7 Sheets—Sheet 1.

W. H. ABEL.

WEFT THREAD KNITTING LOOM.

No. 105,537. Patented July 19, 1870.

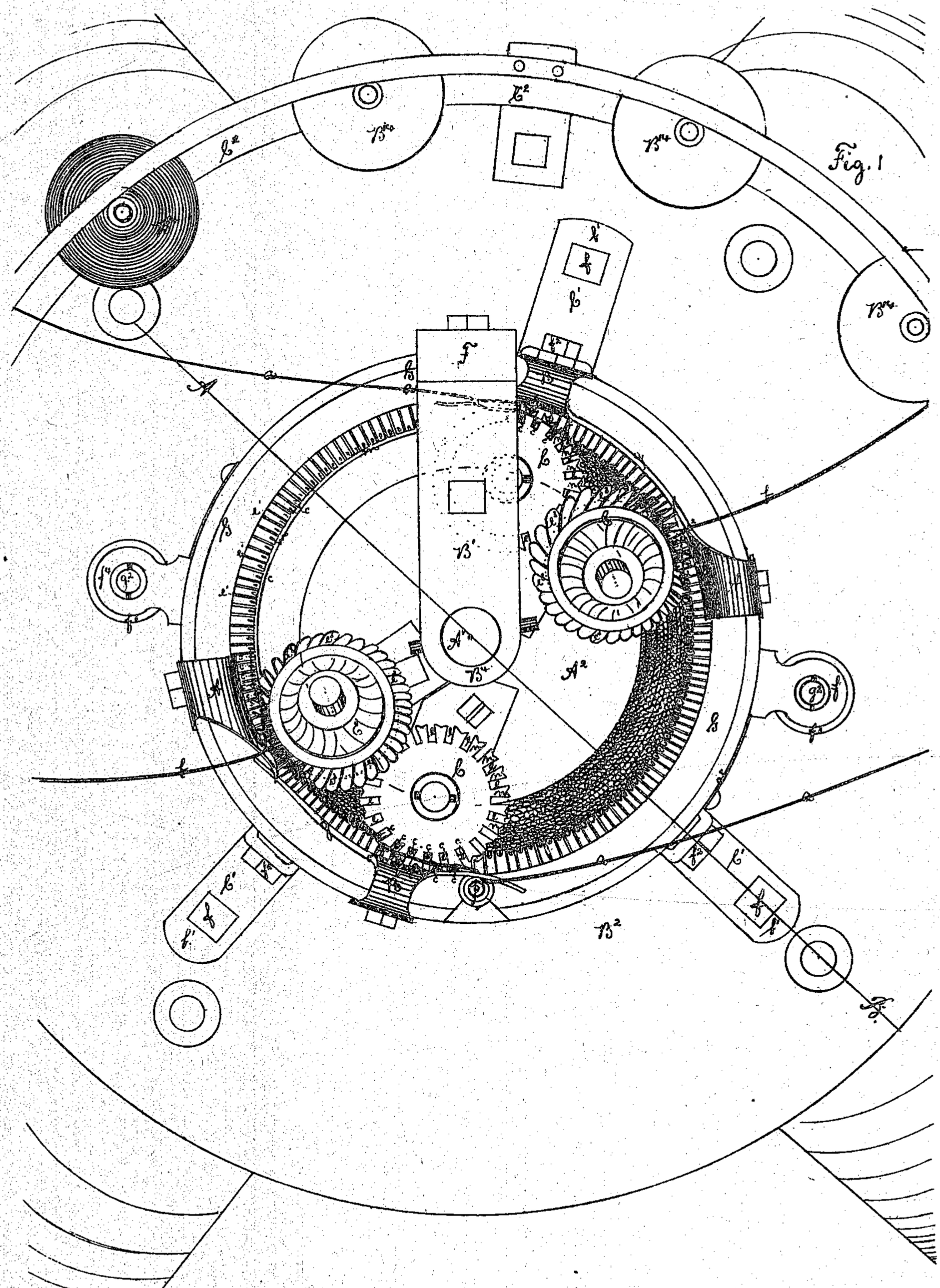

Fig. 1

Witnesses
Wm. J. Brown
Nathan Brown

Inventor.
William H. Abel

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W. H. ABEL.

WEFT THREAD KNITTING LOOM.

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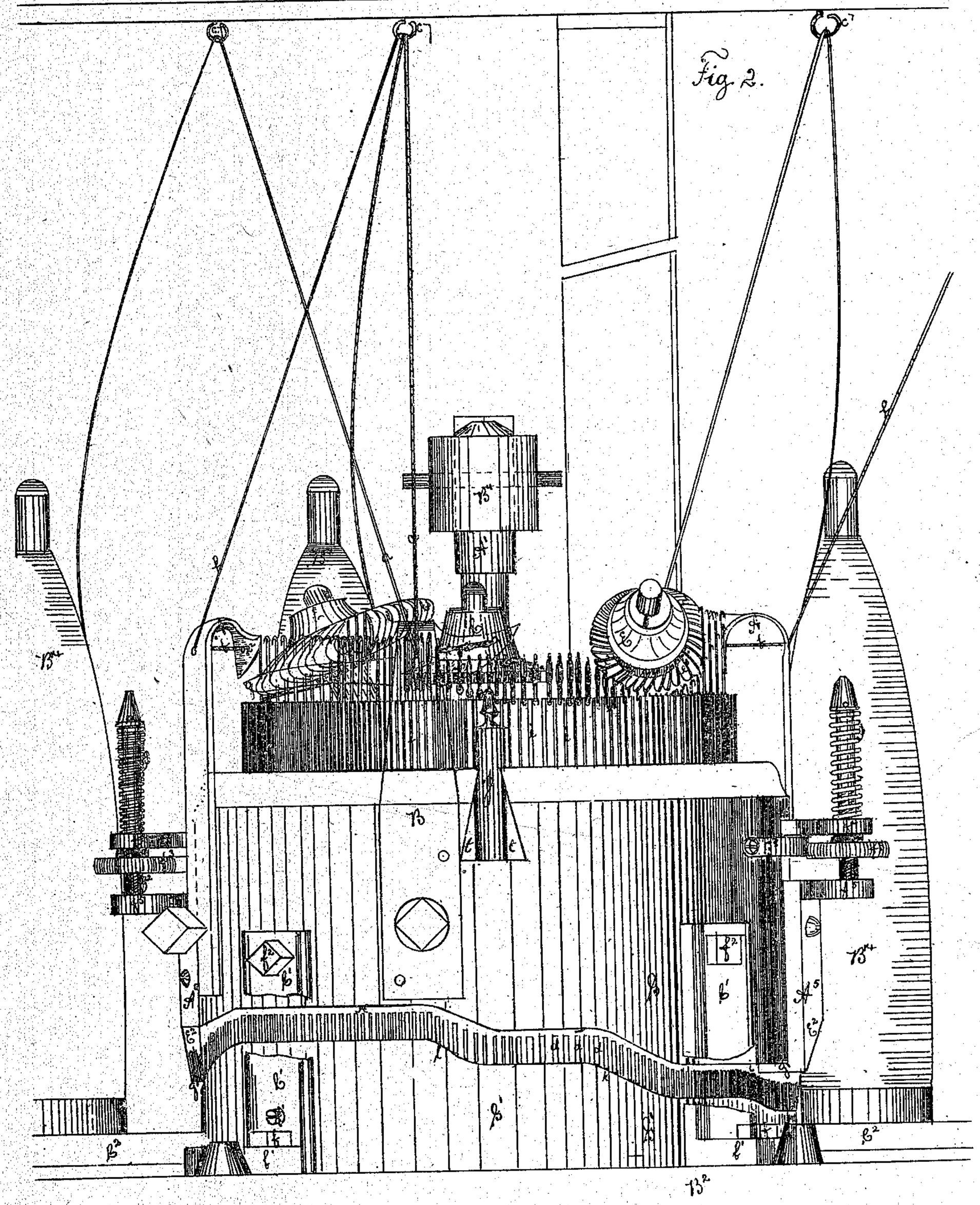
Fig 2.



Witnesses.
Wm. S. Brown
Nathan Brown

Inventor.
William H. Abel

7 Sheets—Sheet 3.

W. H. ABEL.

WEFT THREAD KNITTING LOOM.

No. 105,537. Patented July 19, 1870.

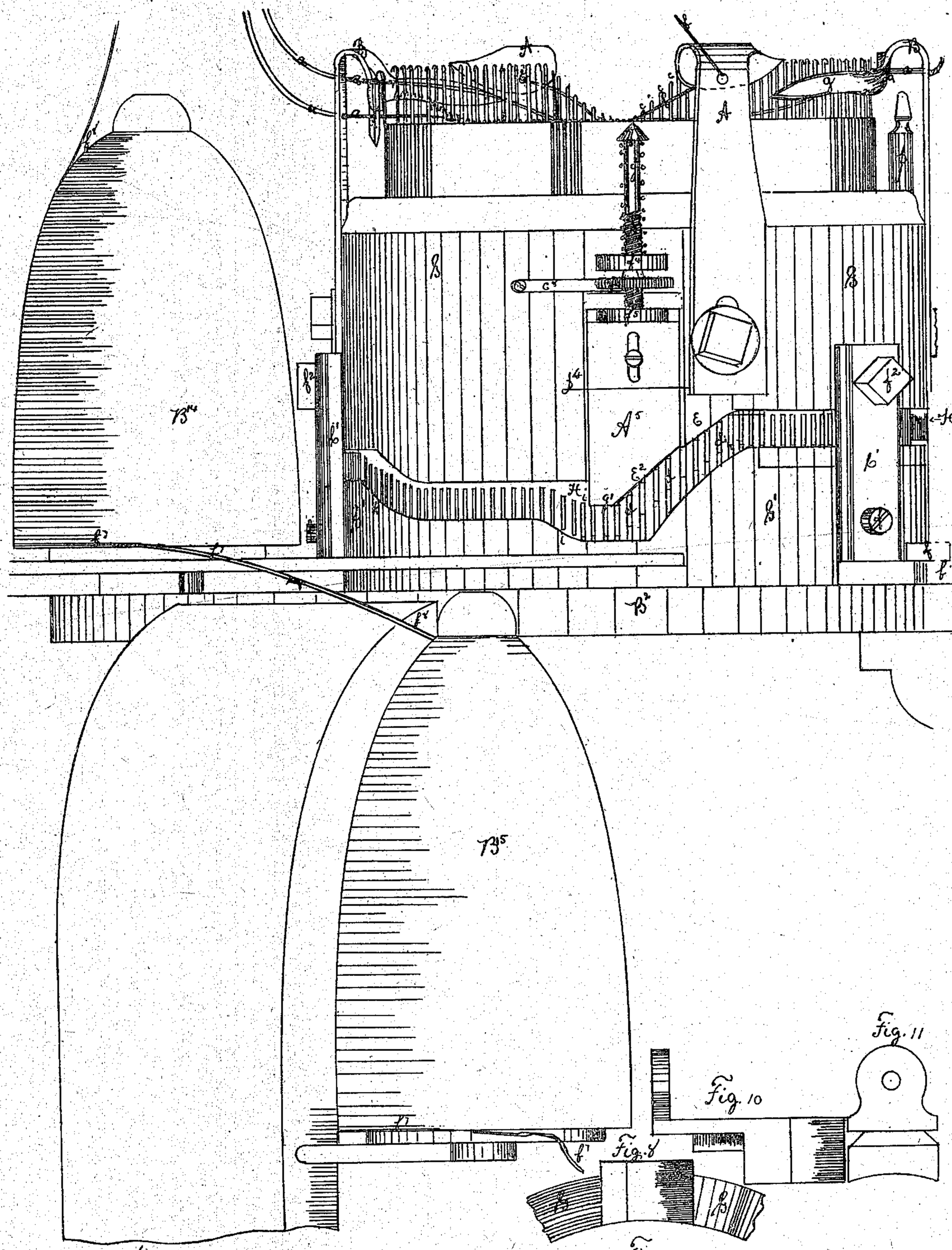


Fig. 11

Fig. 10

Fig. 8

Fig. 9

Witnesses.
Wm. E. Brown
Nathan Brown

Inventor.
William H. Abel

7 Sheets—Sheet 4.

W. H. ABEL.

WEFT THREAD KNITTING LOOM.

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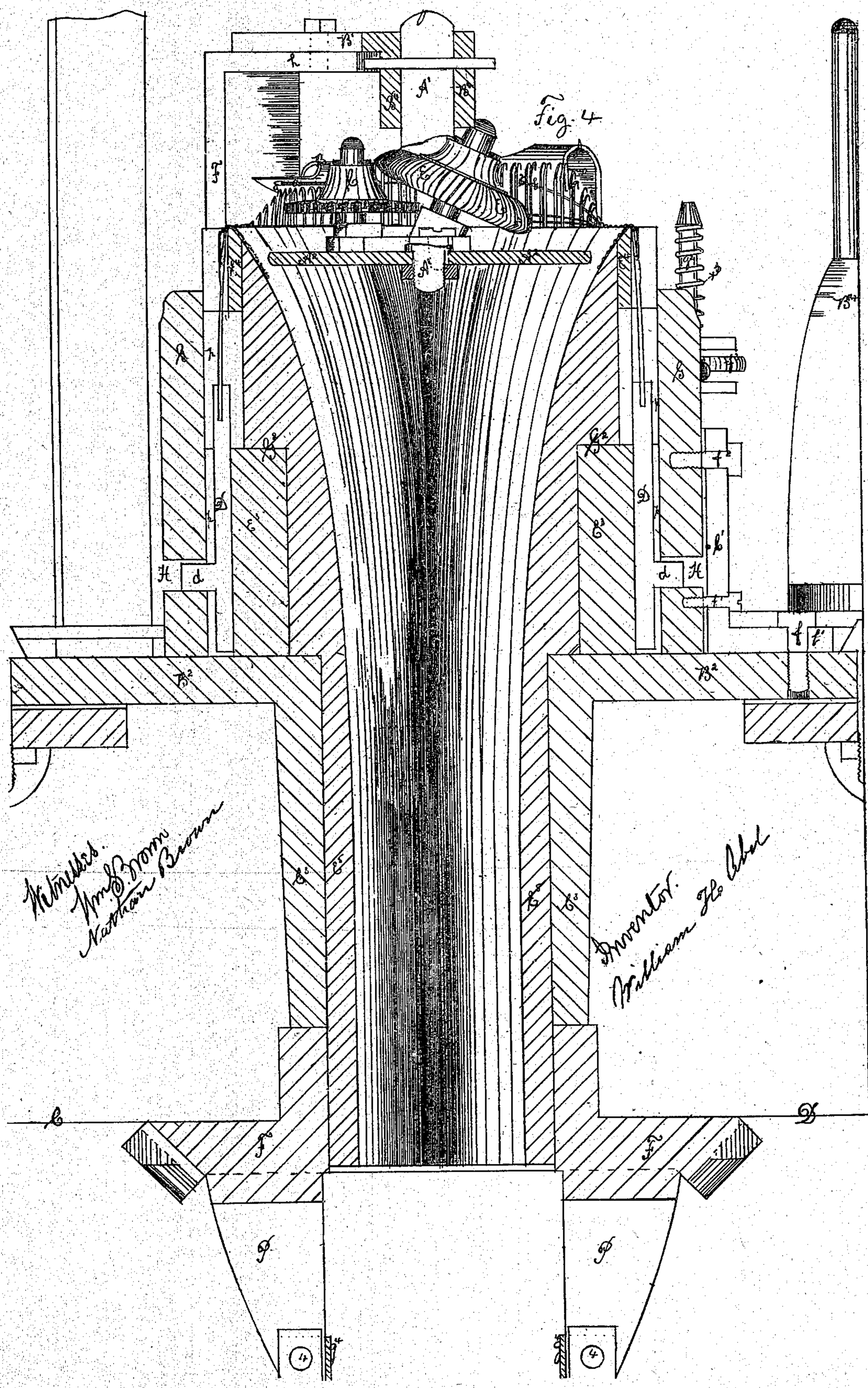
Fig. 4



Witnesses.
Wm. S. Brown
Nathan Brown

Inventor.
William H. Abel

7 Sheets—Sheet 5.

W. H. ABEL.

WEFT THREAD KNITTING LOOM.

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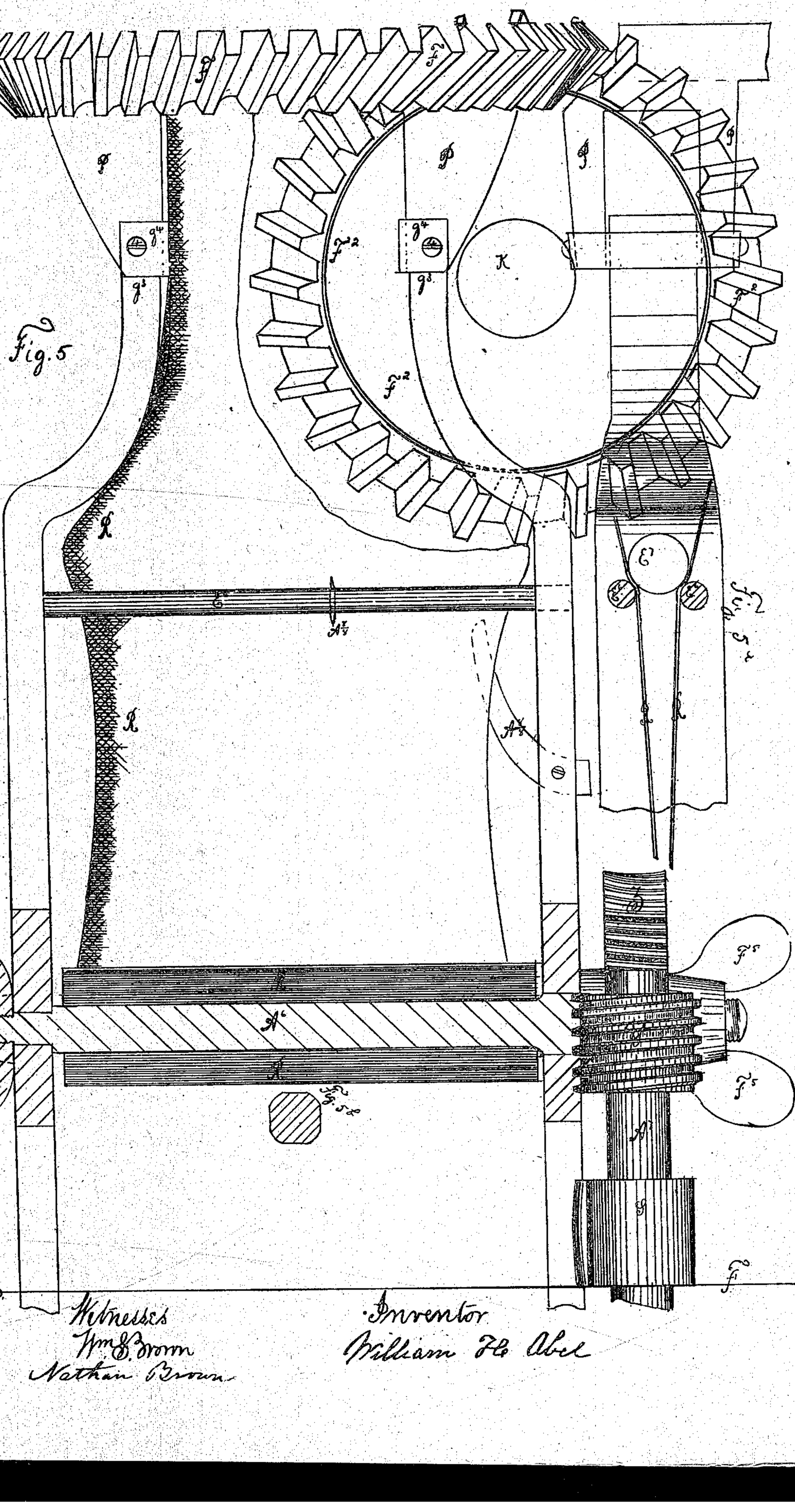

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W. H. ABEL.

WEFT THREAD KNITTING LOOM.

No. 105,537. Patented July 19, 1870.

Fig. 6

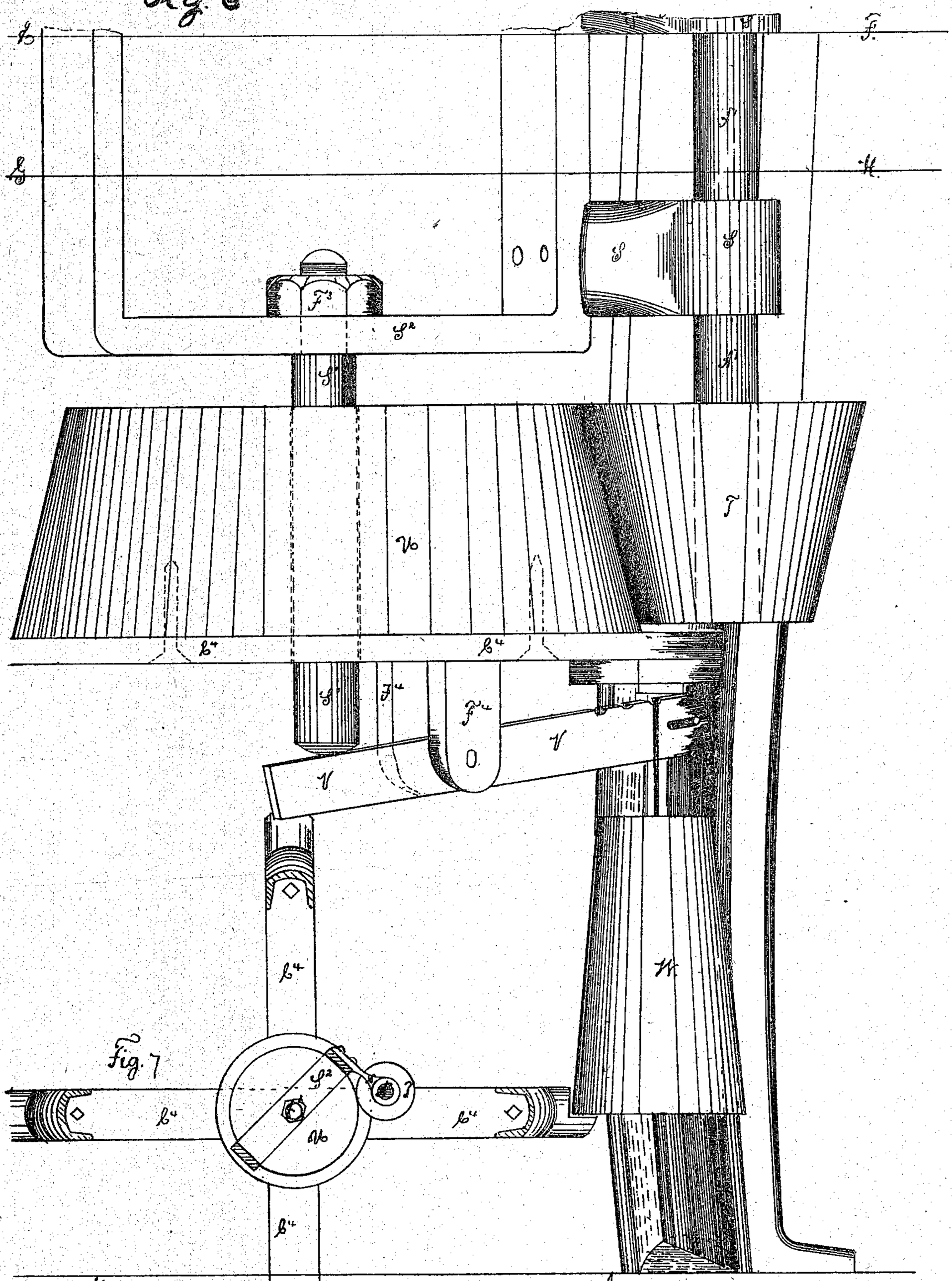


Fig. 7

Witnesses
Wm. C. Brown
Nathan Brown

Inventor.
William H. Abel.

7 Sheets—Sheet 7.

W. H. ABEL.

WEFT THREAD KNITTING LOOM.

No. 105,537. Patented July 19, 1870.

Fig. 12

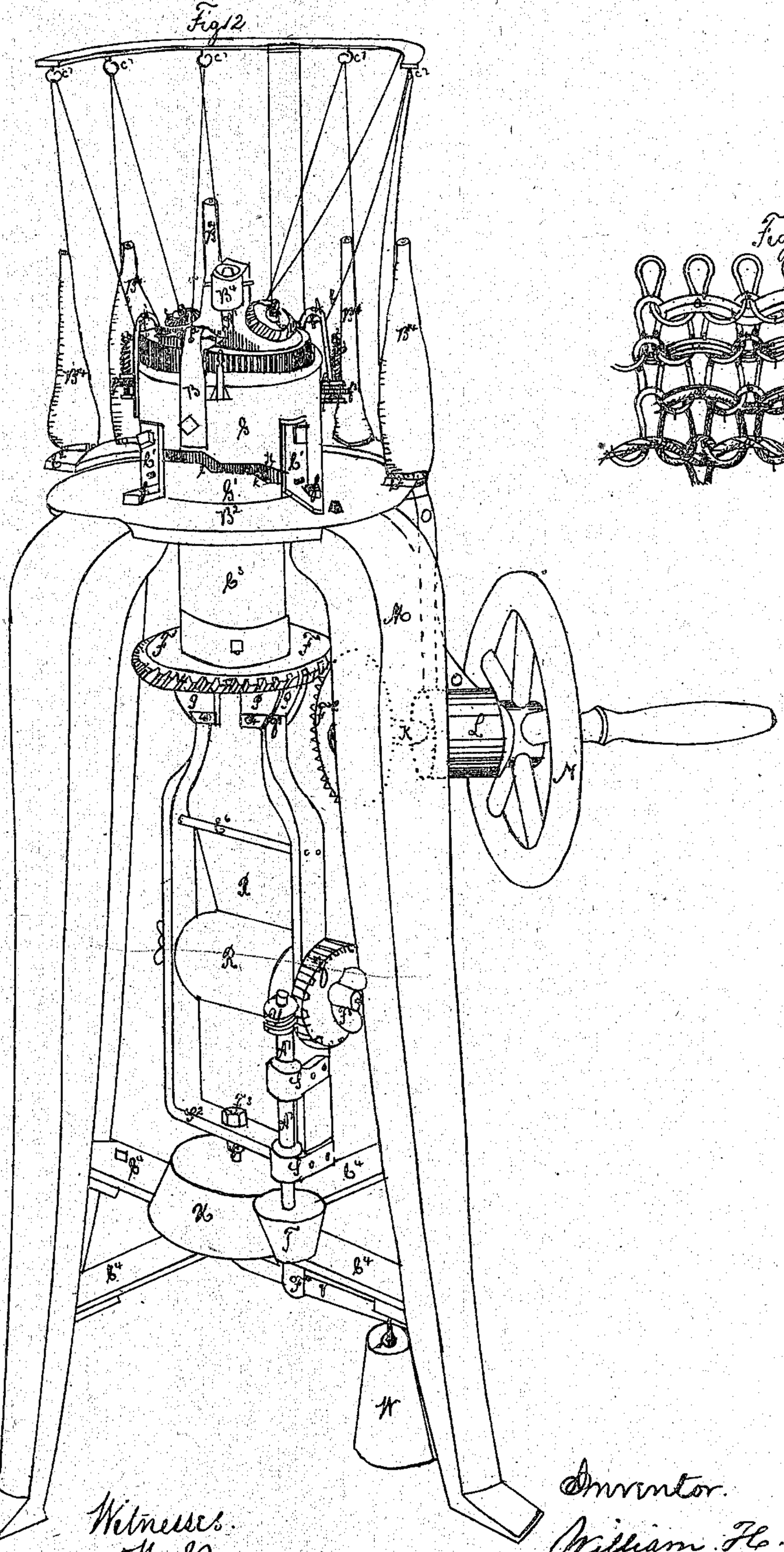
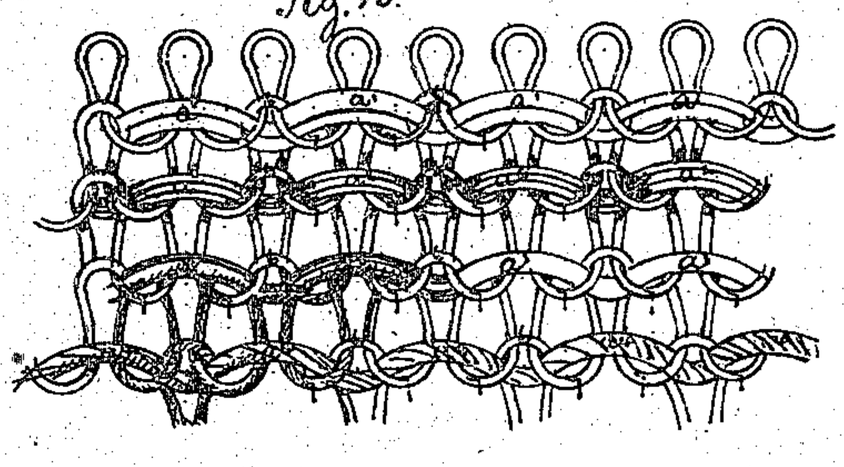


Fig. 13.



Witnesses.
Wm. E. Brown
Nathan F. Brown

Inventor.
William H. Abel.

UNITED STATES PATENT OFFICE.

WILLIAM H. ABEL, OF BENNINGTON, VERMONT.

IMPROVEMENT IN KNITTING-MACHINES.

Specification forming part of Letters Patent No. **105,537**, dated July 19, 1870.

To all whom it may concern:

Be it known that I, WILLIAM H. ABEL, of Bennington, in the county of Bennington and State of Vermont, have invented certain new and useful Improvements in Weft-Thread Knitting-Looms, of which the following is a full, clear, and exact description, which will enable others skilled in the art to make and use my invention, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1, Sheet 1, represents a plan or top view of my said machine in one of its varied arrangements and combinations of parts. Fig. 2, Sheet 2, and Fig. 3, Sheet 3, represent, each, a different side elevation of the upper portion or loom-head with yarn-bobbins arranged thereon. Fig. 4, Sheet 4, represents a central vertical section on the line A B of Fig. 1, the transverse line C D indicating the top of the next or succeeding figure. Fig. 5, Sheet 5, represents the central portion, partly in section, the line C D showing the top line in this and the corresponding line in Fig. 4. Fig. 5^a shows a cross-section of the flier, the stretcher-rods E^6, the stretcher E^7, and the fabric R, the top part of the flier and the ears P, which depend from the web of the gear F, being partly concealed by the gear F^2. Fig. 5^b is a cross-section of the cloth roll or shaft A^6. Fig. 6, Sheet 6, represents the lower portion, or that portion below the line E F of Fig. 5, the same letters in this figure indicating the same line in the former. Fig. 7, Sheet 6, represents a horizontal section on the line G H of Fig. 6. Fig. 8, Sheet 3, represents the lower end of the adjusting-cam A^5, and a portion of the outer cylinder G, with which it is connected; Fig. 9, a section of the latter on the line I^4 of Fig. 3. Fig. 10 is a side, and Fig. 11 a top, and view of one of the cams A^5 detached. On Sheet 7, Fig. 12 represents a perspective view of one of my weft-thread knitting-looms, and of that combination of parts shown in Figs. 1, 2, 3, and 4. The parts shown in Figs. 5, 6, and 7 are the same in all, as also some of the parts shown in the preceding figures, particularly the inner cylinder. Fig. 13 represents a specimen of the fabric produced by my improved weft-thread knitting-loom, drawn very open, to show the position and form of each loop or part, and the direction of each thread or yarn to form the fabric.

Experiments have demonstrated that textile fabric can be formed by the knitting process with greater rapidity or expedition and facility than by any other process, and that, by knitting weft or filling threads in with the loops or stitches, and through the latter, or through alternate loops in either direction, and forward of the reverse loops, a very superior, useful, and cheap textile fabric will be the result.

The machine I have found best adapted for knitting or for forming the aforesaid textile fabric is, in many respects, substantially similar to the common circular-knitting machine; and this machine, with the necessary alterations or changes and additions, which render it eminently successful in the production of such textile fabric, I have clearly shown in the accompanying drawings.

Commencing with Fig. 1, which I have previously stated is a top view of my weft-thread knitting-loom in one of its varied constructions, arrangements, and combinations of parts, I have here shown at one side, and nearly the whole circumference, the work upon the needles, and the two weft-threads *a*, and two warp or knitting threads, *b*, as they appear when passing, the former between, and the latter outside of, the needles *c*. At the opposite side I have shown the top ends of the needles, but no loops or work upon them. The warp or knitting thread guides A are constructed, applied, and arranged to lead or guide their threads to, and outside of, the needles, in the usual way; but the weft-thread guides B are each provided with a latch-guard, *g*, and here Figs. 2 and 3 show the parts shown in Fig. 1. In Fig. 2 the weft-thread guide B, or the upper portion, containing the thread-passages and the latch-guard, is shown in transparent elevation, in order to convey a more clear idea of the work behind it.

The object of the latch-guard is to prevent the latches flying up when the needles rise through the old loops, which snap over the lower ends of the downward-hanging latches. Otherwise the latter would be liable to fly up

as the needles passed through the old loops, and prevent the formation of new loops.

In the various modes or methods known to me for carrying out my invention, I employ the latch-guards on or in combination with the weft-thread guides, particularly on this machine, wherein the third rise of the needles occurs before they reach the guides A, which, in some of the common circular-knitting machines, serve the same purpose by being set in the right position and place against the periphery of the rotating cylinder, and the advancing and receding needles. It is not always necessary that the weft-thread guides, or even the warp or looping thread guides, should be in close proximity with the needles, as in Figs. 1, 2, 3, and 4. These may all be arranged at a distance, and still guide their threads correctly to or between the needles; but the latch-guards should be applied in combination with the weft-thread guides, and so close to the needles as to serve the purpose described. In order to actuate the advancing and receding slides D, and the needles, or to open, divide, or separate the latter, as in Figs. 1, 2, 3, and 4, I employ a disk or wheel, C, of common form, having deep radial slots *e*, at suitable distances apart to receive alternate raised and rising needles, and notched or forked ends or teeth *n*, to engage with all the other needles and carry them outward, while all the divided needles are still rising or advancing, thereby providing or producing a path or passage for the weft-thread *a* between the divided and advancing needles which inclose the weft-thread between them as they fully rise and leave the slotted wheels. Inclosed between the raised needles, these weft-threads are each carried forward beneath the spirally-set fins or wings of a presser-wheel, E, set at such an angle, as shown, that the fins or wings e^3 when passing between the needles and downward, shall be on a line with the latter and their line of motion, and press the weft-thread down onto the old loops, (which are below the latches,) and nearly under or opposite the looping-thread guide A, and the inner thread-passage e^2 through the same. Here the looping-thread is guided into contact with and outside of the needles, and the slides and needles are carried downward, their heads below the inner edge *m* of the rotating cylinder and between the partitions e^1, and this operation forms the new loops under the hooks of the needles, throws up the latches and secures the looping-thread, and draws or throws the alternate old loops over the weft-thread and over the newly-formed loops, which become the old loops for successively inclosing the weft-thread, and for the continuous formation of this warp and weft-fabric.

Two, three, or more of the dividing-wheels C and presser-wheels E, and weft and warp guides A and B, are arranged at suitable distances apart on large machines, in the same or in a similar manner as shown in Figs. 1, 2, 3, and 4, in numbers proportionate to the diameter of the cylinder and the number of slides and needles, two of each of the above-named devices being clearly shown in the drawings. In the formation of the fabric herein shown and described, and in reference to Fig. 13, it will be observed that the weft-thread does not pass over one loop and under the next, but directly over one loop, 6, through the two next inverted loops 7, and forward of another like the first, which it partly conceals; thence over a loop, 6, and through two others, 7, as before, and so on. I sometimes form a fabric by passing the weft-thread over successive loops—as, for example, the weft-threads indicated by a^1, a^2, and a^3 all pass over loops in the same row, series, or wale, and this is done in one way by setting all the dividing-wheels C on the same needles. This produces what I call the "basket-weave," which in appearance is like common plain woven cloth; and if the warp or looping thread is white and the weft-thread black, brown, or other dark shade, the cloth will appear to be in very small checks or squares, each thread or threads thrown up to the surface forming, by the shade or color, a check of small dimensions.

The back or outside of the cloth will be the color or shade of the warp or looping thread. I sometimes form the fabric by passing the weft-thread over alternate loops—as, for example, first the thread a^3 over loops in one row, and then that indicated by a^4 over loops in the next row or wale. This will produce a change in the figure from a square to a diamond in form, and this is done in one way by setting the wheels C on alternate needles. This is what I call the "diamond-weave;" for, instead of its having the appearance of checks or squares, it shows an oblique series of figures, each in the form of a diamond or rhombus. A great variety of other figures can be produced by the two simple changes above described, and by changing either or both the warp and looping threads, and substituting those of other and different colors or shades.

The presser-wheels E, before described, are old devices; but I have combined them each with a fully-raised series of reciprocating latched needles and with a thread-guide as described, whereby the weft-thread is introduced between the divided and rising needles by means of a thread-guide and a presser-wheel unaided by any other device. The dividing-wheels and the presser-wheels are arranged on appropriate studs—the former vertical and the latter set at an angle—as shown, and both, or all, properly set and secured to the top of circular disk or plate A^2, arranged on the lower end of a centrally-depending stud, A^1, a little below the top and within the cylinder, leaving ample room for the fabric to pass between the latter and the outer edge of the plate. The upper end of the stud is secured

within the hub B^4 of a stud-plate, B^1, arranged and fastened to the arm *h* of a back bracket, F, which is generally bolted to the outer cylinder G, all as clearly shown in Figs. 1, 2, and 4.

Referring to Figs. 1, 2, 3, and 4 of the drawings, the outer cylinder G, in this particular machine, is the cam-cylinder, or that which contains the cam-groove H, and this cam-cylinder is stationary and confined to the bed-plate B^2 by knee-formed braces C^1. These braces are secured to the bed-plate by bolts *f*, which pass through the feet b^1, and screw into the plate and to the cam-cylinder by screws or screw-bolts f^1 and f^2. The latter or upper ones hold the upper and lower portions G and G^1 apart, or the upper portion in position above the lower portion, and preserve the perfect form of the cam-groove H. This cam-groove receives the butts *d* of the slides D, which, with the needles, are operated or caused to advance and recede by the rotary motion of the inner grooved cylinder G^2 and by the operating butts, as in the common circular-knitting machine, except that the cam-groove in this machine has three rises or rising inclines for operating the slides and the needles, and lower and upper groove H, operating in connection with the butts *d* of the slides, to continuously and automatically form or organize one or more horizontal series of partially-raised needles, and one or more similar series of fully-raised needles, on which to apply dividing-wheels C and presser-wheels E, for dividing the needles, and for the introduction of weft-thread between the thus divided and rising needles by means of a thread-guide and a presser-wheel, unaided by any other device. The first rise, *i*, occurs where the butts pass and leave the lower ends of the adjusting-cams A^5, the second rise, *k*, a little farther onward and into the range of the dividing-wheels, and the third rise, *l*, where the needles are in contact with and as they are passing and leaving these wheels, and while they are dividing or opening, and divided or opened, and receiving and inclosing the weft-threads between them.

A section of the fully-raised needles, covering a space from the point of leaving each dividing-wheel to a point beyond each presser-wheel, and the farther side or edge of each looping-thread guide, remain thus fully raised to allow the wheels E to press the weft-threads down onto the old loops, and preparatory to drawing the alternate last-named loops over the weft-threads, and over the newly-formed loops. These new loops are all formed by a sudden depression of the needles after passing the guides A, caused by the drawing downward of the slides D by their butts *d* passing beneath the inclines E in Fig. 3, and beneath the inclined edges E^2 of the cams A^5 and their lower ends g^1, and these cams A^5 are adjustable vertically to give a greater or less depression of the slides and the needles, and thereby form or draw longer or shorter loops, according to the size of the weft-thread to be inclosed and bound by such loops, or the nature of the fabric being formed. Long and slack loops produce open and light-weighted fabric, and short close loops produce thicker and more weighty fabric, even with the same weft or filling.

The first rise of the slides and the needles hereinabove described is to relieve the work and the needles, and to give the operative parts an easier action than could be obtained by a sudden and abrupt rise, and to relieve and equalize the action of the slides and the needles preparatory to the second rise, which brings the latter into the range of and into actuating or dividing contact with the dividing-wheels.

The third and last rise of the slides and needles has been measurably explained above, and it will be understood that the alternate needles, which are actuated or thrown outward by the dividing-wheels, must rise or advance after having been thus thrown outward, and while in that position, in order to bring them outside of the weft-thread and above it, so that when they leave the dividing-wheels and resume their position in line with the others, they shall inclose the weft-thread between them. This final rise also carries the latches of all the needles upward through the old loops, and leaves the latter in position to close the latches when the needles recede.

It will be observed that the inner eye 9 of the weft-thread guide is arranged below the tops of the fully-raised needles, and about on a line with or opposite the heads of those partially raised. This insures the line of draft of the weft-thread to between the divided and rising needles, which rise at each side of the weft-thread, and carry their hooks above it when they are fully raised.

By these means, and by means of the presser-wheels, unaided by any other device, the weft-threads are fully introduced between the needles, and cannot escape therefrom.

The cam A^5 is adjusted by a screw-rod, g^2, and nut f^3, the latter being turned on the former beneath an ear, f^4, projecting from the side of the cam-cylinder. The rod is secured to the ear f^5 of the cam A^5, and the rod and cam are held up by a spiral spring, I, between the ear f^4, and a pin through the upper end of the rod.

A spring-catch, c^8, attached to the cam-cylinder, engages with the serrated or milled edge of the nut f^3, and prevents it being turned by accident. The spools or bobbins B^{14} of yarn are placed on spindles rising from a creel or stand, C^2, the yarns passed upward and over or through guides c^7, thence downward to and through the guides A and B to the needles; and in order to continue the weft-thread-knitting process, or to keep the machine continually operating and avoid frequent or oc-

casional stopping to knot or join the yarn or threads, I employ two or more spools, B^{14} and B^{15}, or sets of spools, one above another, as shown in Fig. 3. The first end b^7 of the yarn, which, in the common process of spooling, is concealed and covered by the body of yarn, is left out, where it may be taken up and joined to the leading end b^8 of another. The lower spool B^{15}, or a set or series of such spools of yarn, may be placed on spindles arranged below the bed-plate B^2, or set upon the floor around the machine. The leading ends b^8 of yarn from each of the upper spools B^{14} lead over suspended guides c^7, like those above described, and from these to the guides A and B and the needles.

This method of employing spools of yarn, and of making the yarn continuous from two or more spools, is of considerable importance, as it lessens the liability of the yarn running out, and the consequent pressing off of the work from the needles, which is not uncommon in the ordinary method where the yarn on one spool is not connected with that of another.

At some convenient place in the cam-cylinder C, I provide a gate for removing and replacing slides with broken or injured needles, and this gate or passage is formed from the top of the cylinder down to the cam-groove which contains the butts d, and it opens into the space p next to the outer edges of the slides, and convenient for the removal and replacing of any slide in the series. When the slides and the needles are in operation this gate is closed by a round key, J, which fits and fills the gate, and forms a whole or unbroken inner surface to the cylinder. This gate and key are of some utility and great convenience, easily and cheaply made without materially weakening or injuring the cylinder, and capable of use without disturbing any other part of the machine. The notch or opening t in front of the key renders the latter easily accessible for removal with common pliers or pinchers. The incline and lower end g^1 of the cam A^5 should be hardened or tempered to make the butts work easier beneath it by causing less friction, and to increase its durability.

The bed-plate B^2 has a depending hub, C^3, which is bored to receive the shell E^5 of the inner cylinder, which rotates within the hub, and is shouldered on the top of the bed-plate. This shell is generally of cast-iron, the outer ring E^3 of brass, and the upper ring E^4 of tough metal—say good, tough iron—and all fitted and grooved to receive the slides in the same manner as in most circular-knitting machines. Both of the rings E^3 and E^4 are shrunk onto the cast-iron shell portion by the common process. The lower end of the shell E^5 extends below the lower end of the hub C^3, and a gear, F, is fitted and fastened to it. A similar gear, F^2, is fitted and fastened to a cross-shaft, K, arranged to rotate in the hub or box L of a hanger, O, depending from the bed-plate. The gear F is shown in section in Fig. 4, in elevation in Fig. 5, and in perspective in Fig. 12. The gear F^2 is shown in Fig. 5 and partially in Fig. 12. The hanger O is shown mostly in dotted lines back of the leg M in Fig. 12. On the outer end of the shaft K is a wheel or pulley, N, for operating the machine. Ears P depend from the under side of the gear F, and the space between each pair of ears is for the reception of each top end g^3 of the flier, which is otherwise held in position by straps g^4, extending across the edges of the ears and back on their outer sides, where they are fastened by screws 4. The flier is shown in Fig. 12 with all the other parts connected, and larger elevations in Figs. 5 and 6—the upper and central portion in the former, and the lower portion in the latter. The flier contains the stretcher-rods E^6 and the cloth roll or shaft A^6. The latter is shown in section in Fig. 5^b. On one side of the flier I arrange supporting-stands S, and through them a vertical shaft, A^7, to the lower end of which I apply a conical pulley, T, with its largest end upward. On the cross-stays C^4 I secure a larger conical pulley, U, with its smaller end upward and directly under the center of the operating-head and the rotary movers. The peripheries of these two conical pulleys come in contact, and the smaller is rotated by revolving around the larger and stationary one, being carried by the revolving flier. This flier is supported by a central rod, S^1, shouldered to the under side of the lower end S^2, and secured by a screw-nut, F^3, as shown. The rod passes loosely through the center of the fixed cone U to the top of a lever, V, which is pivoted between ears F^4, depending from one of the cross-stays.

To the opposite end of this lever I hang a weight, W, to partly balance the flier. On the upper end of the shaft A^7 is a worm, Y, and on the end of the cloth-roll a worm-gear, Z. The worm engages with the gear and turns it to wind up the cloth as it comes down from the operating-head, and as the flier revolves. The flier receives motion from the rotating gear F and the ears P. The smaller cone receives motion from the larger one, and this operates the shaft A^7 and the worm, and, through these, the worm-gear and the cloth-roll, to wind or take up the cloth as fast as it is formed.

This take-up or racking-up motion or process is all-important, and the apparatus I have shown is very effective in the production of the desired result, operating as follows: When the roll of cloth begins to form the weight W should be hung near the center of the lever, so that nearly the whole weight of the flier shall be sustained by the cloth, which, forming and coming down fast, allows the flier to sag or settle, and keep the cones constantly in contact, and the smaller one rotating and

turning the shaft A^7, the worm Y, the worm-gear Z, and the shaft A^6, and taking up the cloth. As the roll gradually increases in size and the shaft requires less rotary motion to wind up a given length of cloth, the weight should be gradually, or from time to time, moved outward on the lever. This relieves any undue strain on the fabric, compensates for the additional weight accumulating in or upon the flier, and allows it to rise, or aids it in rising, and liberates or lessens the action of the cones by raising the smaller one partly or wholly from contact with the larger, thereby causing a brief suspension of the rolling or taking-up motion or process, until, by progressive formation, the web or fabric is slackened, when the flier sags, and the cones are brought into more active contact, again to operate the worm-gears and roll, and rack up the cloth until a full roll is formed.

In forming coarse or heavy fabrics the lever V and the weight W may be dispensed with.

The simplicity, cheapness, and consequent durability of the above racking-up tackle, take-up, or regulator, and its certainty and accuracy of operation, render it useful and valuable for the purpose described. The cloth is removed from the shaft on which it is rolled by removing the screw-nut opposite to that marked F^5, and by withdrawing the shaft from within the roll. The passage of the cloth from the needles where it is formed is through the inner shell E^5, downward between the ears P, over the inclosed stretcher E^7, and between the rods E^6, and downward to the shaft A^6, as before described. If preferred, a cutter, A^8_8, may be arranged on the flier, or on either stretcher-rod, to split the tubular web of cloth as it passes to the roll, one or more needles being left out of the series to leave slack loops and form a path for the cutter or splitting device.

By the use of my invention and improvements, as hereinbefore described, I consider that I am enabled to produce warp and weft fabric of superior quality cheaper and faster than by the weaving process, since slack twisted and soft yarn, which cannot be woven on any ordinary loom, is best adapted for the production of my improved fabric, not more than from twelve to fourteen holes twist in the yarn being necessary, instead of from forty to fifty holes twist, as spun for use on a common loom. This also enables me to dispense with about one-half of the spinning, or one-half of the "jacks" or other spinning-machines.

My improved weft-thread knitting-loom is adapted for knitting yarn or thread made of any of the well-known fibrous substances, and either coarse or fine, according to the gage of the machine. Fabrics suitable for calicoes, delaines, or other print goods can be made on a fine-gage machine.

I believe I have described and represented the improvements which I have invented so as to enable any person skilled in the art to make and use them without further invention or experiment. I will now state what I desire to secure by Letters Patent, viz:

I claim—

1. The combination of the thread-guide B and presser-wheel E, for introducing weft-thread between reciprocating divided needles.

2. The dividing-wheel C, in combination with the series of reciprocating needles, actuated by a cam-groove, when the cam and dividing-wheel act so that the needles are partially raised, rest, are divided, and then continue rising after they are divided.

3. The combination of the reciprocating series of divided latched needles with the presser-wheel E, for pressing down the weft-threads, substantially as described.

4. The combination, substantially as described, of wheels C and E and warp and weft guides A and B, the latter having latched guards *g*, with the latched needles, all arranged and operating in the manner and for the purpose specified.

5. The series of reciprocating divided needles, in combination with actuating mechanism, substantially as described, which operates to commence to divide the needles when partially raised, but at rest, and continues to raise them after they are divided.

6. The cam-cylinder having lower and upper rising inclines, and cam-groove H, the adjustable cams A^5, constructed and applied as described; and provided with an ear, f^5, an adjusting-screw, g^2, a spring, I, an operating-wheel, f^3, and a spring-catch, c^8, in combination with the slides, having butts *d*, all arranged and operating substantially in the manner and for the purposes specified.

7. The racking-up apparatus, take-up, or regulator, as described, consisting of cones U and T, shaft A^7, worm Y, and gear Z, in combination with the cloth-roll A^6 and the flier, all arranged and operating substantially in the manner and for the purposes specified.

8. The plate or disk A^2, in combination with wheels C and E and reciprocating latched needles, for the purposes specified.

WM. H. ABEL.

Witnesses:
WM. S. BROWN,
NATHAN BROWN.