(No Model.)

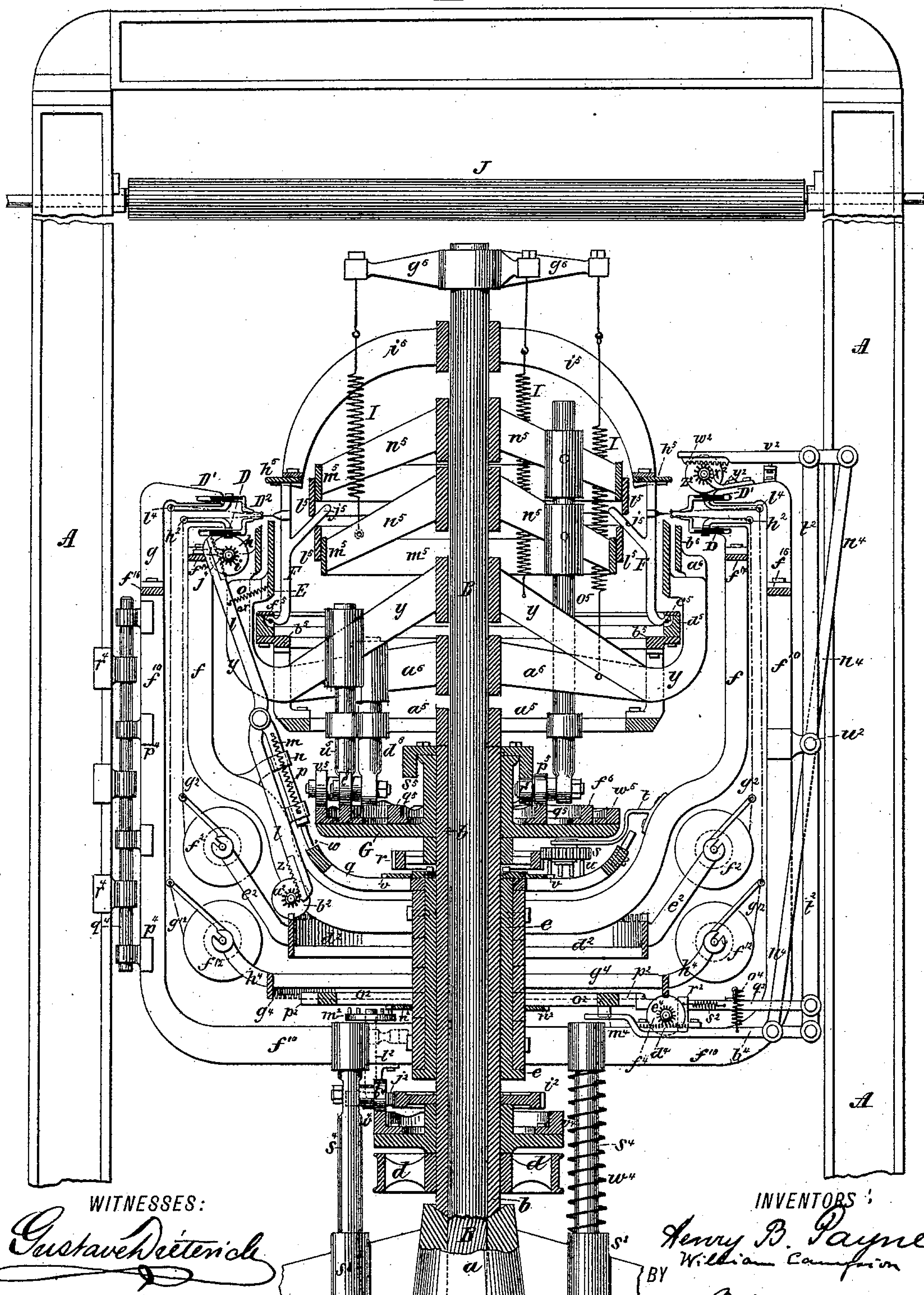
3 Sheets—Sheet 1.

H. B. PAYNE & W. CAMPION.

CIRCULAR WARP KNITTING MACHINE.

No. 397,142. Patented Feb. 5, 1889.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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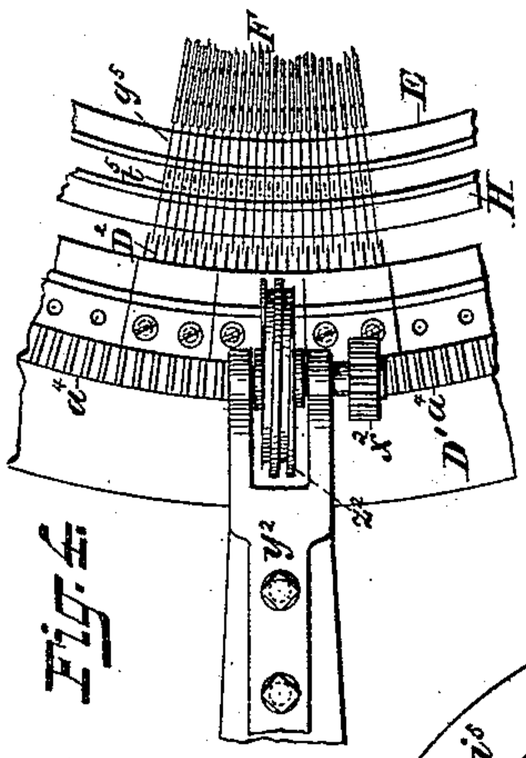

Fig. 4.

Fig. 2.

Fig. 5.

Fig. 6.

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(No Model.) 3 Sheets—Sheet 3.

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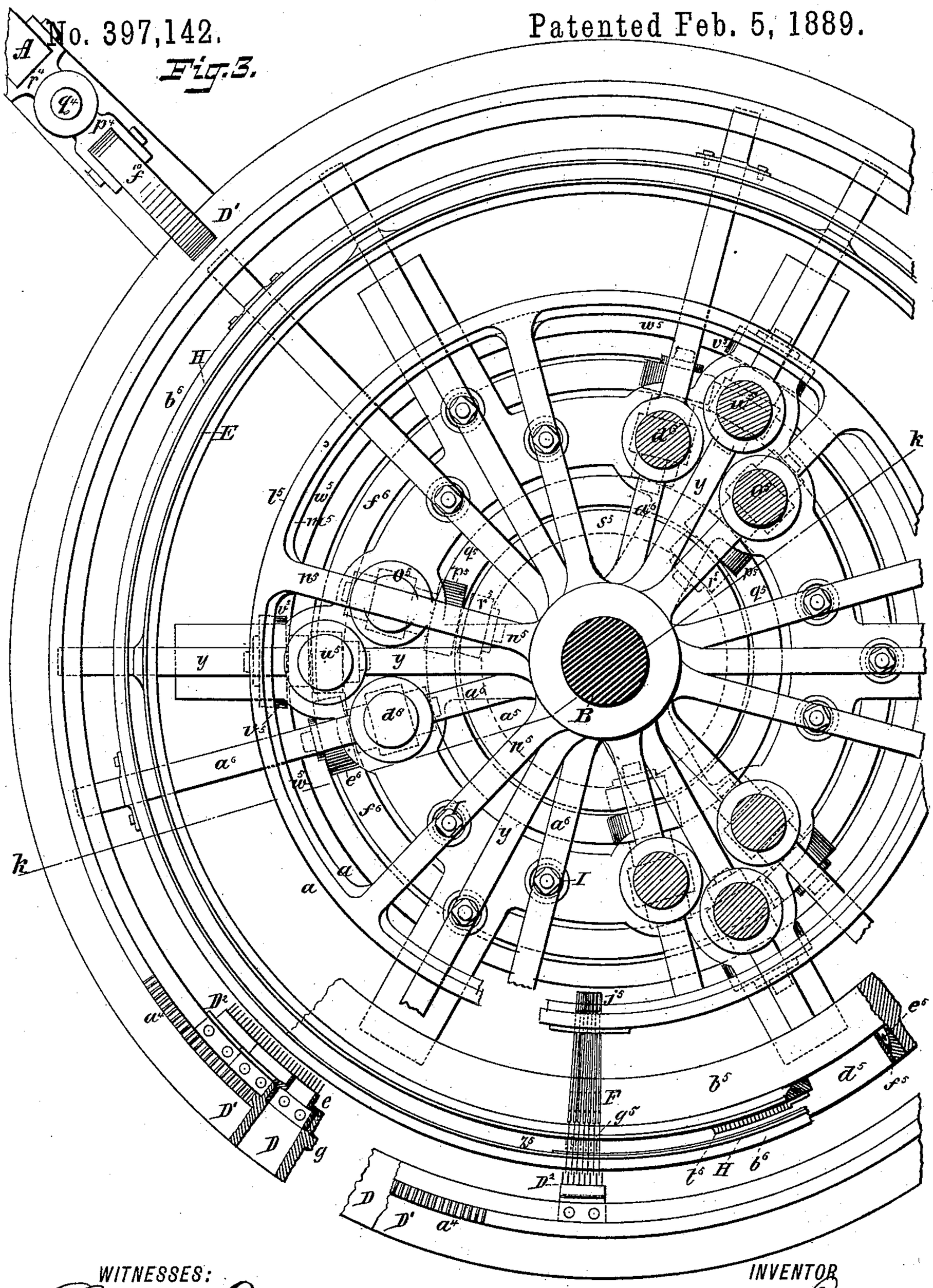
Fig. 3.



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UNITED STATES PATENT OFFICE.

HENRY BLACKFD. PAYNE AND WILLIAM CAMPION, OF NOTTINGHAM, ENGLAND; SAID CAMPION ASSIGNOR, BY MESNE ASSIGNMENTS, TO A. G. JENNINGS & SONS, OF BROOKLYN, NEW YORK.

CIRCULAR-WARP-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 397,142, dated February 5, 1889.

Application filed April 30, 1888. Serial No. 272,300. (No model.) Patented in England February 8, 1886, No. 1,834.

To all whom it may concern:

Be it known that we, HENRY BLACKFORD PAYNE and WILLIAM CAMPION, both of Nottingham, England, have invented certain new and useful Improvements in Circular-Warp-Knitting Machines, (for which we have obtained English Patent No. 1,834, dated February 8, 1886,) of which the following is a specification.

The object of our invention is to so improve circular-warp-knitting machines that they may be worked much faster than the ordinary straight traverse warp-machines.

The invention consists in the details of improvement and the combinations of parts, that will be more fully hereinafter set forth.

Reference is to be had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a central vertical cross-section of a knitting-machine embodying our invention. Fig. 2 is a similar view of the upper portion of the machine drawn on a larger scale. Fig. 3 is a partly-broken horizontal section on the plane of the line *c c*, Fig. 2, on an enlarged scale. Fig. 4 is a detail top view of part of the machine, and Figs. 5 and 6 are detail sectional views showing the guide-rings in different positions with relation to the needles.

In the accompanying drawings, the letter A represents the frame of our machine, which may be of suitable construction.

a is a block or step held on a base-plate or otherwise suitably supported in the frame A.

B is a vertical standard or shaft firmly secured in the block or step *a* or otherwise held in place.

b is a sleeve or tube that surrounds the lower part of the standard B and carries the main driving-pulley *d*, that receives a belt from suitable source for rotating said sleeve or tube. The said tube rests on a step, *a*, as shown.

e is a sleeve that fits loosely over the tube *b*, and is free to move thereon, and is supported as hereinafter shown. The sleeve *e* carries a series of radially and upwardly projecting arms or supports, *f* and f^{10}, whose upper ends extend inwardly, as shown. The supports *f* and f^{10} are held in position or braced near their upper ends by rings f^{14} f^{16}, that are secured to said supports and surround the machine, as shown in Fig. 1. Part of these arms, *f*, we term "inner" and part, f^{10}, "outer" supports. The forked ends of the inner supports straddle the outer circumference of and carry the lower guide-ring, D, and the outer supports, f^{10}, straddle the outer circumference of and carry the upper guide-ring, D′. Each of these guide-rings carries on its inner circumference a series of thread-guides, D^2. These guide-rings D and D′ are supported in the arms *f* and f^{10}, respectively, and are capable of revolving or turning in said supports and to move up and down with them. They receive their rotary or oscillatory motion as follows: The lower guide-ring, D, carries on its under side an annular rack, *g*, that meshes with a worm, *h*, journaled on one of the inner supports, *f*. The axle of the worm *h* carries a pinion, *i*, that gears with a rack, *j*, on an upwardly-extending lever, *l*. The lever *l* is pivoted to a rod, *m*, that slides in bearings *n*, carried by the inner support, *f*. The rack *j* is held in gear with the pinion *i* by means of a spring, *o*, that is secured at one end to the lever *l* and at its other end to the sinker-ring E, hereinafter described, or by other means. The rod *m* is drawn downward and pressed upon a pattern-wheel, *q*, by a spring, *p*, that is secured at one end to the rod *m* and at its other end to a bearing, *n*, or by other means. The circumference of the pattern-wheel *q* has projecting studs or protuberances *w*. The wheel *q* is placed around the sleeve *e*, and is free to turn thereon.

The pattern-wheel *q* receives rotary motion as follows: *r* is a gear-wheel fixed to the sleeve *b*, and which gears with a pinion, *s*, journaled on an arm, *t*, that is carried by an inner arm or support, *f*. The pinion *s* carries a number of pins, *u*, that engage a toothed wheel, *v*, which is fastened to the pattern-wheel *q*. As the gear-wheel *r* rotates with the sleeve *b*, the pattern-wheel *q*, through the pinion *s*, pins *u*, and wheel *v*, will be rotated. The studs *w* on the pattern-wheel *q* thereby act with the spring *p* to raise and lower the rod *m*, and with the same the lever *l* and rack *j*, thereby

turning the worm h and advancing the lower guide-ring, D, in the desired direction. The rack j is moved out of gear with the pinion i when desired, so as not to actuate the guide-ring D during one movement of the rack j, by means of a pin, x, on an arm, y, of a series that support the sinker-ring E, which arms receive up-and-down motion, as hereinafter shown. As said arm y descends the pin x strikes the lever l and moves it outward, thereby disengaging the rack j and pinion i. As the arm y rises and removes the pin x from the lever l the rack j is drawn into engagement with the pinion i by the spring o, so that the pinion may again be turned by the next longitudinal movement of said lever.

Instead of securing the pin x to an arm, y, it may be attached to any other appropriate vertically-reciprocating part of the machine.

At or near the lower end of the lever l is a rack, z, that gears with a pinion, a^2, journaled on an inner support, f. On the axle of the pinion a^2 is secured a worm, b^2, that gears with a toothed wheel, d^2, which is hung loosely on the sleeve e, its boss resting on the boss of the wheel g^4 below it. The wheel d^2 carries on suitable projecting arms, e^2, bobbins or other warp-beams, f^2, the threads g^2 from which pass upward and over a rod, h^2, suitably supported by the lower guide-ring, D, to the guides D^2 on the guide-ring D. As the lever l and rack z are reciprocated by the pattern-wheel q and spring p, the wheel d^2, carrying the threads g^2, will be turned in unison with the lower guide-ring, D, the rack z being thrown in and out of gear with the pinion a^2 in manner similar and at the same time to that described with reference to rack j and pinion i.

The upper guide-ring, D′, is rotated or oscillated substantially in the manner shown with reference to the lower ring, D, but, on account of its position, with a few slight changes in detail. The following is the manner of rotating said upper guide-ring, D′: Upon the sleeve b is secured a gear-wheel, i^2, that gears with a pinion, j^2, on a shaft, l^2, journaled in bearings in an outer support, f^{10}. The shaft l^2 carries a pin-wheel, m^2, the pins of which mesh with a toothed wheel, n^2, secured to a stud or pattern-wheel o^2, that is loosely hung on the sleeve e, its boss resting on the boss of the support f^{10} below it. The studs p^2 of the pattern-wheel o^2 engage a rod, q^2, that slides in bearings r^2, carried by the outer support, f^{10}. This rod q^2 is drawn inward and held against the pattern-wheel o^2 by a spring, s^2, that is secured at one end to the rod q^2 and at its other end to a bearing, r^2, or otherwise. The outer or free end of the rod q^2 is jointed to a lever, t^2, that is pivoted at u^2 to the outer support, f^{10}. To the upper end of the lever t^2 is jointed a lever, v^2, that extends inward and carries a rack, w^2, that meshes with a pinion, x^2, journaled in an extension, y^2, of the outer support, f^{10}. (See Fig. 4.) On the shaft of the pinion x^2 is secured a worm, z^2, that gears with an annular rack, a^4, on the upper guide-ring, D′. The lower end of the lever t^2 is also jointed to a lever, b^4, that carries a rack, d^4, which engages with a pinion, e^4, journaled in the outer guide-ring support, f^{10}. On the same shaft with the pinion e^4 is a worm, f^4, that gears with a toothed wheel, g^4, hung loosely on the sleeve e, its boss resting on the boss of the wheel o^2 below it. The wheel g^4 carries in suitable arms, h^4, bobbins or warp-beams f^{12}, from which the threads g^{12} pass upward and over rods l^4, that are carried on the ring D′, and thence to the guides D^2 on the upper guide-ring, D′. As the rod q^2 is moved intermittently by the pattern-wheel o^2 and spring s^2, the lever v^2 and rack w^2, through the lever t^2, will be moved to turn the pinion x^2 and worm z^2 to advance the upper guide-ring, D′. As the lever t^2 is moved as above, it will also draw on the rod b^4 and rack d^4 to turn the worm f^4, and thereby rotate the wheel g^4, carrying the warp-threads g^{12}, in unison with the upper guide-ring, D′.

The racks w^2 and d^4 are moved out of gear with their respective pinions x^2 and e^4, so as not to turn the upper guide-ring, D′, and wheel g^4 on one stroke of said racks by means of adjustable pins or projections m^4, carried by the pattern-wheel o^2, that bear at intervals upon the inner end of the lever b^4 and depress said lever, thereby moving the rack d^4 out of gear with the pinion e^4. The lever b^4 is connected to the outer end of the lever v^2 by means of a rod, n^4, which is pivoted at its ends to said levers. As the lever b^4 is depressed by the pins m^4, the rack w^2 on the lever v^2 will be elevated and moved out of gear with the pinion x^2 by the rod n^4 drawing down the outer end of the lever v^2. The lever b^4 is raised to throw the rack d^4 and pinion e^4 into gear by a spring, o^4, secured at one end to the lever b^4 and at its other end to the rod q^2. As said lever b^4 is raised, the rack w^2 will be lowered through the action of the rod n^4 on the lever v^2. By the above construction, after the worms z^2 f^4 have been turned to move the upper guide-ring, D′, and wheel g^4 around in position to lap the threads on the needles, the racks w^2 d^4 can be thrown out of gear with their pinions and put in position to again move said guide-ring and wheel in the direction desired, and the motions are repeated; but the rack w^2 could remain in gear with its pinion x^2, and the combined actions of the pattern-wheel o^2 and spring s^2 through the levers q^2, t^2, and v^2 would reciprocate the rack w^2, and thereby move the upper guide-ring, D′, foward and backward similarly to that shown with reference to the lower guide-ring, D. Thus it will be seen that as the sleeve b rotates the guide-rings D D′ and their spool-wheels d^2 and g^4 are moved around the machine in the desired direction, or the guide-rings are moved backward and forward in position for lapping the needles.

All the parts supported by the outer sleeve,

e—that is, the pattern-wheels q o^2, the bobbin-wheels d^2 g^4, the supports f f^{10}, and the parts they carry—receive an up-and-down motion with said sleeve. One or more of the outer supports, f^{10}, carry eyes p^4, in which a rod, q^4, is secured. This rod q^4 passes freely through eyes r^4, carried by the frame A. By this means the supports f^{10} are guided in their up-and-down motion, and are also prevented from turning on the standard B.

The sleeve e and the parts it carries are supported and receive an up-and-down or reciprocating motion, as follows: Depending from the outer supports, f^{10}, are a number of rods, s^4, that are preferably guided at their lower ends in fixed sockets s^8. Certain of these pendent rods s^4 carry rollers t^4, that run upon the cam-surfaces of a wheel or disk, v^4, secured to the sleeve b. As said disk v^4 is rotated by the sleeve b, the cam-surfaces, acting on the rollers t^4, raise the supports f, sleeve e, and connected parts, the weight of the parts holding the rollers t^4 on the cam-wheel v^4. By this cam-wheel v^4 the sleeve e and the parts it carries are supported. Certain of the rods s^4 have springs w^4 coiled around them, which act to cushion the parts carried by the sleeve e.

From the foregoing description it will be seen that the guide-rings D D′ receive an up-and-down and a rotary or backward-and-forward motion, while their supports f^{10} merely receive an up-and-down motion, that the pattern-wheels receive an up-and-down motion in unison with that of the guide-rings, and also a rotary motion to impart rotary or backward-and-forward motion to the guide-rings, and that the bobbin-wheels d^2 g^4 receive an up-and-down motion in unison with the guide-rings D D′, and also a rotary or a backward-and-forward motion in unison with said guide-rings, so as to keep the threads in a straight line with the guides through which they pass.

Having shown how the guide-rings D D′ are operated, we will now show how the needles, presser-bar, and sinkers are operated. The standard B carries a number of outwardly and upwardly projecting arms, a^5, upon the upper ends of which arms is placed a ring, b^5. The arms a^5 may be in one piece or in separate pieces connected together. The ring b^5 carries a circular ledge or rim, d^5. In a recess in the rim d^5 is laid and suitably supported a continuous wire, e^5. Upon this wire e^5 the lower hooked ends of the needle-jacks F rest. These hooks are held upon the wire e^5 by a plate or plates, f^5, screwed on the rim d^5 and projecting over the ends of the hook ends of the jacks F, as shown clearly in Fig. 2. There may be any number of these jacks F desired placed around the machine in series. Each needle-jack F carries one, two, or more needles, g^5, that are cast in the jacks or secured thereto in other suitable manner. The upper ends of the needle-jacks F are held in position by means of a ring, h^5, that is carried by arms i^5, that project from the standard B. The under side of the ring h^5 is provided with radial grooves, in which the upper ends of the needle-jacks F rest, and by which said needle-jacks are guided. The needles g^5 receive an in-and-out or longitudinally-reciprocating motion, as follows: Each needle-jack F has a projecting inclined arm, j^5, that passes between blades or plates l^5, that are adjustably secured to circular rings m^5, carried by arms n^5, that project from the standard B, which arms slide freely on said standard. The blades l^5 are arranged above and below the arms j^5 and in contact therewith. To certain of the arms n^5 are secured pendent rods o^5, that are guided in the arms a^5, and that carry at their lower ends rollers p^5, that ride upon cam-surfaces q^5 on the upper face of a disk or wheel, G, that is secured to the sleeve b. The rods o^5 also carry rollers r^5, that bear upon counter-cams s^5, carried by said disk G. As said disk G rotates, the rods o^5, through the cams q^5 s^5, will be reciprocated, thereby raising and lowering the arms n^5 and blades l^5. As these blades l^5 are thus raised and lowered, they will, by acting on the inclined arms j^5, rock the needle-jacks F on their wire or pivot e^5, thereby moving the needles g^5 in and out toward and from the guide-rings D D′.

The needles g^5 pass through the sinkers t^5, that are secured to the circular sinker-ring E, that is carried by the arms y. These arms y extend from the standard B and slide freely thereon. From certain of the arms y depend rods w^5, that are guided in the arms a^5, and that carry rollers v^5, which bear upon cams w^5 on the disk G. As the cams w^5 rotate with said disk, the rods w^5 will be reciprocated, thereby imparting down-and-up motion to the arms y, sinker-ring E, and sinkers t^5.

Extending from the standard B, and sliding freely thereon, are a series of outwardly and upwardly projecting arms, a^6, that carry at their upper ends a ring, b^6, to which is secured the presser-ring H. Depending from certain of the arms a^6 are rods d^6, that are guided in the arms a^5, and carry at their lower ends rollers e^6, that bear upon cams f^6 on the disk G. As said cams f^6 are rotated with the disk G, the rods d^6 will be reciprocated, thereby imparting up-and-down motion to the arms a^6 and the presser-ring H, for pressing the beards of the needles.

In order to relieve the weight of the parts carried by the arms n^5, a^6, and y we attach to those arms n^5, a^6, and y that do not carry the rods o^5, w^5, and d^6 springs I, that are secured at their opposite ends to supports g^5, carried by the standard B. We prefer that every alternate arm n^5, a^6, and y should carry a rod, the others connecting with the springs. By this means the parts are nicely balanced. The fabric from the needles passes upward to a roller, J, journaled in bearings in the frame A, which roller may be turned by suitable means. (Not shown.)

This circular warp-knitting machine oper-

ates in making fabric as follows: The needles g^5 first move outward or forward about half their length into position to receive threads, while the guide-rings D D′ are both above said needles, as in Fig. 5. The guide-rings D D′, being supplied with threads, then turn in the direction desired for a certain distance by means of their respective pinions i and x^2, worms thereon, racks j and w^2, and parts connected therewith. The guide-rings then descend through the action of the supports $f\,f^{10}$ and parts connecting same with the cam u^4 until they are beneath the needles, as in Fig. 6. The guide-bars then move in the desired direction horizontally the proper distance, and are then moved upward again by the cam w^4 and supports $f\,f^{10}$, when the threads will be properly lapped on the needles. The needles then move farther outward or forward to pass the laps well over the beards onto the shanks of the needles. The needles then return, bringing the laps under their beards, and just as the beard-points enter the sinkers t^5 the presser H rises and presses the beards into the eyes or grooves of the needles, the needles continuing in their backward or inward movement. When the ends of the needles get aligned with the nibs of the sinkers, the sinkers fall sufficiently to permit the needles carrying the laps to pass inward of the nibs or points of the sinkers. The needles then enter with their ends the back part or knocking-over part of the sinkers sufficiently to draw a proper length of loop, the thread lying in part across the face of the knocking-over part. The sinkers then move upward and secure the loops in the arch of the sinkers, preventing the loops from following the needles in their next outward movement. These movements are then repeated.

For making some kinds of fabric it may not be necessary to rotate both the guide-bars at once, as one may be stationary while the other moves, or one may be moved in one direction and the other in the opposite direction, or both may remain stationary at any moment, if desired.

Having now described our invention, what we claim is—

1. In a circular-warp-knitting machine, the guide-ring D and means, substantially as described, for moving said ring horizontally, combined with means, substantially as described, for moving said ring up and down, substantially as described.

2. In a circular-warp-knitting machine, the horizontally-movable guide-ring D, having the rack g, combined with the supports f, and with means, substantially as described, for moving said guide-ring, and with means, substantially as described, for reciprocating the supports f, as specified.

3. In a circular-warp-knitting machine, the standard B and supports f, combined with the circular guide-ring D, that is carried by said supports, and with means, substantially as described, for reciprocating said supports and for moving said guide-ring intermittently in either direction, substantially as specified.

4. The standard B, supports f, and the guide-ring D, carried by said supports and having the rack g, combined with the worm h, pinion i, rack j, lever l, rod m, spring p, and pattern-wheel q, for actuating said lever l, substantially as described.

5. The standard B and bobbin-wheel d^2, that is adapted to carry the bobbins f^2 and to rotate on said standard, and the rack on the wheel d^2, combined with worm b^2, pinion a^2, rack z, lever l, rod m, spring p, and pattern-wheel q, for actuating said lever, substantially as described.

6. In a circular-warp-knitting machine, the standard B, supports f, guide-ring D on said supports, rack g on said ring, worm h, pinion i, rack j, lever l, rod m, and spring p, combined with the bobbin-wheel d^2, having a rack, worm b^2, pinion a^2, rack z, and pattern-wheel q on said standard, all arranged and operated substantially as herein shown and described.

7. In a circular-warp-knitting machine, the combination of the standard B, sleeve b, gear-wheel r on said sleeve, pinion s, meshing with said gear-wheel, pins u on said pinion, pattern-wheel q, and toothed wheel v on said pattern-wheel, all arranged and operated substantially as described.

8. The standard B and guide-ring supports f carried thereby, said supports having pendent rods s^4, the rods s^4 carrying rollers t^4, certain of said rods having springs w^4, combined with the sleeve b on the standard B, disk v^4, secured to said sleeve, and the cam on said disk, said cam engaging the roller t^4, whereby as said cam rotates the supports f will be reciprocated, substantially as described.

9. In a circular-warp-knitting machine, the standard B, sleeve e, guide-ring supports f^{10}, guide-ring D′ on said supports, and rack a^4 on said ring, combined with the worm z^2, pinion x^2, rack w^2, levers $t^2\,v^2$, rod q^2, spring s^2, and pattern-wheels o^2, substantially as herein shown and described.

10. In a circular-warp-knitting machine, the standard B and pattern-wheel o^2 carried thereby, said pattern-wheel having studs m^4, combined with the lever b^4, having rack d^4, pinion e^4, worm f^4, bobbin-wheel g^4, having a rack, lever t^2, rod n^4, lever v^2, rack w^2, pinion x^2, worm z^2, and guide-ring D′, having rack a^4, substantially as described.

11. In a circular-warp-knitting machine, the standard B, pattern-wheel q, rod m, and lever l, actuated thereby, and rack j on said lever, combined with the sinker-ring arms y and means, substantially as described, for reciprocating said arms, pin x on said arms, that is adapted to engage the lever l, and with the pinion i, worm h, and guide-ring D, having rack g, substantially as herein shown and described.

12. The guide-ring support f^{10}, having brack-

ets p^4, combined with the frame A, having brackets r^4, and with the rod q^4, passing through said brackets and rigidly secured to certain of said brackets, whereby the supports f^{10} are guided in their reciprocating motion and are held from turning in the machine, substantially as described.

13. In a circular-warp-knitting machine, the guide-ring D, means, substantially as described, for moving said guide-ring horizontally, and means, substantially as described, for raising and lowering said ring, combined with the needles g^5, and with means, substantially as described, for reciprocating said needles, as specified.

14. The standard B, having radial arms a^5 and rim d^5, supported by said arms, combined with the needle-jacks F, one end of which rests in the rim d^5, and with vertically-movable blades l^5, for actuating said needle-jacks, and means, substantially as described, for actuating said blades l^5, as specified.

15. The needle-jacks F, having arms j^5, supporting-rim d^5 for said jacks, and the guide-rim h^5, combined with the blades l^5, that contact the arms j^5 on opposite sides, and arms n^5, carrying said blades, which arms project from and slide on the standard B, and with means, substantially as described, for raising and lowering said arms n^5, as specified.

16. The standard B, arms n^5, that slide freely thereon, blades l^5, and rod o^5, carried by said arms, said rod having rollers p^5 and r^5, combined with the disk G, carrying cams g^5 s^5, that contact said rollers and give reciprocating motion to said rod o^5, needle-jacks F, and supporting-rim d^5, substantially as described.

17. In a circular-warp-knitting machine, the standard B, arms a^5 and i^5, and rims d^5 h^5, carried by said arms, combined with the needle-jacks F, that are supported and guided in said rims, and with means, substantially as described, for actuating the jacks, substantially as described.

18. In a circular-warp-knitting machine, the standard B, arms y, projecting therefrom and sliding freely thereon, sinker-ring E, carried by said arms and having sinkers t^5, and means, substantially as described, for actuating the arms y, and ring E, combined with the needles g^5, and with means, substantially as described, for reciprocating the needles, all arranged and operated substantially as herein shown and described.

19. The standard B, arms y, projecting therefrom, and sinker-ring E, carried by said arms, combined with the rod w^5, roller v^5 on said rod, cam w^5, disk G, carrying said cam, and sleeve b, surrounding the standard B and supporting the disk G, whereby the sinker-ring E will be raised and lowered, as set forth.

20. In a circular-warp-knitting machine, the standard B, arms a^6, and presser-ring H, carried by said arms, combined with means, substantially as described, for moving said presser-ring up and down to press the beards of the needles, and with the needles g^5, that are engaged by said presser-ring, and with means, substantially as described, for reciprocating the needles longitudinally, substantially as described.

21. The standard B and arms a^6, projecting therefrom and carrying the presser-ring H, combined with the rotary disk G, having cam f^6, and rod d^6, secured to the arm a^6 and having a roller, e^6, that rides on said cam f^6, whereby as the disk G rotates the presser-bar will be raised and lowered to press the needles, substantially as described.

22. The guide-ring D, means, substantially as described, for actuating the same, needle-jacks F, carrying needles g^5, and means, substantially as described, for actuating said jacks, combined with the sinker-ring E, means, substantially as described, for raising and lowering said sinker-ring, and with the presser H, and means, substantially as described, for actuating said presser, all arranged and operated substantially as herein shown and described, and for the purposes set forth.

23. In a circular-warp-knitting machine, the standard B, arms n^5 and blades l^5 on said arms, arms y and sinker-ring E on said arms, and the arms a^6 and the presser-ring H on said arms, said arms projecting from the standard B, combined with means, substantially as described, for reciprocating said arms n^5, y, and a^6, springs I, that are attached to said arms for relieving the weight carried by said arms, and with the needle-jacks F, and means, substantially as described, for supporting said jacks, substantially as specified.

24. In a circular-warp-knitting machine, the guides D^2 and means, substantially as described, for giving rotary and up-and-down motion to said guides, combined and operating with the reciprocating needles g^5, means, substantially as described, for reciprocating the needles, the sinkers d^5, means, substantially as described, for giving the sinkers up-and-down motion, and the presser-ring H, and with means, substantially as described, for giving said ring up-and-down motion, for the purposes set forth.

The above specification signed by us this 6th day of January, 1888.

H. BLACKFD. PAYNE.
WILLIAM CAMPION.

Witnesses:
H. J. F. CROSBY,
MATTHEW WHATE.