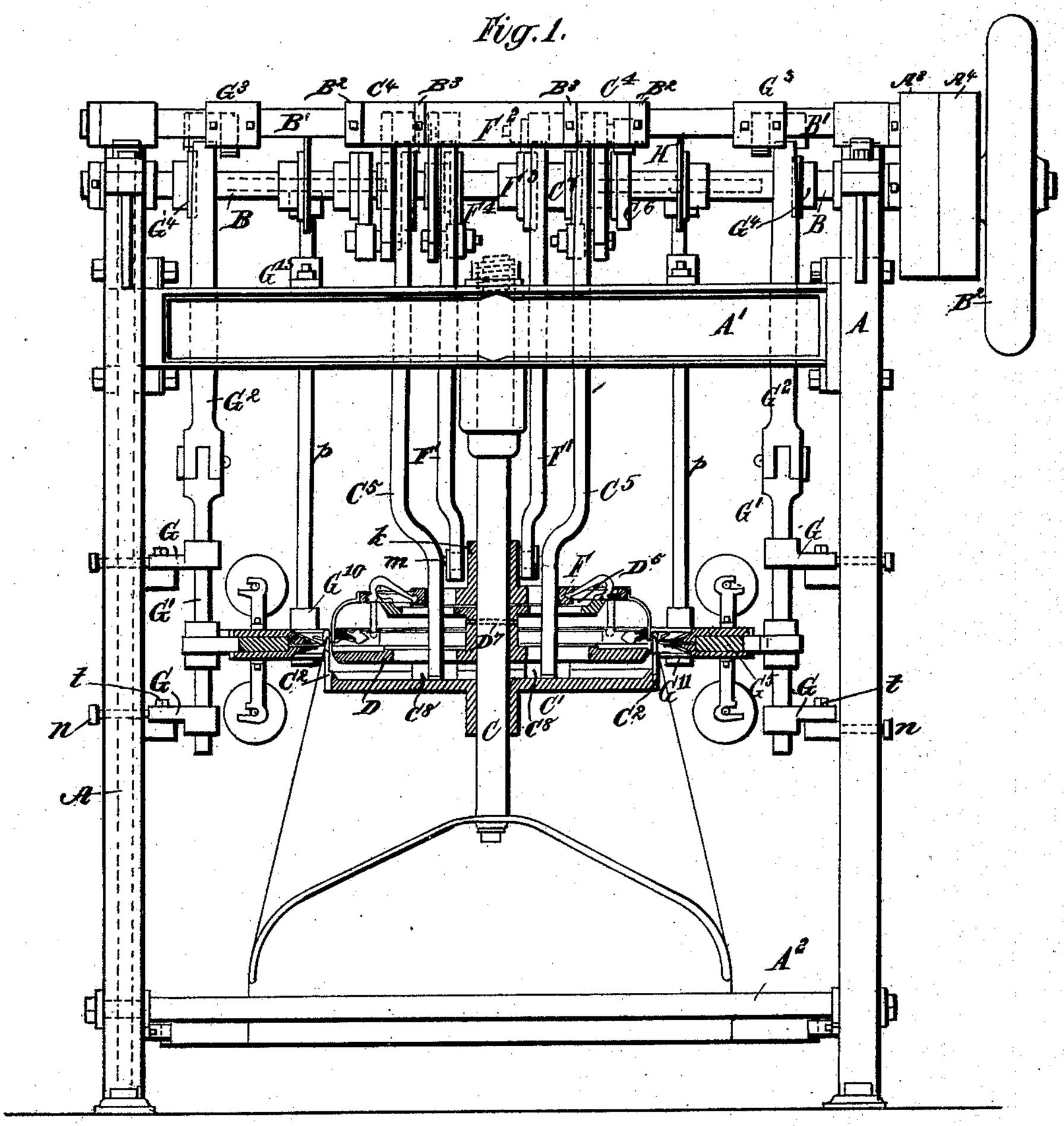
(No Model.) 9 Sheets—Sheet 1.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 1.



Witnesses.
Victor Coombs
Robt Everett.

Inventor
William Start
By James L. Norris.
Atty.

(No Model.) 9 Sheets—Sheet 2.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

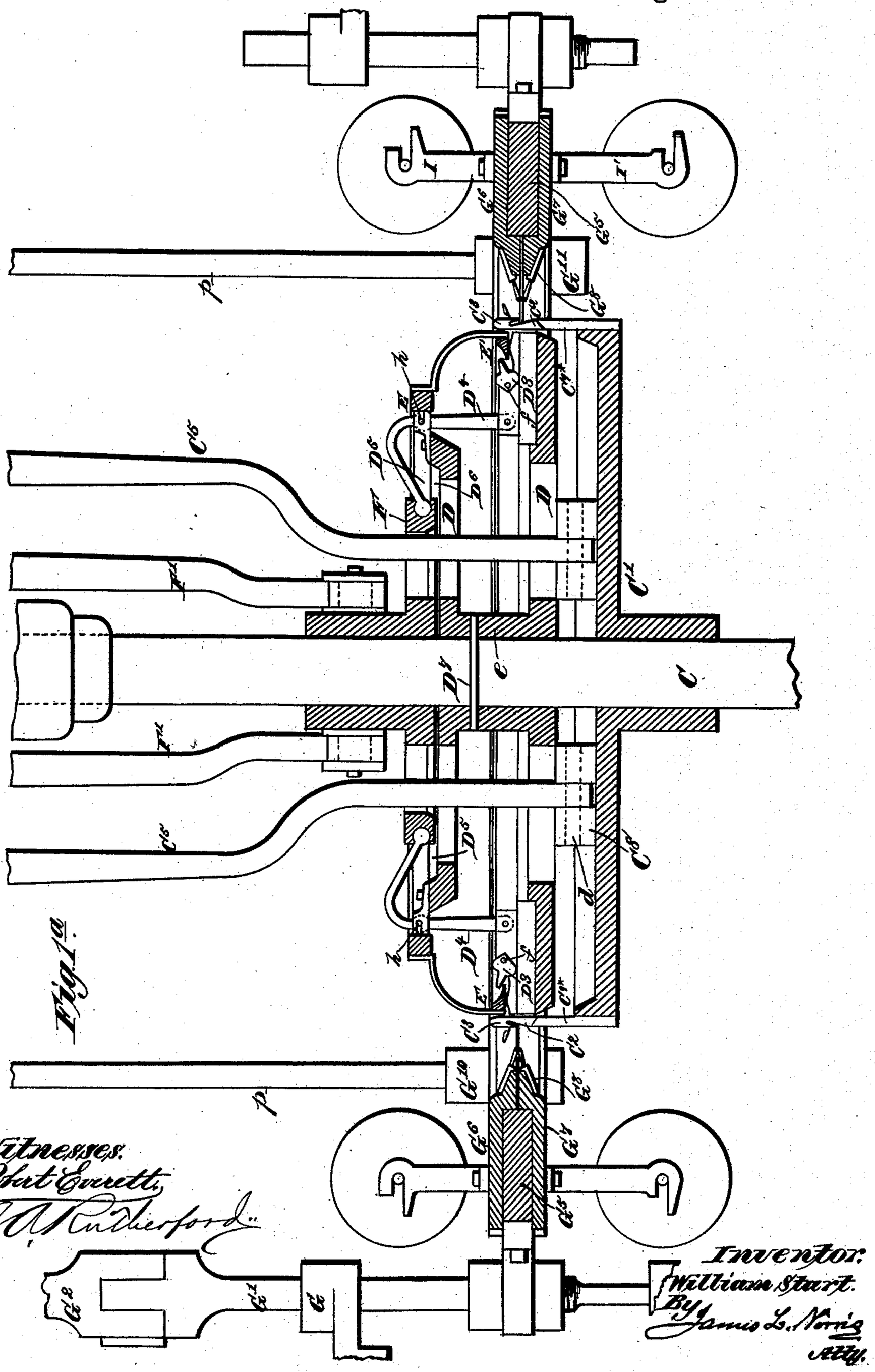


Fig. 1a.

Witnesses:
Robt Everett,
J. A. Rutherford.

Inventor:
William Start.
By James L. Norris
Atty.

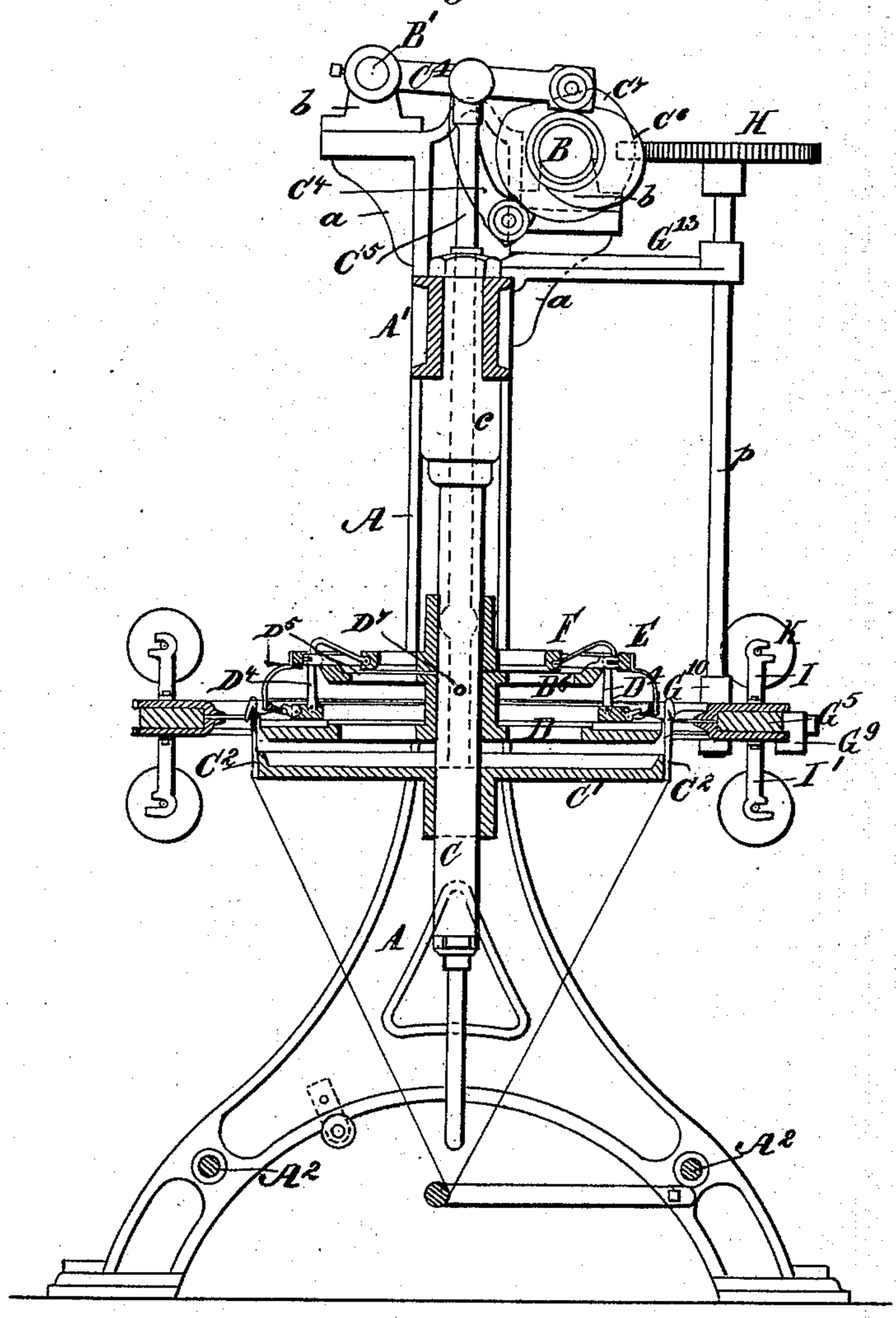
(No Model.) 9 Sheets—Sheet 3.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 2.



Witnesses.
Victor Coombs
Robert Emmett.

Inventor:
William Start.
By James L. Norris,
Atty.

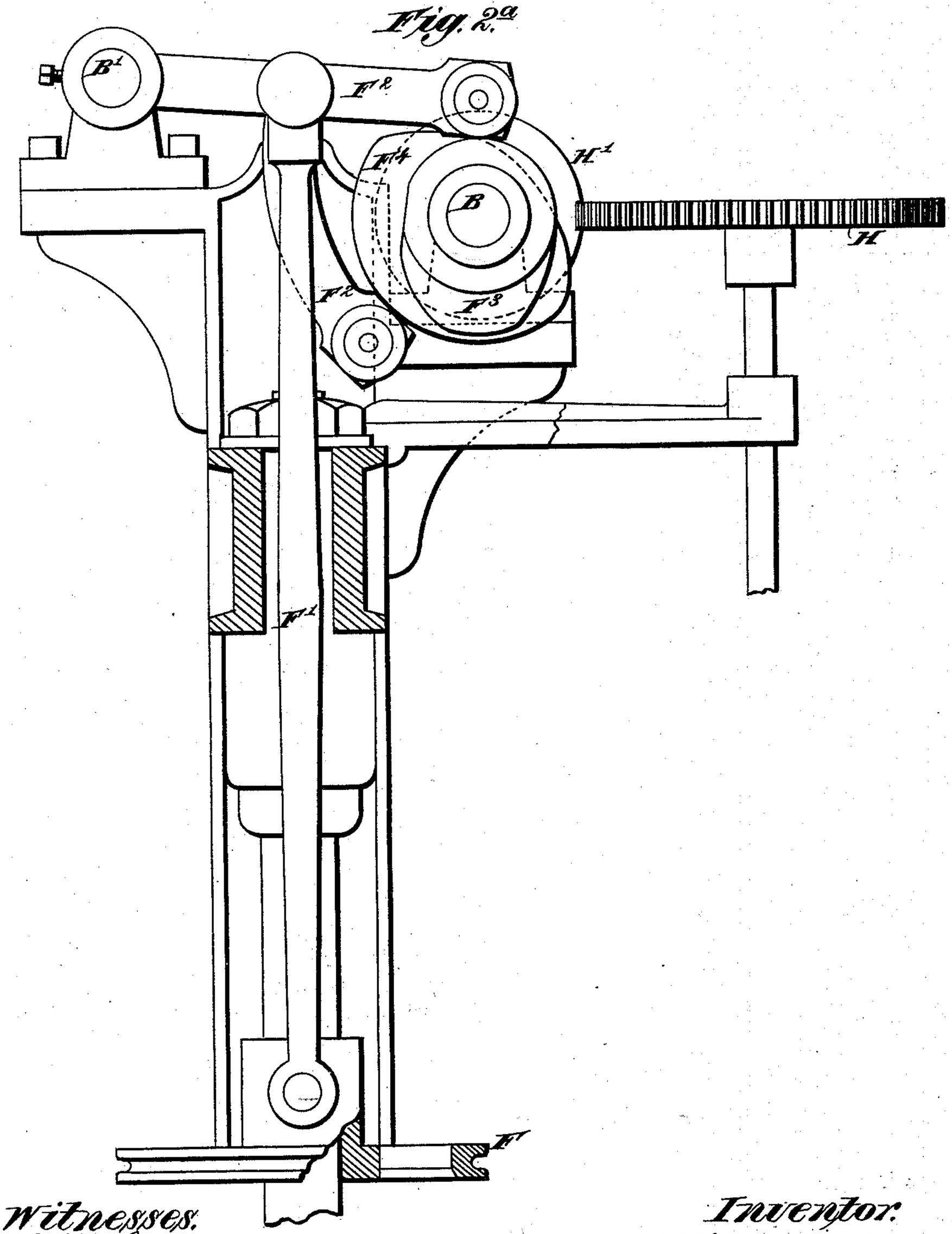
(No Model.) 9 Sheets—Sheet 4.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 2a



Witnesses.
Robt Everett.
J. A. Rutherford.

Inventor.
William Start.
By James L. Norris.
Atty.

(No Model.) 9 Sheets—Sheet 5.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 2b

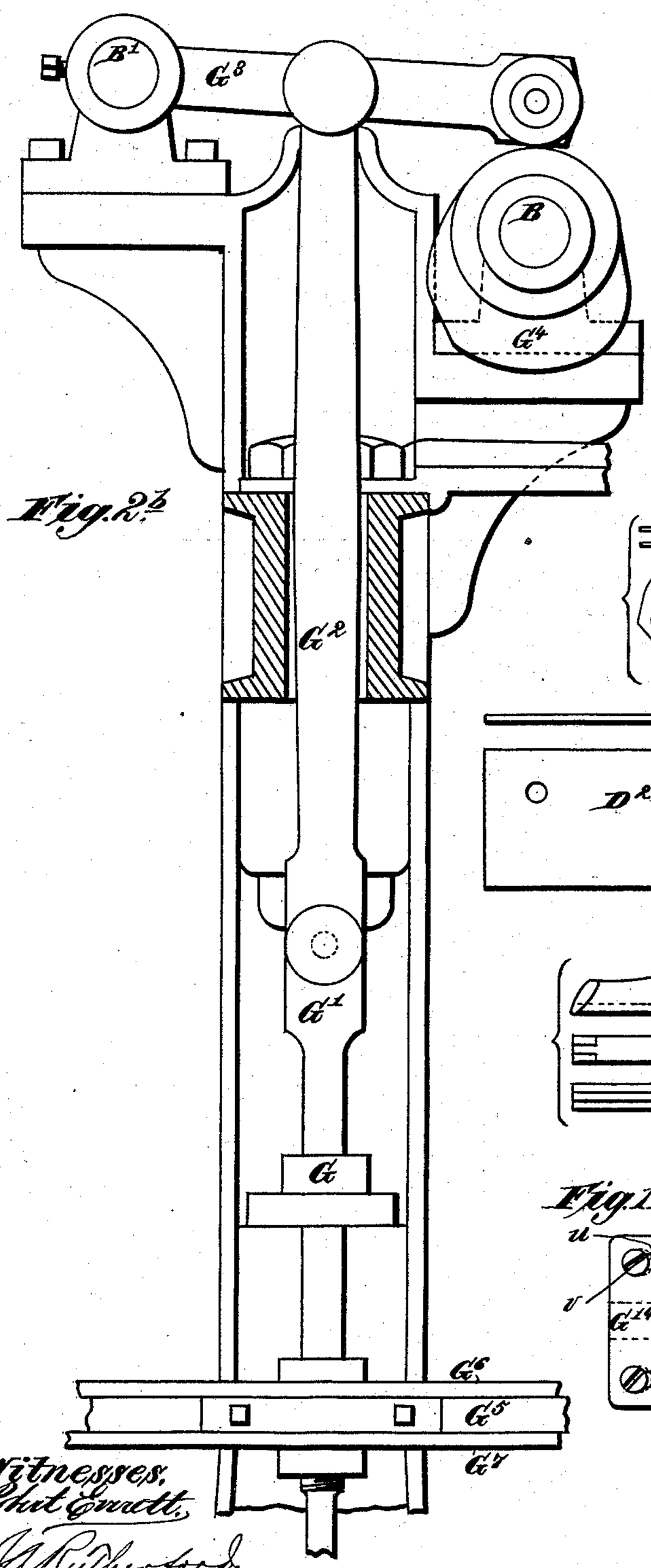


Fig. 4a

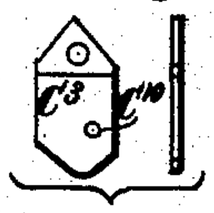


Fig. 4b

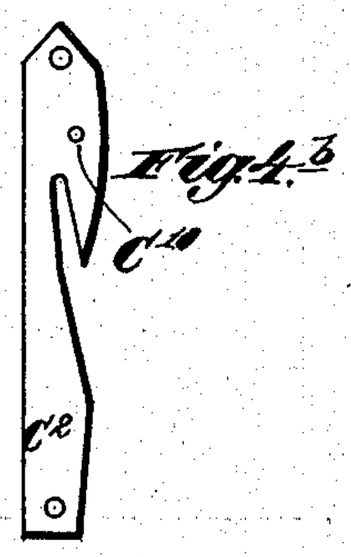
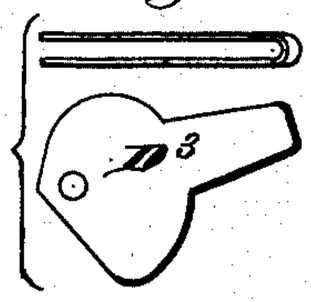


Fig. 4c



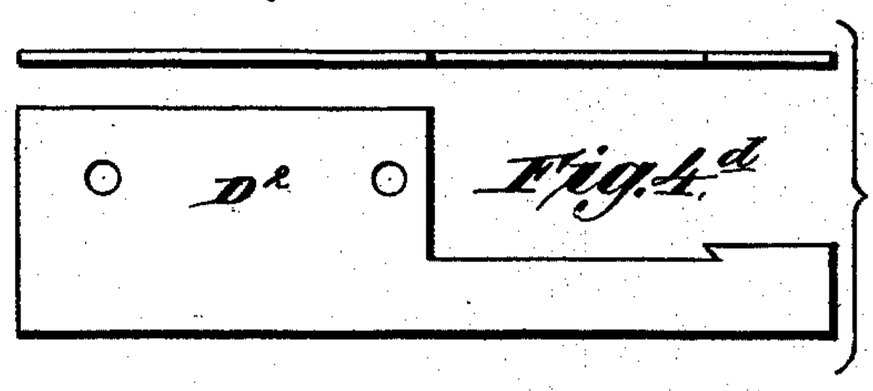


Fig. 4d

Fig. 6a

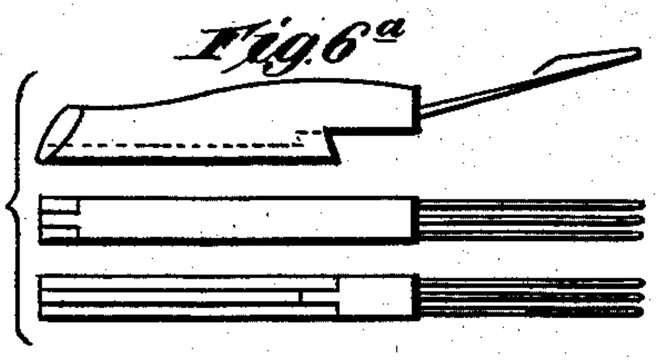
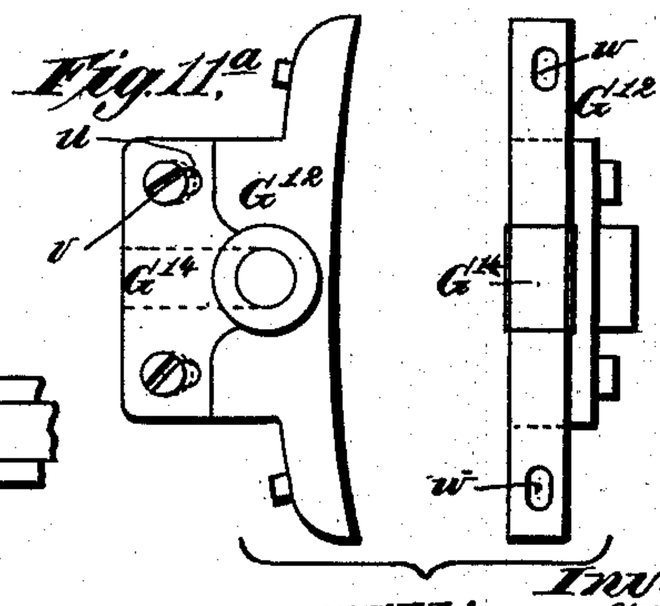


Fig. 11a



Witnesses.
Phil Emott.
J. A. Rutherford

Inventor.
William Start.
By James L. Norris.
Atty.

(No Model.) 9 Sheets—Sheet 6.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 12.

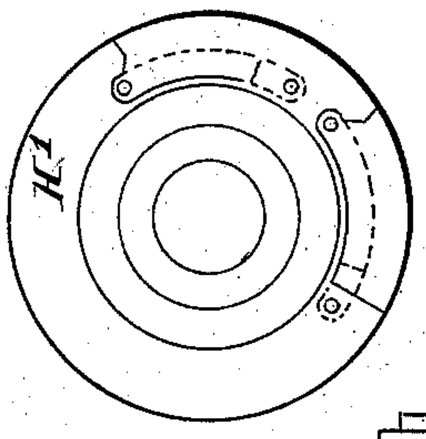


Fig. 13.

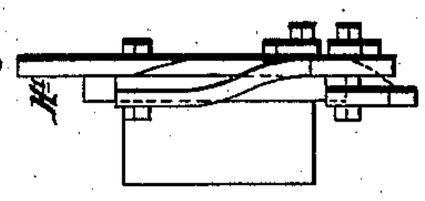
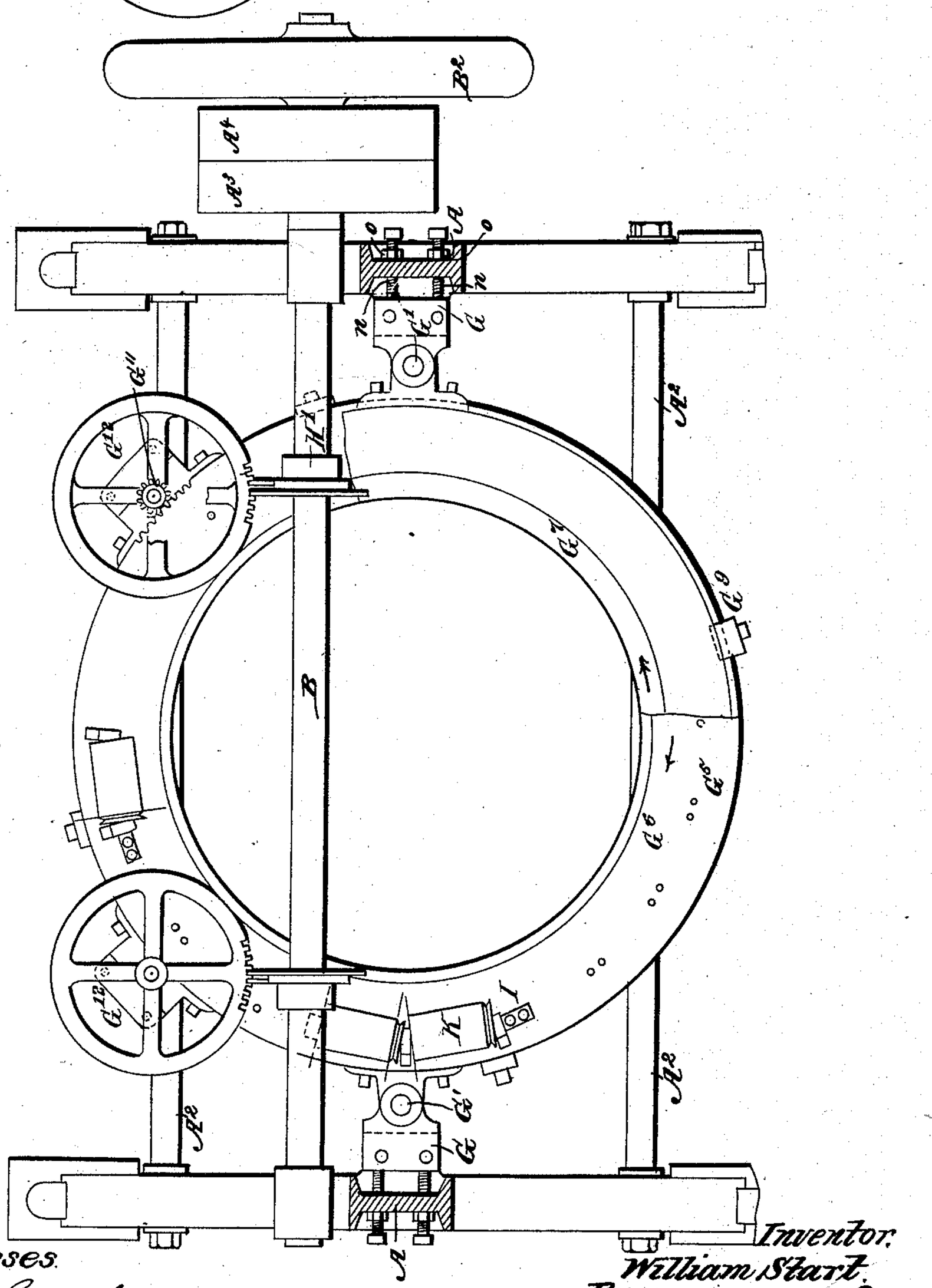


Fig. 3.



Witnesses.
Victor Coombe
Robt Everett.

Inventor.
William Start.
By James L. Norris
Atty.

(No Model.) 9 Sheets—Sheet 7.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 7.

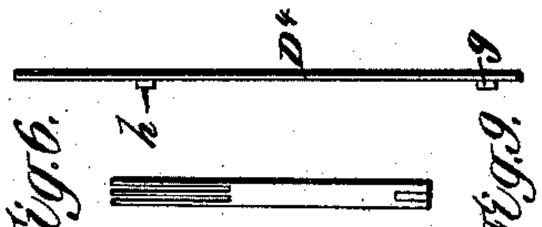


Fig. 6.

Fig. 9.

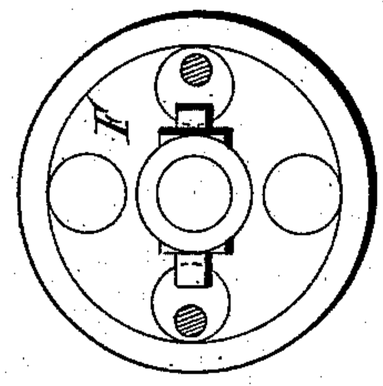


Fig. 10.

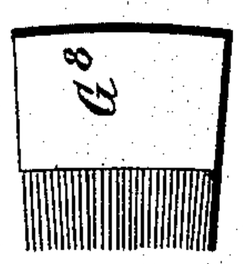
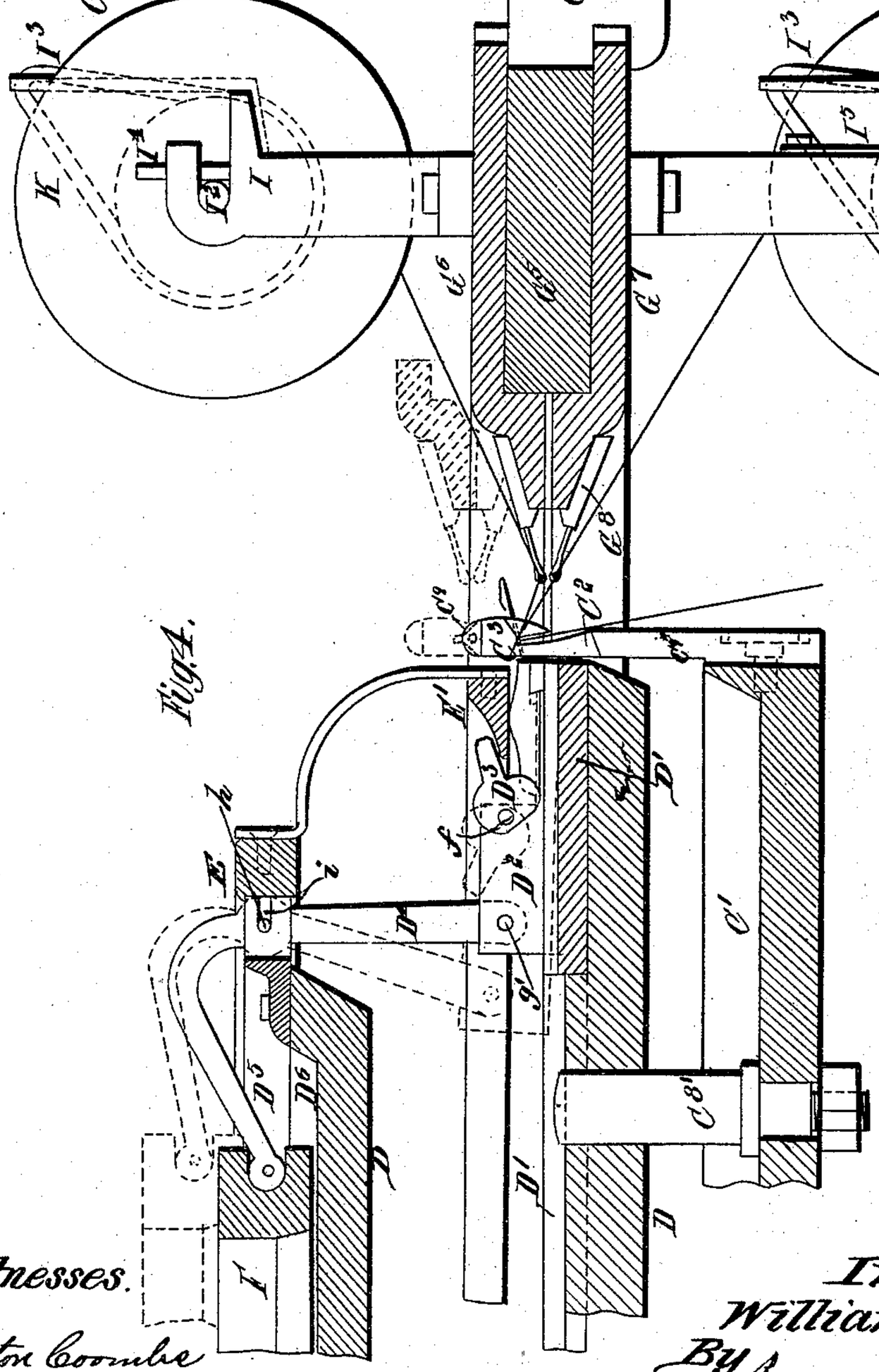


Fig. 5.

Fig. 4.



Witnesses.

Victor Coombe

Robert Evett.

Inventor.

William Start.

By James L. Norris.

Atty.

(No Model.) 9 Sheets—Sheet 8.

W. START.

CIRCULAR WARP KNITTING MACHINE.

No. 410,040. Patented Aug. 27, 1889.

Fig. 8.

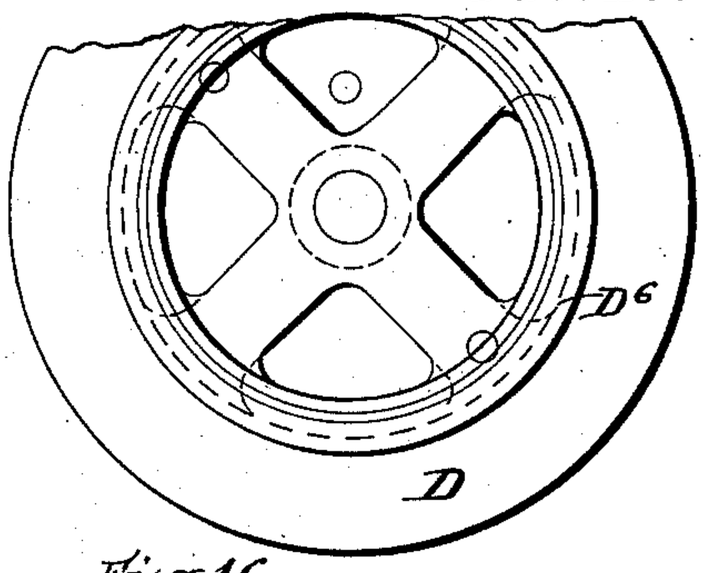


Fig. 16.

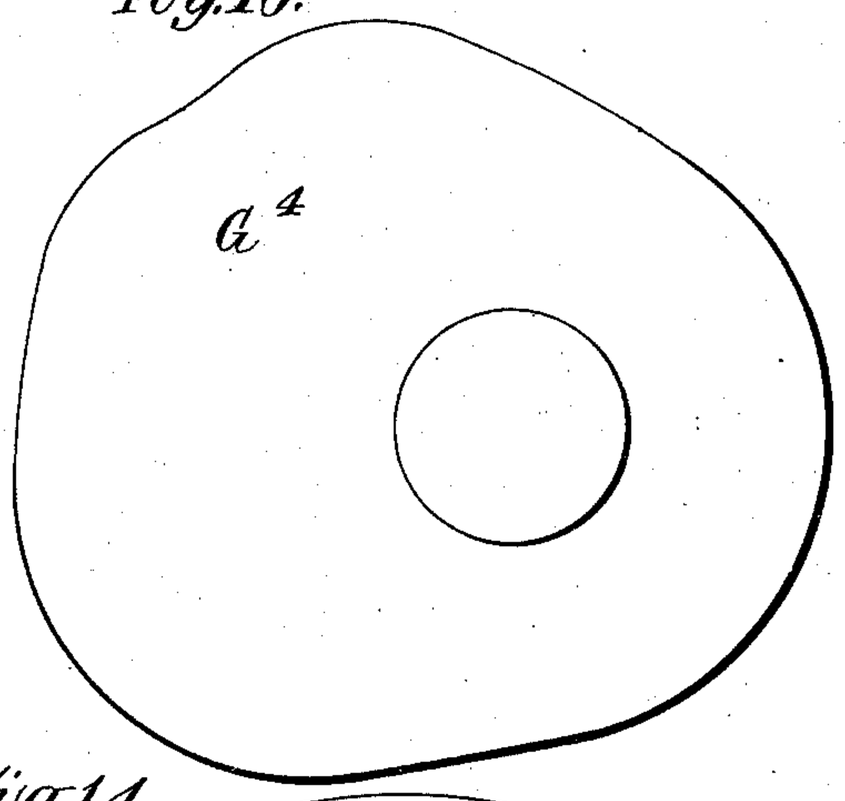
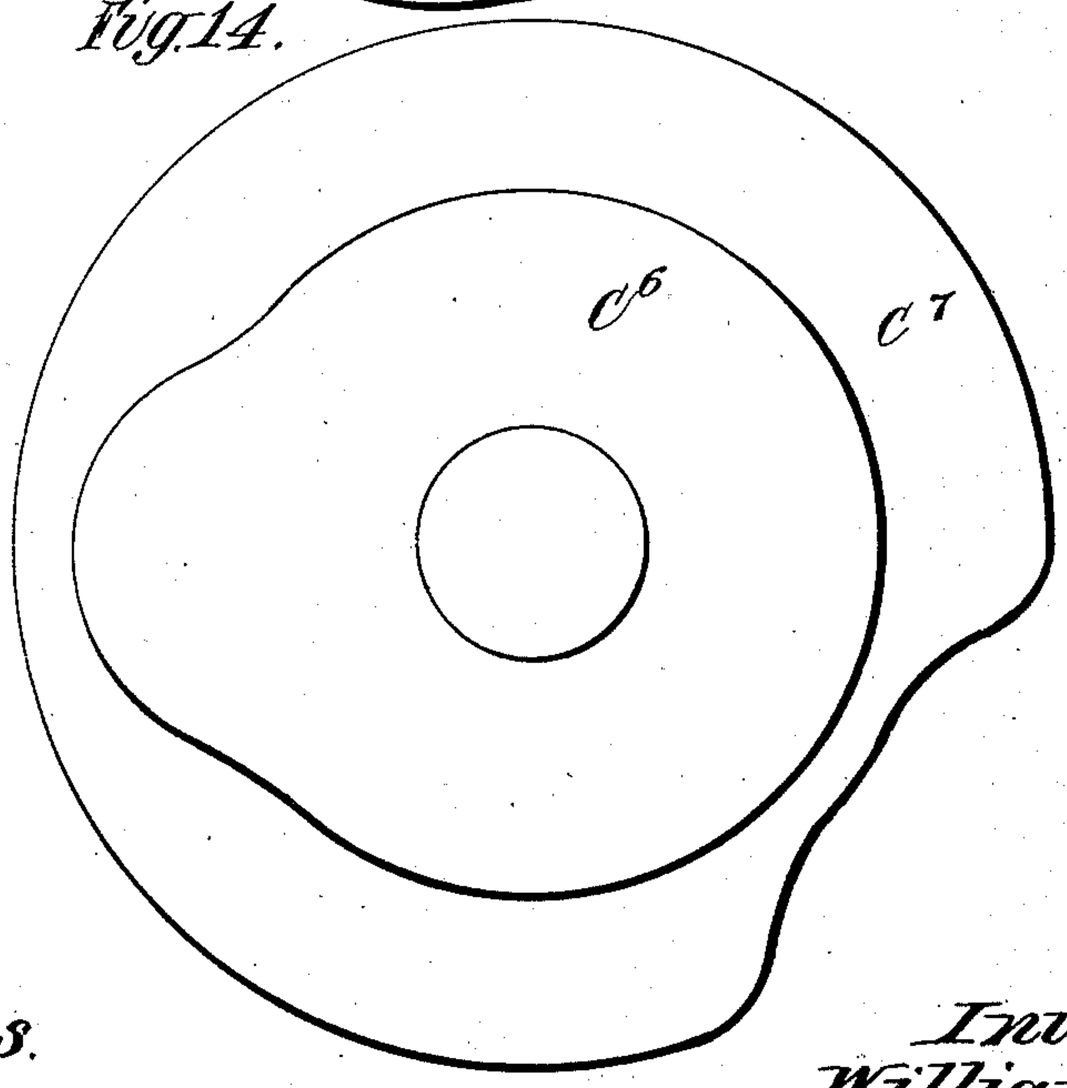


Fig. 14.



Witnesses.
Victor Coombs
Robt Sorrett.

Inventor.
William Start.
By James L. Norris.
Atty.

(No Model.) 9 Sheets—Sheet 9.

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CIRCULAR WARP KNITTING MACHINE.

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Fig. 11.

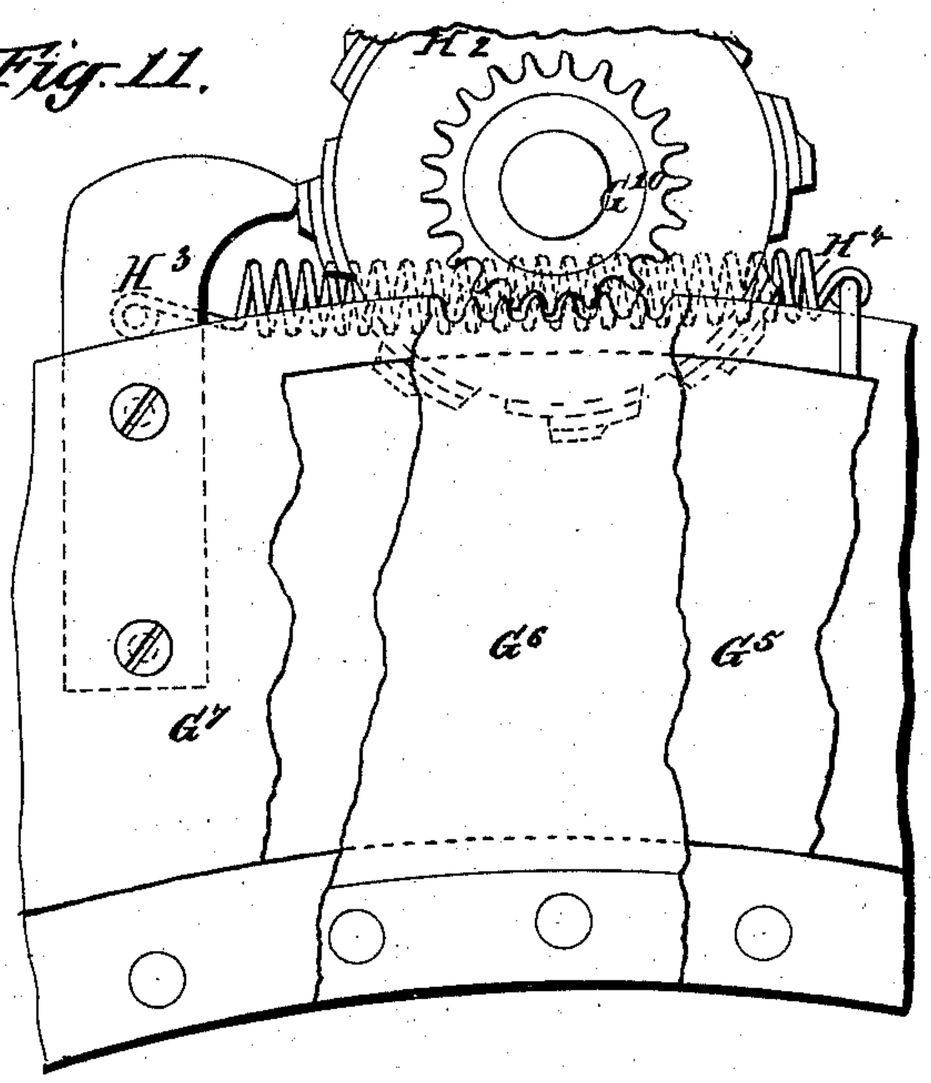
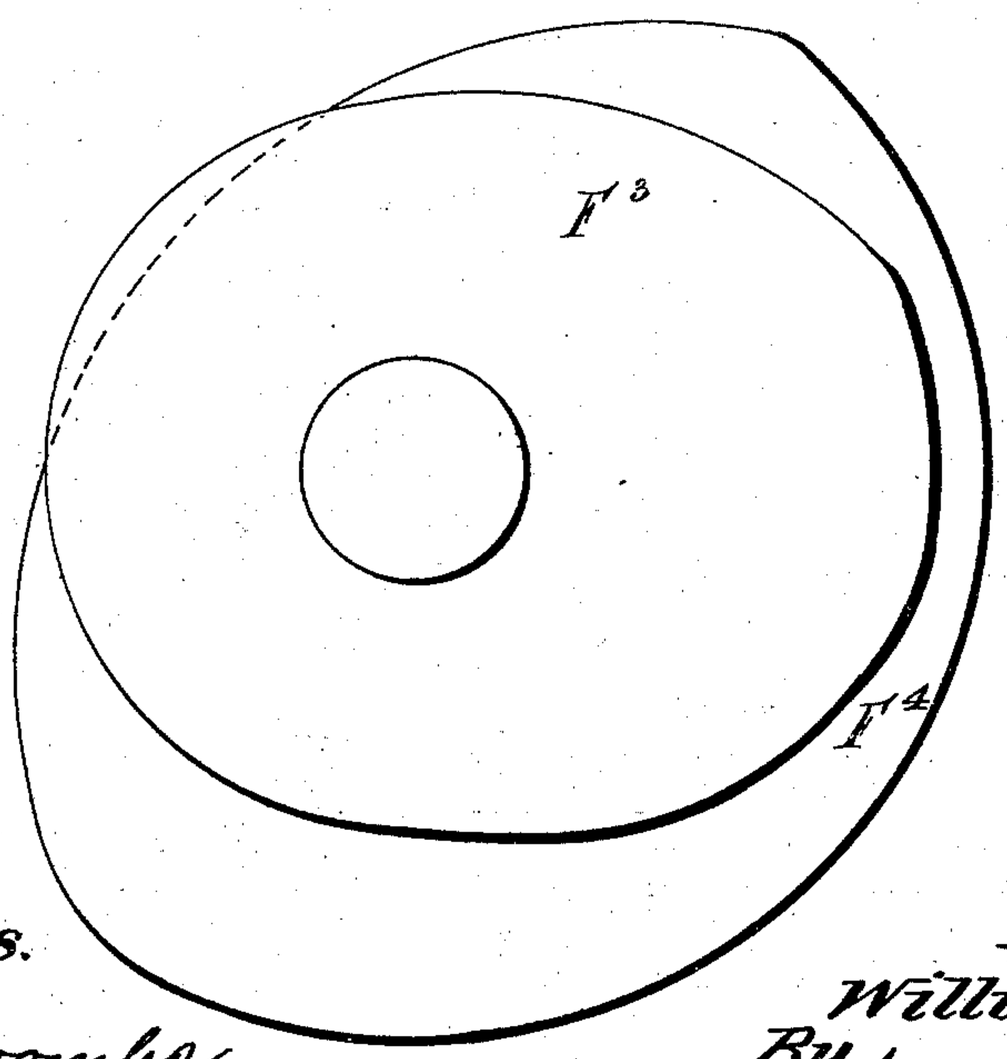


Fig. 15.



Witnesses.
Victor Coombs
Robert Swett.

Inventor.
William Start.
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

WILLIAM START, OF NOTTINGHAM, ENGLAND.

CIRCULAR WARP KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 410,040, dated August 27, 1889.

Application filed December 23, 1886. Serial No. 222,382. (No model.) Patented in England February 26, 1886, No. 2,782, and in Germany November 23, 1886, No. 39,904.

To all whom it may concern:

Be it known that I, WILLIAM START, machinist, a subject of the Queen of Great Britain, and a resident of Nottingham, England, have invented new and useful Improvements in Circular Warp Knitting Machines, (for which I have obtained a patent in Great Britain, No. 2,782, February 26, 1886, and in Germany, No. 39,904, November 23, 1886,) of which the following is a specification, reference being had to the accompanying drawings.

Figure 1 is a front view of my improved traversed warp machine with the plates carrying the operating-instruments shown in section. Fig. 1^a is an enlarged sectional detail view of the lower front portion of the machine. Figs. 2, 2^a, and 2^b are vertical sectional views of the machine, looking from the right-hand end. Fig. 3 is a plan view showing the relative positions of a sole-plate carrying two revolving circular guide-plates, two vertical shafts, two toothed wheels, and two worm-wheels on the cam-shaft. Fig. 4 shows a sectional view, drawn to an enlarged scale, of the operating-instruments in their operative positions. Figs. 5 to 13 and Figs. 4^a, 4^b, 4^c, 4^d, 6^a, and 11^a illustrate portions of the machine, shown separately and severally referred to hereinafter; and Figs. 14, 15, and 16 show enlarged side views of the cams employed.

Each machine consists of two end standards A, connected at their upper ends by a tie-bar A′ and at their lower ends by two stretchers A^2. The standards have brackets *a a* projecting from them, which carry bearings *b b* for two shafts B and B′. The shaft B is provided with a fly-wheel B^2, and a fast pulley A^3 and a loose pulley A^4 for a driving-strap. This shaft B carries three pairs of cams C^6, C^7, F^3, F^4, and G^4, each pair of which operates a pair of truck-bearing levers C^4 F^2 G^3, (see Figs. 1, 2, 2^a, and 2^b,) the two central pairs of which are free to move partly round upon the shaft B′, which is parallel with the cam-shaft. The two outer levers forming the third pair are secured to and rock with the shaft B′.

From the lower side of the slotted tie-bar A′, at its center, a boss *c* projects, in which a vertical rod C is secured, on the lower end of which a circular plate C′ slides vertically. This plate is provided on its circumference with leads carrying sinker-hooks C^2, Fig. 4^b, of any required gage. (Shown at Figs. 1, 2, 4, a front view of one such lead being presented at Fig. 5.) Presser-bits C^3, Fig. 4^a, are placed between the sinkers when bearded needles are employed. The rising and falling of the sinker-plate C′ is effected by one pair of two-armed truck-bearing levers C^4, which are free to move partly around upon the shaft B′, being hinged to the upper ends of a pair of vertical rods C^5, the lower end of each of which is secured to the sinker-plate by an axle-pin *d*, passed through it, and a stud C^8 on each side of it, which projects from the sinker-plate.

Each lever C^4 is operated by a cam C^6, which acts upon the truck on the outer end of the lever, the truck on the lower end of the lever being operated by a counter-cam C^7, Figs. 1 and 2. A side view of one pair of these cams is shown at Fig. 14.

A side view and outer edge view of one of the presser-bits C^3 are shown at Fig. 4^a, and a side view of one of the sinker-hooks C^2 at Fig. 4^b. Thirty-two sinker-hooks and thirty-two presser-bits are placed side by side, a wire being passed through the hole C^{10} in each of them. The sixty-four pieces are riveted together, and after the ends of the rivet are filed off flush with the pieces the whole are placed in a mold having tricks inside, which keep the sinker-hooks parallel, while molten metal (tin and lead) is poured into the mold, which incloses the tops of the presser-bits and sinker-hooks in one mass C^9. It also flows through and around the holes in the lower ends of the sinkers and around said ends and takes the form C^{9*}, forming one lead of sinker and presser-bits, as shown at Fig. 5, the requisite number of such leads being secured by screws to and rising and falling with the circular plate C′, which is provided with two pairs of studs C^8, connected by axle-pins *d* to the lower ends of the two rods C^5. (See Fig. 1^a.)

Above the sinker-plate C′ is a double-flanged circular bed D, which is supported

by being securely fixed to the vertical rod C by means of a pin D^7, which is passed into holes in the tubular center *e* of the bed D and a corresponding hole in the rod C, as shown in Figs. 1, 1ª, and 2. The lower flange of the bed D is provided with a circular brass sley D′, in which tricks are cut. These tricks radiate from the center and in each a slide D^2 moves to and fro. Each slide D^2 is provided with a locker-plate D^3, the sides of which clip the slide and rock upon an axle-pin *f*, secured in it. Each locker-plate, when in the position shown at Figs. 1, 2, and 4, secures a lead of needles. One of these leads is shown in plan at Fig. 6ª. The lower edge of the lead is grooved, as shown, to receive the top of the slide, upon which it is firmly pressed by the locker-plate. When a needle is broken, the lead may be readily released by simply turning the locker-plate up into the position shown by dotted lines at Fig. 4. The lead can then be taken off and a new one substituted. Each lead is provided with the requisite number of bearded or latch needles. One of the slides D^2 is shown in plan and side view at Fig. 4ª, and one of the locker-plates D^3 is shown in plan and side view at Fig. 4ᶜ, and one lead of needles is shown in side view, plan, and under side view at Fig. 6ª. The under side of each lead is grooved to receive the top edge of the slide, and the back end of the needle-lead has a recess on each side, the remaining central piece being clipped by the two under edges of the locker-plate carried by the slide. Bearded needles are shown in the drawings. The outer ends of these needles pass to and fro between the sinkers at each course, being operated by the following means:

Each of the whole circle of slides is moved inward and outward by right-angled jacks D^4. A jack is shown in edge view at Fig. 7. The lower end of each jack carries a stud *g*, which takes into a hole *g′* in the back end of the slide, as shown in Fig. 4. Above the lower stud each jack is provided with a projecting stud *h* on one side, which lies in a groove *i*, cut in the circumference of a slotted sley D^5, Figs. 1, 2, 4, and 1ª, in which the jacks rock. This sley is secured to the upper flange D^6 of the fixed circular bed, before described, and shown separately in plan at Fig. 8. The jacks are kept in position by a loose ring E encircling the whole of them. The inner edge of the ring rests upon the outer upper edge of the sley D^5, and has four arms secured to it, the lower ends of which are attached to a light ring E′, which rests upon the tops of the needle-leads, before named. This ring prevents a needle-lead from rising up when the fabric is pressed off the needles, and thereby avoids breakage. The circular plate C′ carries two vertical pins C^8, which slide vertically in corresponding holes in the lower flange of the circular bed D, as shown in Fig. 4. This arrangement prevents vibration and insures the sinkers always being in a central position between the next adjacent needles. The jacks D^4 are rocked by their inner ends taking into a groove cut in the circumference of a circular plate F (Shown separately in plan, Fig. 9.) This circular plate has a rising-and-falling movement communicated to it by the following means: The boss *k* of the plate F carries a short axle-pin *m* on each side, which pins are connected to the lower ends of the vertical rods F′, having their upper ends hinged to a second pair of truck-bearing levers F^2, which are free to turn upon the shaft B′, before named, as shown in Fig. 2ª, the truck on the outer end of one lever being operated by a cam F^3 and the truck on the lower end of the other lever being operated by a counter cam F^4, both cams being shown in side view at Fig. 15. Each standard on one side has two projecting brackets, upon which a pair of bearings G are secured by means of screws *t*, Fig. 1. Each bearing is capable of adjustment by means of two set-screws *n* and lock-nuts *o*. (Shown in plan at Fig. 3.) In each pair of bearings a plunger-rod G′ slides vertically. The upper ends of these rods are hinged to the lower ends of links G^2, each of which at its upper end is hinged to one of the third pair of truck-bearing levers G^3. These levers are each operated by a cam G^4, Fig. 2ᵇ, one of which is shown in side view at Fig. 16. These cams communicate a rising-and-falling movement to a circular sole-bar G^5, which is attached to the plunger-rods.

The sole-bar carries two circular guide-plates G^6 G^7, one above and the other below it, and each plate is provided with leads of thread-guides G^8, the guides in which radiate toward the center of the machine. One such lead of guides is shown in plan at Fig. 10. The upper guide-plate G^6, as it is revolved or traversed, slides upon the sole-bar, and the lower guide G^7 is kept in position by and slides upon four clips G^9, secured to the sole-bar. Either plate can be revolved the reverse way to the other, or both together either way, by the following means:

Each guide-plate has teeth cut round the whole of its circumference. Only a few of these teeth are shown in the drawings, Figs. 3 and 11. The teeth of the upper guide-plate engage with a toothed wheel G^{10}, and the teeth of the lower guide-plate engage with a toothed wheel G^{11}. The wheel G^{10} is shown in gear with a portion of the guide-plate G^6 at Fig. 11. Each of the toothed wheels is secured on the lower end of a vertical shaft *p*, which revolves in a bearing G^{14}, capable of adjustment, as hereinafter explained, on a bearing-bracket G^{12}, which is secured to the sole-bar, and shown in plan at Fig. 3. The upper end of each shaft revolves in a bearing G^{13}. (Shown only at Figs. 1 and 2.) The shafts are each provided with a toothed wheel H. A portion only of these teeth are shown in plan at Fig. 3. Each wheel is partially revolved by a worm H′ of the cam-shaft B. The lower

ends of the vertical shafts *p*, carrying the toothed wheels G^{10} and G^{11}, revolve in bearings G^{14}, which are slotted at *u*. Through these slots screws *v* are passed to adjust said bearings on the bearing-brackets G^{12}. One such slotted bearing G^{14} and bracket G^{12} is shown in plan and inner edge view at Fig. 11^a. There are slots *w* near the ends of the bracket G^{12}, through which screws pass to secure it when adjusted to the sole-bar G^5.

The worm-wheel at the right end of the machine is shown in side view at Fig. 12 and in edge view at Fig. 13.

The upper circular guide-plate is provided with as many bearing-brackets I as are required, the number varying with the diameter of the guide-plates. The lower guide-plate is provided with a like number of bearing-brackets I′. Each bracket carries one end of two spindles I^2, upon which two next adjacent warp-spools K revolve. One end of each spool is provided with a grooved pulley, around which an india-rubber band I^3 is passed, by which the required tension is put upon the warp-threads in the usual way. The spindles are retained in the bearings on the upper guide-plate by split pins I^4, and in those of the lower guide-plate by springs I^5, both of which are shown at Fig. 4. The whole of the warp-threads either traverse or are revolved with their respective guide-bars. When the guide-plates are revolved, they move in a reverse direction, as indicated by the arrows shown in Fig. 3.

The highest positions of the guide-leads G^8, the sinker-hooks C^2, and presser-bits C^3 when the work has been knocked over the heads of the needles by the completion of the inner movement of the slides D^2 are indicated in Fig. 4 by dotted lines. The back position of one such slide is also shown by the dotted lines at Fig. 4. When the guide-bars G^6 G^7 have been moved to their highest position by the upward movement of the sole-bar G^5, they are traversed in a reverse direction to each other, as shown by the arrows in Fig. 3, over one needle. The guides are then passed down through the needles, and are traversed under two needles at each course to make plain traversed warp fabric.

The guide-bars do not move vertically while being revolved; but when the guides are at their highest position both guide-bars are traversed to carry the guides over the requisite number of needles before being lowered through the needles.

When patterned warp fabrics are required to be made, the plate G^6 is traversed at each course by means of the toothed wheel G^{10}, the wheel G^{11} being removed from the machine to allow the plate G^7 to be operated by a pattern-wheel H^2. The bar G^7 is provided with a projecting stop-piece H^3, which is held to the pattern-wheel by means of a spring H^4, one end of which is attached to it, the other end of the spring being attached to a stud projecting from the sole bar or plate G^5. The guide-plate G^7 is traversed intermittently under two needles and over one as the pattern-wheel is revolved.

The machine is provided with a work-roller to receive the fabric below the circular sinker-plate, the roller being operated by a cam and levers in the usual way.

Having now described the several parts of the machine separately, I will describe the combined movements of the operating-instruments while making one course of work.

The needles being out and the sinkers and guides being down in their relative positions, as shown in Fig. 4, the guides rise up through the needles and the top guides are traversed to the left and the bottom guides to the right, in which position they are lowered through the needles to their lowest point. The needles are drawn in to place the inner ends of their beards against the sinker presser-bits, the beards being slightly depressed by the bits as the needles are drawn in and the previous loops being landed on the beards. The inward movement of the needles is continued until their heads are level with the webs of the sinkers. The sinkers then rise to allow the heads of the needles to pass under the webs, the work being knocked over the heads of the needles by the bellies of the sinkers as the sinkers rise, and the needles complete their inward movement. The sinkers are then lowered to place the work under the arches of the sinkers, and the needles resume their first outward position. The movements are repeated for the next course.

Thus upon a machine constructed and operating as above described I am enabled to make single traversed net with one plate or both plates, or double traversed net with the two plates being reversely traversed; or I can make patterned warp lace, taffeta, or knotted fabrics by changing the pattern-wheels according to requirements.

Having thus described my invention, what I claim is—

1. The combination of the shafts B B′, the vertical rod C, the vertically-sliding sinker-plate C′, the sinker-hooks and presser-bits carried by said plate, the double-armed levers C^4, the vertical rods C^5, to the upper ends of which said levers are hinged, the studs C^8, and the axles *d*, for connecting the lower ends of said rods to the sinker-plate, and the cams C^6 C^7, located on the shaft B, for actuating the levers C^4 and rod C^5 to raise and lower the sinker-plate, substantially as described.

2. The combination of the vertically-sliding sinker-plate C′, means for actuating said sinker-plate, the vertical rod C, the circular bed D, secured to said rod above the sinker-plate, the sley D′, supported by said bed, the radial slides D^2, supported in the sley, each of said slides being provided with a pivoted locker-plate D^3, the needles, sinker-hooks, and presser-bits, the jacks D^4, one of which is pivoted in the rear or inner end of each slide, the slotted sley D^5, engaging the upper

ends of said jacks, the rings E E′, and means for rocking the jacks, substantially as described.

3. The combination of the vertical rod C, the vertically-sliding sinker-plate C′, means for actuating said sinker-plate, the bed D, the sley D′, the radial slides D^2, the needles, sinker-hooks, and presser-bits, the right-angled jacks D^4, the vertical sliding plate F, the vertical rods F′, connected with said plate, the levers F^2, hinged to the upper ends of said rods, the shafts B B′, and the cams F^3 F^4, substantially as described.

4. The combination of the standards A, having adjustable bearings G, the plunger-rods G′, adapted to slide vertically in said bearings, the links G^2, hinged to the upper ends of said rods, the levers G^3, hinged to said links, the shaft B′, the shaft B, the cams G^4, mounted on said shaft to actuate the levers G^3, the vertically-sliding sole-bar G^5, carried by the plunger-rods, the circular guide-plates G^6 G^7, carried by the sole-bar, the thread-guides G^8, carried by said guide-plates, and means for revolving the guide-plates, substantially as described.

5. The combination of the vertically-sliding sole-bar G^5, the toothed circular guide-plates G^6 G^7, carried by the sole-bar, and each provided with thread-guides G^8, the toothed wheels G^{10} G^{11}, engaging the guide-plates and provided with vertical shafts *p*, the toothed wheels H on the upper ends of said shafts, the worms H′, and the shaft B, carrying said worms, substantially as described.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

WILLIAM START.

Witnesses:
H. W. GOUGH,
MARK SHAW.