to lay the thread which it holds into the thread-carrier.

The direct control of the motion of these thread-controlling levers is obtained by means of cam-plates, to be hereinafter described, which project into the path of their cam-arms l^2 as the plate G rotates. It is also necessary to prevent the displacement, accidental or otherwise, of one of these control-levers, whereby the changers might be thrown up prior to the throwing down of the other one, which it is obvious should never occur. This is effected by the trigger-plate N, which is pivoted to plate G on the upright post n. This trigger-plate is held normally in the position of the drawings under the tension of a spring n^2, attached to the post l^4. Its tripping extremity is blunt at the end and furnished with a beveled surface at the side, which comes in contact with the long arms of the levers and is so related in position to them that when either of them is moved by the action of the cam-plates in the direction to depress its thread-changer the long arm l' as it moves outwardly rides against the beveled surface of the trigger and pushes it in opposition to the spring n^2 until its blunt end is clear from contact with the long arm l' of the other thread-controlling lever, whereupon, and not before, this other thread-controlling lever is free to move in the opposite direction under the tension of its spring and remove its thread from action.

(*d*) *The automatic gate.*—A flat lever O is pivoted on top of plate G by a pivot o. On top of one extremity is set a handle o' and on top of the other a stop-pin o^2. From the lower side of this latter extremity depends a post o^3, which passes down through a slot cut in plate G. The lower end of this post carries a horizontal wire gate o^4, which by the motion of lever O is thrown either toward or away from slot g^2. When this gate is in its forward position, it not only serves to retain in place whichever thread-changer has been depressed, but maintains the complete efficacy of the flange g^4 as a latch-guard, which otherwise would be interrupted by the break in its continuity occasioned by the slot g^2. When the lever O is swung back, the gate is removed from its position over the thread-changers. The gate is normally held thus open by the tension of a coiled spring o^5; but when manually thrown the other way stop-pin o^2 engages with a notch p, cut in one extremity of a bell-crank lever P. When this engagement occurs, upon closing the gate the movement of the bell-crank lever P under the tension of the coiled spring p^2 maintains it, keeping the gate closed until bell-crank lever P is positively thrown in the other direction against the action of this spring, whereby the gate is released. This occurs when the upright post p^3, set in its other extremity, comes in contact with the cam-plates which are now to be described.

III. *The Cam-Plates which Actuate the Levers.*

At intervals around the periphery of the swinging table E are affixed three supporting-blocks Q Q′ Q², their attachment being effected by screws passing through horizontal slots q, by which their circumferential position with reference to the table may be adjusted with accuracy. Near their extremities these blocks are enlarged to form vertical bosses j. Passing vertically through each of these bosses are reciprocating posts j'. The lower ends of the posts of each plate are united by a horizontal base-plate j^2. The upper ends of the posts, mounted in supporting-block Q, are united by the horizontal cam-plate M, those of the supporting-block Q′ by the horizontal cam-plate M′, those of the supporting-block Q² by the horizontal plate m^2. In each instance these cam-plates have united to them a fellow horizontal plate supported in close proximity, but in a different horizontal plane. Thus immediately below cam-plate M is its fellow cam-plate m, immediately below cam-plate M′ is its fellow m', and immediately above cam-plate m^2 is its fellow M².

As shown in the drawings, all three pairs of cam-plates are in their uppermost position, being held in this position under the tension of coiled springs m^3, which extend from their points of attachment on the bosses to the base-plate, lifting it into contact with the lower side of the supporting-block Q Q′ Q². In each case means are provided whereby the pair may be manually thrown to the lower position. Thus attached to supporting-block Q is an eccentric disk R, with a lever-arm r, which by its semirotation depresses base-plate j^2, thereby lowering cam-plates M m and holding them in their lower position until the lever is again thrown in the opposite direction. Similarly, the position of cam-plates M² m^2 is controlled by a disk R². The means for controlling the position of cam-plates M′ and m' are somewhat different, consisting of a rock-shaft R′, which is journaled beneath the table E. One extremity of this rock-shaft is turned over to form a hook, which engages with the base-plate j^2. The other extremity, which is near the front of the machine, is fitted with a hand-lever r'. The tension of the spring m^3 normally maintains cam-plates M′ m' in their upper positions, except when manual pressure upon the hand-lever r' causes their depression, and they immediately rise again whenever the pressure upon the lever is removed.

The two plates of each of these three sets are separated from each other by a distance equaling the vertical distance between the control-levers. When a set is in its uppermost position, both plates are wholly inefficient, being entirely out of reach of the con-

trol-levers as they rotate with the rotating plate G; but when in its lowermost position its upper and lower plates are brought into the horizontal planes, respectively, of the upper and lower control-levers, and the cam-surfaces of each of the cams are such as to come within the reach of the cam-arms l^2 l^2 of the control-levers. Thus when cam-plate M, with its fellow m, are depressed by the semirotation of lever-arm r the cam-surface of plate M is in position to control the motion of the upper control-lever l and the cam-surface of its fellow plate m to operate the lower of the control-levers l, and similarly the other two sets of plates when depressed become operative to effect the motion of the control-levers as the plate G rotates.

By referring to Fig. 3 the contour of the cam-surfaces on the inner sides of these plates may be traced. They are arranged so that while one plate of each pair is operating to set the control-lever which comes into contact with it its fellow plate is operating to effect the release of the other control-lever. Thus prior to reaching plates M and m the control-levers are in the reverse position from that shown in Fig. 3—*i. e.*, the top one is released and the bottom one set. As the top lever passes along the cam-surface of plate M it is set, its position being under the control of the cam-surface during its entire length, although the incline which actually does the work of depressing the thread-changer so as to throw the thread into action is the more marked incline, which occurs near the middle of the surface. It is by means of the accurate adjustment of the position of this incline by the screws passing through the slots q that the change of thread is caused to occur between any two needles of the needle-cylinder, as desired. While the top lever is thus being set, the bottom lever is under the control of the cam-surface of plate m and is by it simultaneously released and its thread thrown out of action. Its first action is to raise the long arm slightly from the end of the trigger, and then while the trigger is pushed out of the way by the long arm of the other lever it is gently released and returned to the position of the drawings. The motion is thus accomplished gradually and without shock. Ordinarily in a change-thread mechanism it is desired that the old thread shall be thrown out two, three, or four needles after the new thread is thrown in. By this mechanism I am able to accomplish this with entire certainty, each change occupying the same number of needles.

The operation of cam-plates M′ and m' is identical and that of cam-plates m^2 M^2 is the reverse, setting the lower control-lever and releasing the upper one.

I have found that if after throwing in a new thread by the depression of a thread-changing lever the removal of the old thread is left to the automatic action of another lever under the control of a spring there may be occasional irregularities in the interval by which the one change succeeds the other, owing doubtless to the speed of the rotation of the machine and other factors but by placing both control-levers under the positive actuation of cam-surfaces during their respective changes this uncertainty is avoided, and it is possible to compel any given change to both begin and end between the same needles at every rotation of the machine.

v v are oiling-disks attached a short distance in advance of supporting-plates Q Q^2, which as the plate G rotates come into contact with the cam-arms of the control-levers immediately prior to their coming under the influence of the cam-surfaces of the cam-plates, thereby rendering the interaction of these parts more easy.

It will further be observed that if prior to the depression of any one of the sets of cam-plates the automatic gate o^4 is closed the first rotation of plate G brings upright post p^3 on the projecting extremity of bell-crank lever P into contact with the cam-surfaces which have been depressed, thus tripping lever O and automatically opening the gate, which action, owing to the relative position of the bell-crank lever P and the control-levers, must precede any action of the control-levers, whereby the opening of the gate is insured prior to any motion of the control-levers.

Having thus described the mechanism of my invention, I will now explain its method of operation in the particular machine which I have shown, which, as explained, is arranged for the purpose of knitting a split-foot stocking. Let it be supposed that it is desired to knit a stocking of which the leg portion shall be black with the heel and toe pockets white and with the foot split, so that its upper half or instep is black and its lower half or sole is white, this being an arrangement of colors which is usual and desirable. For this purpose the black thread will be fed from the bobbin which has been referred to as mounted exteriorly of the knitting-cylinder and will pass down through the central aperture h^4 on top of the standard H′ and descend thence to the thread-eye of that one of the thread-changers which is under the control of the lowermost of the two control-levers of the machine. The white thread will be fed from the bobbins h^2 and from one of them will be led to the other thread-changer—that is to say, the one which, as shown in the drawings, is depressed. The other white thread is merely used for the purpose of reinforcing the heel and toe pockets, if desired, and no further reference to it need be made. During the knitting of the leg from the black thread the thread-changing lever containing that thread

will be depressed and the automatic gate closed, holding it firmly in position, while the entire leg is knit by ordinary round-and-round knitting. Upon the completion of the leg rotation of the machine will stop and give place to reciprocation. Simultaneously with this change hand-lever r' will be depressed by hand long enough to hold down cam-plates M' m' during the first complete reciprocation, and by the cam-surface of the uppermost of these plates M' the uppermost control-lever, which during the knitting of the leg has had its cam-arm in its projected position, will be returned to its alternative position, the converse motion of the lowermost control-lever being simultaneously effected by the cam-surface of the cam-plate m'. Thereupon reciprocation proceeds and the heel-pocket is knit with the white thread. Under some circumstances it is desirable that the change from the black to the white thread shall not take place simultaneously with the commencement of the knitting of the heel-pocket, but farther down the back of the heel. In this case hand-lever r' is not depressed at the commencement of the reciprocation, but after the desired number of courses have been knit with the black thread.

After the knitting of the heel is completed reciprocation gives way to rotation for the purpose of knitting the foot. At the commencement of this operation both levers r r^2 are turned, thus depressing cam-plates M m and M^2 m^2. As rotation proceeds with these cam-plates depressed into action the alternation of the position of the control-levers is by them effected twice for each rotation of the machine—that is to say, during each rotation when the control-levers come into position to be operated upon by cam-plates M^2 m^2 the lower control-lever is thrown against the operation of its tension-spring by the cam-surface of plate m^2, so as to depress the thread-changer carrying the black thread, while immediately succeeding this motion (by preferably the space of two needles) the white thread is thrown out of operation by the raising of the thread-changer carrying it. Thereupon the top of the first course of the foot is knit with the black thread; but as soon as in the course of this first rotation the control-levers come within reach of the cam-plates M m the levers are again changed, so that the bottom of this course is knit with the white thread. Similar changes are similarly effected twice for each rotation during the formation of the entire foot, so that the instep is knit with the black thread and the sole with the white thread. Upon the completion of the foot both sets of cam-plates M m M^2 m^2, which have been depressed, are raised and reciprocation of the machine with the white thread proceeds during the knitting of the toe-pocket. Thereupon the change from white to black thread is effected by momentarily lowering cam-plates M^2 m^2 during a single rotation. Thereupon the machine is ready to knit the leg of another stocking and the operation begins to repeat itself.

The variations of the mechanism which I have shown are obviously very great. Thus, although the cam-surfaces of each of the sets of cam-plates are shown as arranged to cause the throwing out of the old thread to occur a space of only two needles after the throwing in of the new by simply altering the relative position of the inclines, the number of needles during which the threads are caused to overlap may be increased as desired. Likewise, although I have shown but three sets of plates, it is obvious that the number may be increased according to the number of changes which it is desired to make during each rotation of the machine, thereby a stocking or part of a stocking having longitudinal stripes may be produced.

Having thus described my invention, I claim—

1. In a knitting-machine, the combination of the knitting-cylinder; a plurality of thread-changing levers; a latch-guard surrounding the heads of the needles; a slot or break in the continuity of the thread-guard through which the thread-changers perform their functions; and a movable gate independent of the thread-changers by the closing of which the continuity of the latch-guard may be established, substantially as described.

2. In a knitting-machine, the combination of the knitting-cylinders; an annular rotating plate supported above the knitting-cylinders and concentrically therewith, said annular plate being furnished interiorly with a depending flange which reaches down to and surrounds the heads of the needles; a vertical slot cut from the top of this flange to near its bottom; a second opening in the rotating plate alongside of said slot; a plurality of pivoted levers swinging vertically in the latter opening with the movable ends adjacent to and in line with the slot; means for controlling the raising and depressing of said levers; a yoke bridging the second aperture; springs supported by the cross-piece of this yoke and having their lower ends attached to the thread-changers by the tension of which the latter are drawn to their uppermost position, in combination with mechanism whereby a positive motion of depression may be given to any one of the levers, substantially as described.

3. In a circular-knitting machine the combination of the knitting-cylinders; a plurality of thread-changing levers rotating synchronously with the cam-cylinder; actuating projections associated one with each thread-changing lever and all in different horizontal planes; and cam-plates in vertical sets, mounted at different points around the cylinders; each set comprising a plurality of cam-surfaces one in control of each thread-changing lever, substantially as described.

4. In a circular-knitting machine the com-

bination of the knitting-cylinders; a plurality of thread-changing levers rotating synchronously with the cam-cylinder; actuating projections associated one with each thread-changing lever and all in different horizontal planes; cam-plates in vertical sets, mounted at different points around the cylinders; each set comprising a plurality of cam-surfaces one in control of each thread-changing lever; and means for throwing each entire set into or out of operative position, substantially as described.

5. In a circular-knitting machine the combination of the knitting-cylinders; a plurality of thread-changing levers rotating synchronously with the cam-cylinder; a similar plurality of control-levers one for each thread-changing lever and each in a different horizontal plane; and a similar plurality of cam-plates in corresponding horizontal planes and in such relation to each other that the positive control of all of the thread-changing levers is simultaneously effected, substantially as described.

6. In a circular-knitting machine the combination of the knitting-cylinders; a plurality of thread-changing levers rotating synchronously with the cam-cylinder; actuating projections associated one with each thread-changing lever, all said projections being mounted one over the other in different horizontal planes; and a set of cam-plates also mounted one over the other in corresponding horizontal planes which at a certain point in each rotation of the cylinder positively control each of the thread-changing levers, substantially as described.

7. In a circular-knitting machine, the combination of a pair of thread-changing levers revolving in fixed relation to the cam-cylinder; means for actuating each of said thread-changing levers each in different horizontal planes; and two or more pairs of cam-plates situate on different sides of the machine, the plates of each pair being in the horizontal planes mentioned, the cam-surfaces of each pair being adjusted so as to compel the action of the thread-changers in the proper sequence as often during each rotation of the machine as there are pairs of cam-plates, substantially as described.

8. In a knitting-machine, the combination of the knitting-cylinders; a plurality of thread-changing levers mounted on a common horizontal pivot; a similar plurality of control-levers mounted on a common vertical pivot, both sets of levers revolving simultaneously with the cam-cylinder; a similar plurality of horizontal cam-plates separated by distances corresponding to those between the control-levers and means for throwing said cam-plates into and out of range of the control-levers, substantially as described.

9. In a machine for knitting split-foot hosiery, the combination of a pair of thread-changing levers pivoted in fixed relation to the thread-carrier; a pair of control-levers one above the other, one controlling each thread-changer, likewise revolving with the thread-carrier; and two pairs of cam-plates, one on each side of the knitting-cylinder, the plates of each pair being in horizontal planes corresponding to those of the control-levers whereby each thread-changer is thrown into and out of action on opposite sides of the machine, during the rotation of the cam-cylinder, substantially as described.

10. In a knitting-machine, the combination of the knitting-cylinders; a plurality of thread-changing levers mounted on a common horizontal pivot; a similar plurality of control-levers mounted on a common vertical pivot, both sets of levers revolving simultaneously with the cam-cylinder; a trigger-plate by which the release of one control-lever is forbidden until the setting of another; a similar plurality of horizontal cam-plates separated by distances corresponding to those between the control-levers; and means for throwing said cam-plates into and out of the planes of the control-levers, substantially as described.

EMIL A. HIRNER.

Witnesses:
RANDOLPH SAILER,
JAMES H. BELL.