(No Model.) 2 Sheets—Sheet 1.

M. RHOME & H. F. HERKNER.

CIRCULAR KNITTING MACHINE.

No. 430,300. Patented June 17, 1890.

FIG. 12

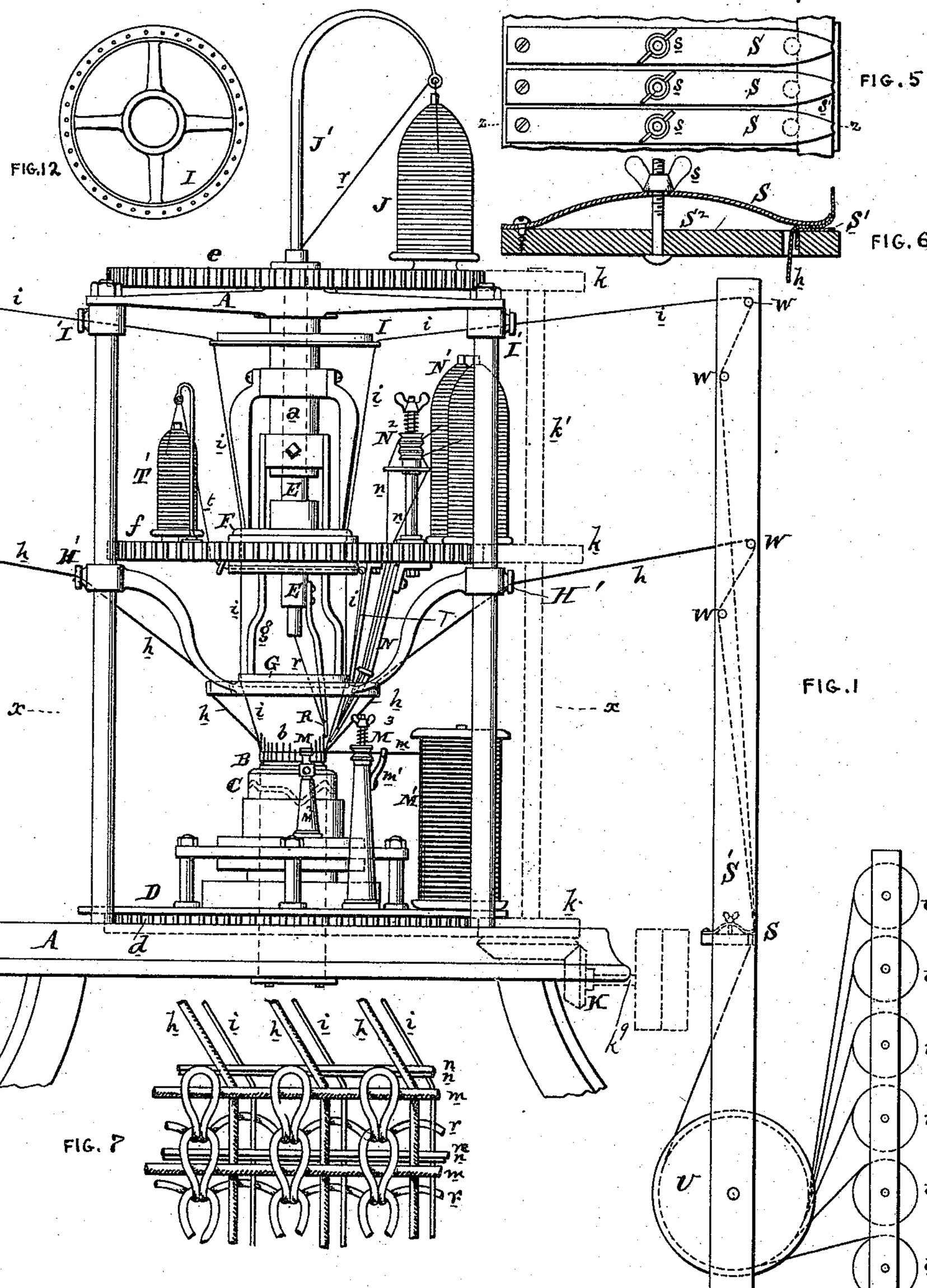


FIG. 1

FIG. 5

FIG. 6

FIG. 7

FIG. 8

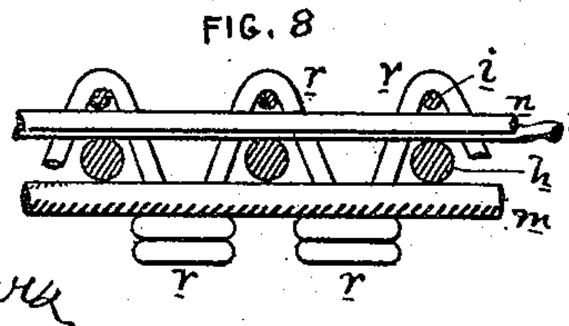
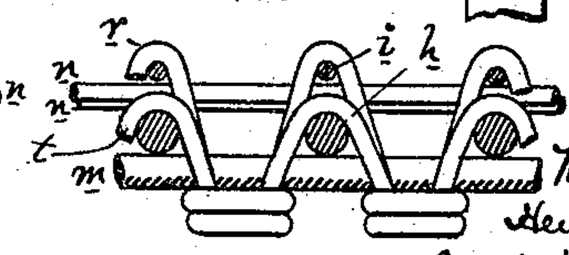


FIG. 9



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John T. Lewis

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Thos. Drury

(No Model.) 2 Sheets—Sheet 2.

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CIRCULAR KNITTING MACHINE.

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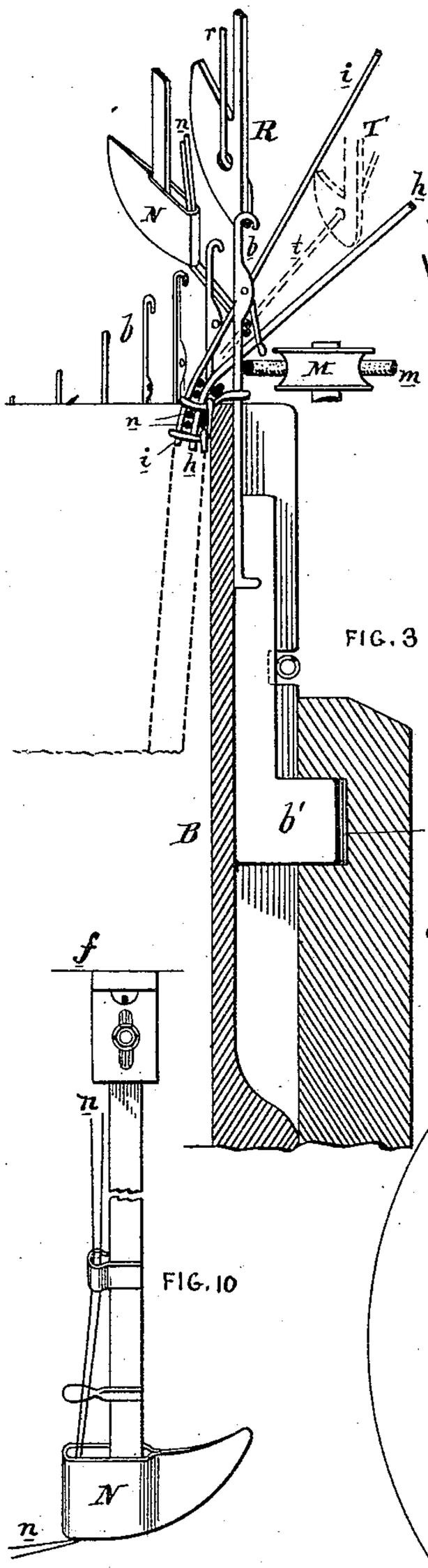

FIG. 3

FIG. 10

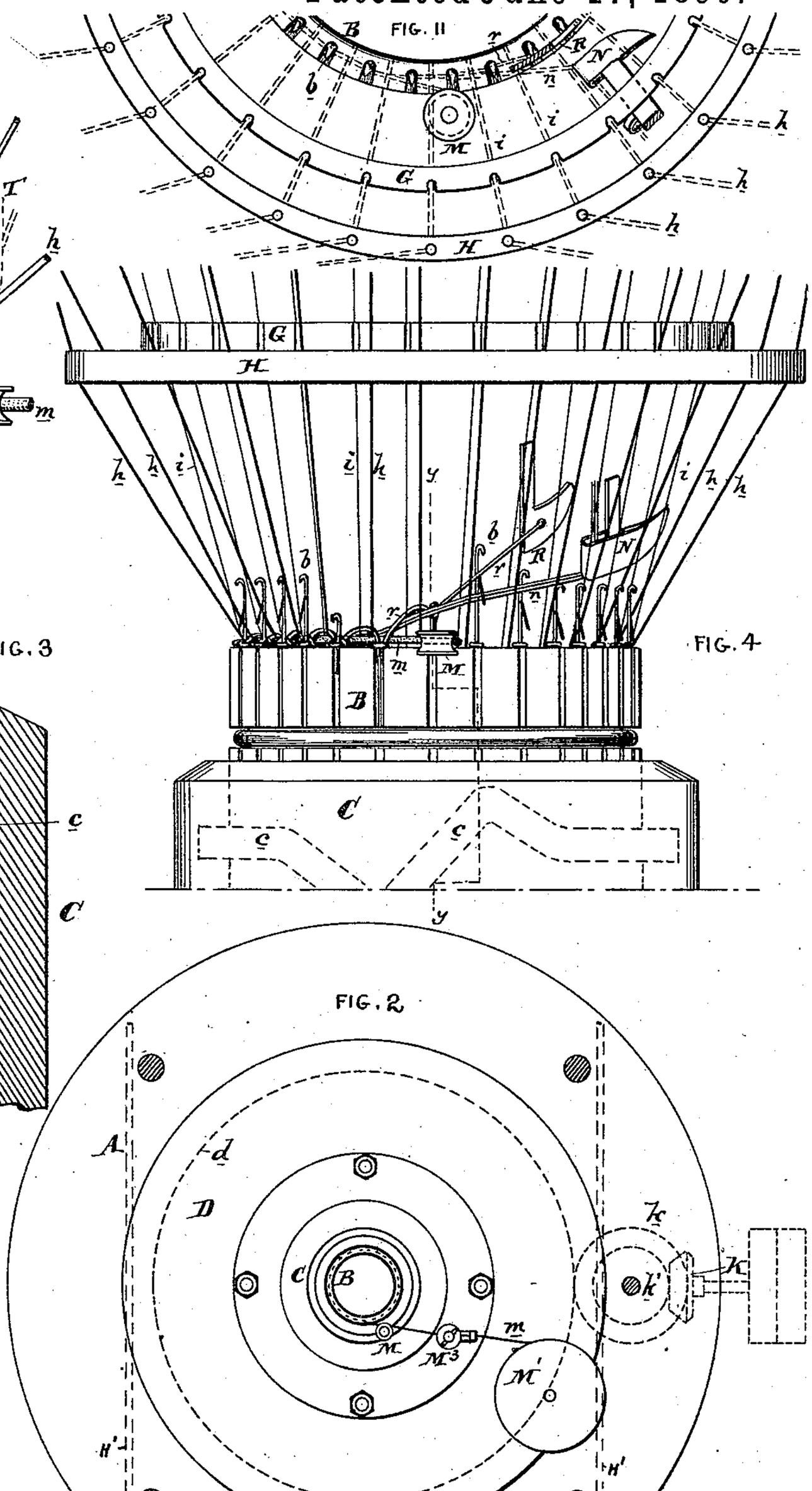

FIG. 11

FIG. 4

FIG. 2

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UNITED STATES PATENT OFFICE.

MATHEW RHOME AND HENRY F. HERKNER, OF NEW YORK, N. Y.; SAID RHOME ASSIGNOR TO SAID HERKNER.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 430,300, dated June 17, 1890.

Application filed August 2, 1889. Serial No. 319,533. (No model.)

To all whom it may concern:

Be it known that we, MATHEW RHOME and HENRY F. HERKNER, both of the city, county, and State of New York, have invented an Improvement in Circular-Knitting Machines, of which the following is a specification.

Our invention has reference to knitting-machines for knitting tubing, &c.; and it consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

The object of our invention is to provide an organized machine which shall be capable of knitting a fabric of several plies embodying two or more sets of warps and two or more sets of weft or filling threads tied or bound together by the loops of the knitting thread or threads.

In carrying out our invention we provide a rotating cam-ring and stationary needle-cylinder, having reciprocating needles furnished with latches. In conjunction with these parts we provide in the present machine two sets of warp-guides arranged to feed the warps across the needles, and so as to deliver the warp-threads to the interior of the needle-cylinder at different angles to form a shed, and also two rotary weft-thread guides for delivering the weft-threads to the outside of the stationary needles and respectively in front of each of the two sets of warp. Furthermore, we provide with such devices a knitting or binding thread guide within the warp-guides and rotating synchronously with the cam-cylinder, so as to deliver the knitting-thread to the needles within the warp and weft, so that the said knitting-thread shall bind the warps and wefts together into an integral structure. In addition to the foregoing we may also provide a second binding or knitting thread guide, which may be rotated about the needle-head between the inner and outer sets of warps and through the shed formed thereby, whereby such knitting-thread shall bind one set of warps and wefts, while the other knitting thread shall bind both sets of warps and wefts, making a heavier and firmer fabric. The fabric is essentially double-ply. By the use of these words we mean a fabric having two or more sets of warps or two or more sets of wefts, or two or more sets of both warps and wefts. In addition to these features there are many details of construction fully set out hereinafter.

We do not confine ourselves to the mere details, as in a great measure they may be modified and varied without departing from the spirit of our invention.

In the drawings, Figure 1 is a side elevation of a knitting-machine embodying our improvements. Fig. 2 is a sectional plan view of the same on line $x\,x$ of Fig. 1, with the yarn-guides omitted. Fig. 3 is a sectional elevation on line $y\,y$ of Fig. 4. Fig. 4 is an enlarged view showing the relative arrangement of the warp, weft, and binding threads with the needles, warp-guides, and cam-ring. Fig. 5 is a plan view of a portion of the tension devices. Fig. 6 is a sectional elevation of a portion of the same on line $z\,z$, Fig. 5. Fig. 7 is an elevation of a piece of the knitted fabric, showing the relative arrangement of the threads. Fig. 8 is a sectional plan view of the same. Fig. 9 is a similar sectional plan view showing the employment of two binding or looping threads. Fig. 10 is an elevation of one of the weft-guides. Fig. 11 is a plan view, part in section, of what is illustrated in the forward part of Fig. 4, and Fig. 12 is a plan view of the upper guide for the inner warps.

A is the main frame of the machine.

B is the needle-cylinder, and carries the latch-needles b, having the jacks b'.

C is the cam-ring, having the usual cam-groove c in its inner wall or surface. This cam-ring is adapted to rotate while the needle-cylinder remains stationary, and is secured to the rotating plate or frame D, having the gear d, which plate and gear have the needle-cylinder as their axis of rotation.

E is a tubular shaft journaled in a tubular bearing a in the upper part of the frame A over and concentric with the needle-cylinder, and is provided with the large gear-wheel e, similar in diameter to the gear d. The tubular bearing a of frame A has a yoke which carries a stationary ring F, on which is journaled a third large gear-wheel f, correspond-

ing to wheels *d* and *e*. All of these gear-wheels mesh with pinions *k* on a shaft *k'*, driven by bevel or miter gears K from driving-shaft k^9. By this means all three gears *d*, *e*, and *f* rotate with the same velocity. Supported by the tubular bearing *a* is a ring-guide I, having a series of holes about its periphery, Fig. 12, and farther down and below the journal-ring F is a second guide-ring G, which has a series of notches cut in its periphery, Fig. 11, corresponding in number to the holes in ring I and to the needles in the head. This ring G is suspended from the tubular bearing *a* by the frame *g*, Fig. 1, and by it may be raised or lowered.

The frame *g* is provided at its upper end with a sleeve which fits over the lower end of the tubular bearing *a*, and is adjustably secured thereon by set-screws, as shown. By adjusting the sleeve and its frame *g* higher or lower a corresponding adjustment is given to the ring G.

Concentric with the guide G is a second and larger guide-ring H, supported by the main frame A. The guide-ring H is provided with a series of holes corresponding in number to the spaces between the needles *b*, and hence to the needles themselves, and the notches in the periphery of ring G correspond with the holes in the rings H and I, and are preferably in the same radial planes, so that a warp *i* from the guide G may pass obliquely to a space between two needles in the same plane that a warp *h* passes from the guide-ring H obliquely to the same space between the needles. These constructions are clearly shown in Figs. 3, 4, and 11.

J is the bobbin or spool for the knitting or binding thread, and *r* is the thread thereof. The thread *r* extends upward through the guide J', and thence down through the tubular shaft E to the thread-guide R, which is secured to and rotates with the lower end of the tubular shaft E, it delivering the thread *r* to the needles *b* in the ordinary manner. Both the bobbin J and guide R rotate with the wheel *e* and shaft E. The thread-guide R projects down through the open center of the guides G and H and makes its revolution within them.

N is a thread-guide, Fig. 10, which projects down from the rotating wheel *f* close to and in front of the needles *b*, but so as to travel in the shed formed by the warp *i* and *h*, and this guide is adapted to lay in front of the needles and between the two warp-threads a single or double weft *n*. As shown, the weft is preferably composed of two threads, for reasons explained later on. The weft-threads *n* pass from spools or bobbins N' between tension-disks N^2, and thence through the wheel *f* to the guide N. The spools, tension-rollers, and guide are all carried and rotate with the wheel *f*, and by the gearing shown they also rotate about the needles synchronously with the thread-guide R.

Supported upon the lower frame D or wheel *d* is a spool M', carrying the outer weft-thread *m*, and which weft-thread is laid against the outer parts of the needles and exterior to all of the threads *n*, *h*, and *i*. The thread *m*, after leaving the spool, passes through an eye *m'* and then through the tension device M^3. From the tension device the weft-thread *m* passes around the guide post or roller M, which delivers it to the needles low down and preferably just above the needle-cylinder.

The guide-roller M is supported upon a standard M^2, and is adjustable vertically by being journaled on the end of a vertically-adjustable arm, which is arranged upon the upper end of the standard and is secured in position by a set-screw or any suitable clamp. The guide-roller M and tension device M^3, as well as the spool M', all rotate with the wheel and frame *d* D, and consequently their rotation about the needles is synchronous with the rotation of the other guides R and N.

S' is a frame having at its upper part wires W, over which the warp-threads *i h* are guided, at its middle tension devices S, through which the threads pass, and at its lower part a cylinder V, about which the warps pass from the spools *u*. It is quite evident that the cylinder V might constitute a warp-beam and be the source of supply of the warps. The tension devices consist of springs S, arranged above a board or plate S^2 and pressed down by tension-adjusting screw and nut devices *s*. The threads each pass up through a hole in the board S^2, and then between the spring S and a smooth plate *s'*. The spring S imparts any degree of friction desired, and this may be varied by adjusting the tension of the spring. By these tension devices the various warps may be put under the requisite tension to insure their proper delivery to the knitting-machine. After the warp-threads pass from the wires W they pass through guide-plates I' H' on the frame A of the machine. These guide-plates then deliver the warps to the guide-rings I and H. These guides I' H' may be flat bars or ring shape. In practice we arrange one-half of the warp-thread upon each side of the machine and lead said warps through corresponding guide-plates I' H' to the opposite halves of the guides I and H. In Figs. 1 and 11 the warp-threads are shown as coming in from opposite sides.

The guides G and H are both of greater diameter than the needle-head or circle of needles, and guide G is smaller in diameter than guide H, so as to leave an annular passage-way through which one of the weft and one of the knitting thread guides pass into the shed of warp-threads.

With the foregoing description we will now be able to explain the method of making the double fabric shown in Figs. 7 and 8, in which there are two sets of warp-threads, two sets of weft-threads, and one looping or binding thread. As the fabric is knitted, the warp-

threads *h i* are pulled down with a speed commensurate with the knitting operation, and in passing into the needle-head they pass obliquely between the needles *b*, and so that the needles may be projected up back or within them to take the looping or binding thread *r*, as shown in Fig. 3, so that when the needle descends it draws its loops between the warp-threads, leaving them in front of the horizontal portions of the loops and between the loops proper. While this operation is being performed the weft-threads *n m* are being laid in, and these wefts are tied so that weft *n* is in front of the warp *i* and weft *m* in front of warp *h*. Hence these weft-threads hold the warp in place, and, since the wefts themselves are held back of the vertical lines of loops, the entire structure is a solid cloth dependent upon the looping-thread for its integrality. By making the outer warp *h* and outer weft *m* of thick threads and the inner weft *n n* and warp *i* of thinner threads the interior surface is made much more smooth and also allows the threads to lie closely together, since the difference in thickness of the threads compensates for the difference in the internal and external circumferences. This is important, as the fabric is knitted circular, and as it is especially adapted for hose the diameter of the tubing is small compared to its thickness. The guides M, N, and R lie in the threads *m*, *n*, *n*, and *r* in such a manner that the threads *m* and *n n* are in position in front of the needles before the binding or looping thread is delivered, so that the looping-thread ties or binds the warp and weft threads together.

By using two weft-threads *n n* on the inner part of the fabric and between the warps they are enabled to lie one above the other, Figs. 7 and 8, and thus enable the fabric at the back to be filled up smooth and also reduce the thickness to a minimum without weakening the structure as an entirety.

We now refer to the fabric indicated in Fig. 9, in which two binding-threads *r* and *t* are employed. This fabric differs from that above described by the addition of the binding-thread *t*, which only extends back of the outer warp and weft threads *h m*. We employ an additional thread-guide T, (shown in dotted lines in Fig. 3,) running between the warp-shed, substantially as in the case of the weft-guide N, but so as to deliver the binding-thread *t* to the hooks of the needles instead of below their latches. Otherwise the construction and operation are the same as the apparatus and method employed in making the fabric shown in Figs. 7 and 8. When this thread-guide T and thread *t* are employed, the thread leads from a bobbin T′ on the rotating wheel *f*. In practice we usually use two or more cams in the cam-cylinder, or have two actuating parts, so that the needles are reciprocated twice or more for each rotation of the cam-cylinder. This is shown in Fig. 1 in dotted lines, and has the effect of increasing the capacity of the machine. The warps *i*, after passing through the guides I′, are threaded through the ring I and thence pass down through the bearing F and in the notches of the guide-ring G, Fig. 11, around which they bend inward, assuming an angle, and pass between the needles. In the case of the warp *h* we have the threads first passed through the guides H′, thence through holes in the circular guide H, and from that obliquely inward to the needles in line with the threads *i*. The way these threads pass to the needle-head is clearly shown in Figs. 1, 3, 4, and 11. The particular shape of these guides G′ H is immaterial, though we prefer to make them circular, as shown.

We do not confine ourselves to any particular shape of thread-guides, as they may be modified as desired and shifted relatively to each other, provided they do not change the result produced.

The general construction of the machine may be varied without departing from the spirit of our invention, and it is evident that the relative motions of the parts may be otherwise mechanically produced.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. The combination of a needle-head, a cam-cylinder, inner and outer guides of greater diameter than the needle-head for two sets of warp-threads, so as to form an oblique open shed between the warps as they pass to the needle-head, inner and outer weft-thread guides arranged to deliver upon the outer or hook side of the needles and below their latches, and a knitting-thread guide located within the guides for the warp and weft.

2. The combination of a needle-head, a cam-cylinder, inner and outer guides of greater diameter than the needle-head for two sets of warp-threads, so as to form an oblique open shed between the warps as they pass to the needle-head, inner and outer weft-thread guides arranged to deliver upon the outer or hook side of the needles and below their latches, a knitting-thread guide located within the guides for the warp and weft, and power mechanism for causing a relative rotation between the needles and thread-guides.

3. The combination of a needle-head, a cam-cylinder, inner and outer ring-guides of greater diameter than the needle-head, arranged concentrically and of different diameters for two sets of warp-threads, so as to form an open oblique shed between the warps as they pass to the needle-head, inner and outer weft-thread guides arranged to deliver upon the outer or hook side of the needles and below their latches, one of which is arranged exterior to the warp-guides and the other between the warp-guides, and a knitting-thread guide located within the guides for the warp and weft, so as to deliver its thread to the needle-hooks above the latches.

4. The combination of a needle-head, a cam-

cylinder, inner and outer guides of greater diameter than the needle-head for two sets of warp-threads, so as to form an open oblique shed between the warps as they pass to the needle-head, inner and outer weft-thread guides arranged to deliver upon the outer or hook side of the needles and below the latches, a knitting-thread guide located within the guides for the warp and weft, and tension devices acting on the warp-threads before passing to the guides.

5. The combination of a needle-head, a cam-cylinder, inner and outer guides of greater diameter than the needle-head for two sets of warp-threads, so as to form an oblique open shed between the warps as they pass to the needle-head, inner and outer weft-thread guides arranged to deliver upon the outer or hook side of the needles and below their latches, a knitting-thread guide located within the guides for the warp and weft, and independent tension devices acting on the warp-threads before passing to the guides.

6. The combination of a series of reciprocating needles arranged in a circle with a rotating cam-ring to reciprocate said needles, guides for two sets of warp-threads arranged about said needles and of greater diameter or size than the needle-cylinder, so as to feed the warp-threads obliquely between the needles to form an oblique open shed, and a rotating thread-guide for the knitting-thread, located within the space bounded by the inner set of warp-threads and adapted to feed the knitting-thread back of the warp-threads and into the hooks of the needles.

7. The combination of a series of reciprocating needles arranged in a circle with a rotating cam-ring to reciprocate said needles, guides for two sets of warp-threads arranged about said needles and of greater diameter or size than the needle-cylinder, so as to feed the warp-threads obliquely between the needles to form an oblique open shed, a rotating weft-thread guide arranged upon the outside of the warp-threads and below their guides, a rotating weft-thread guide rotating in the shed formed by the two sets of warp-threads and adapted to feed the thread below the latches of the needles, a rotating thread-guide for the knitting-thread, located obliquely within the space bounded by the inner set of warp-threads and adapted to feed the knitting-thread back of the warp-threads and into the hooks of the needles, and a rotating oblique thread-guide for a second knitting-thread, located between the two warp-guides, so as to travel in the oblique shed formed by the two sets of warps.

8. The combination of a set of reciprocating needles arranged in a circle with a rotating cam-ring to reciprocate said needles, ring-guides of greater diameter than the circle of needles for two sets of warp-threads, arranged about said needles to deliver the warp-threads obliquely to the needle-head between the needles, a rotating roller-guide for an outer weft-thread, arranged outside of the needles below their latches and below the warp-guides, a rotating obliquely-arranged inner weft-thread guide between the warp-guides and traveling in the oblique shed formed by the warp-threads, and an inner rotating guide for the knitting-thread, arranged between the needles and inner warp-guide.

9. The combination of a set of reciprocating needles with a rotating cam-ring to reciprocate said needles, guides for two sets of warp-threads, arranged about said needles to deliver the warp-threads obliquely to the needle-head between the needles, but at different angles, to form a shed, a rotating roller-guide for an outer weft-thread arranged outside of the needles below their latches and below the warp-guides, a rotating inner oblique weft-thread guide between the warp-guides and traveling in the shed formed by the warp-threads to feed the weft-threads to the front of the needles below the latches, an inner rotating guide for the knitting-thread, arranged between the needles and inner warp guide, and a rotating oblique guide for a knitting-thread, located between the warp-guides and in the path of the needles while reciprocating and passing obliquely down between the two sets of warp-threads and feeding the knitting-thread to the needles above the latches.

10. The combination, in a knitting-machine, of a series of reciprocating needles with warp-guides for delivering two sets of warp-threads obliquely to the needle-cylinder between the needles at different angles and so as to form an oblique open shed, a rotating weft-guide exterior to the warp-threads to feed the weft-thread to the front of the needle below the latches, a rotating weft-guide for delivering two weft-threads, adapted to travel between the two warp-guides and feed the threads to the front of the needles below the latches, a rotating frame carrying said latter weft-guide and having guides and supports for bobbins for two weft-threads, a needle-head, a cam-cylinder, and an inner rotating guide for the knitting-thread, located between the needles and inner warp-thread to feed the knitting-thread to the hooks of the needles above the latches.

11. The combination, in a knitting-machine, of a needle-head, cam-cylinder, and a series of reciprocating needles with warp-guides for delivering two sets of warp-threads to the needle-cylinder between the needles and so as to form an oblique open shed radiating from the front of the needles, a rotating weft-guide exterior to the warp-threads for delivering a weft-thread to the needles below their latches, a rotating oblique weft-guide for delivering two weft-threads to the needles below their latches, adapted to travel between the two warp-guides, a rotating frame carrying said latter weft-guide and having guides and supports for bobbins for two weft-threads, a rotating oblique knitting-thread guide arranged be-

tween the warp-guides for delivering a thread to the needles above the latches, and an inner rotating guide for the knitting-thread, located between the needles and inner warp-thread for feeding a thread to the needles above the latches.

12. The combination of the needle-cylinder B, having a series of reciprocating needles *b*, and a cam-cylinder with warp-thread guides H G, rotating wheels D *d*, *f*, and *e*, a weft-thread guide M and weft-spool support carried by the wheel D *d*, an inner weft-guide N and weft bobbin or spool support carried by the wheel *f*, a knitting-thread guide R and bobbin or spool support carried by the wheel *e*, and power mechanism to rotate all the wheels at the same velocity.

13. The combination of the needle-cylinder B, having a series of reciprocating needles *b*, and a cam-cylinder with warp-thread guides H G, rotating wheels D *d*, *f*, and *e*, a weft-thread guide M, tension device and weft-spool support carried by the wheel D *d*, an inner weft-guide N, tension device and weft bobbin or spool support carried by the wheel *f*, a knitting-thread guide R and bobbin or spool support carried by the wheel *e*, power mechanism to rotate all the wheels at the same velocity, and tension devices to control the tension of the warp-threads.

14. In a knitting-machine, the combination of a series of needles with warp-thread guides for an inner and outer set of warps arranged outside and above the needles and adapted to guide the two sets of warp-threads obliquely to the needle-head at different angles to form an open circular and oblique shed.

15. A circular-knitting machine for making double-ply warp and weft fabric, provided with a ring-guide for each set of warps, arranged to guide said warps to form an oblique open shed between the warps, and in which one ring-guide is of greater diameter than the other ring-guide and both of greater diameter than the needle-head, a rotating guide for each set of weft-threads, and a knitting-thread guide located inside the innermost of said warp-guides.

In testimony of which invention we hereunto set our hands.

MATHEW RHOME.
HENRY F. HERKNER.

Witnesses:
H. DURANT CHEEVER,
JAMES H. COBB.