

(No Model.)

3 Sheets—Sheet 1.

J. J. SCHOLFIELD.

Machine for Plicating Fabrics.

No. 229,479.

Patented June 29, 1880.

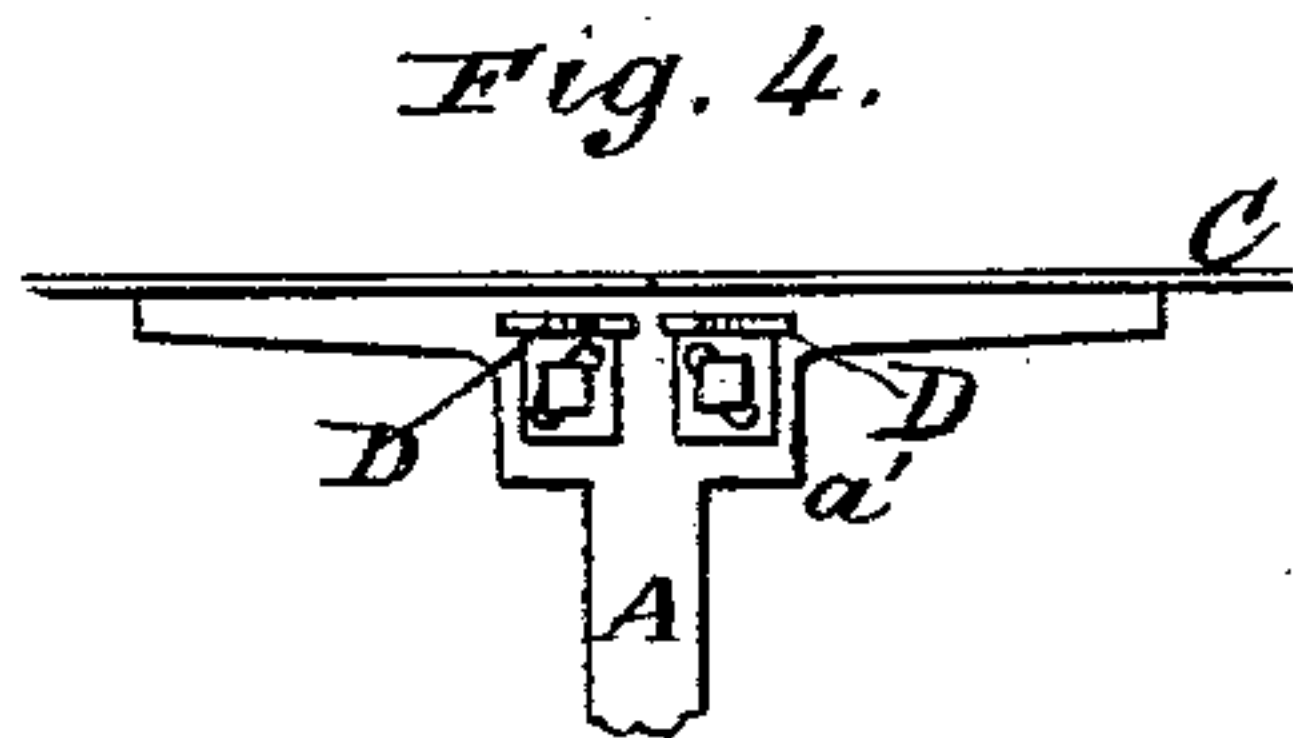
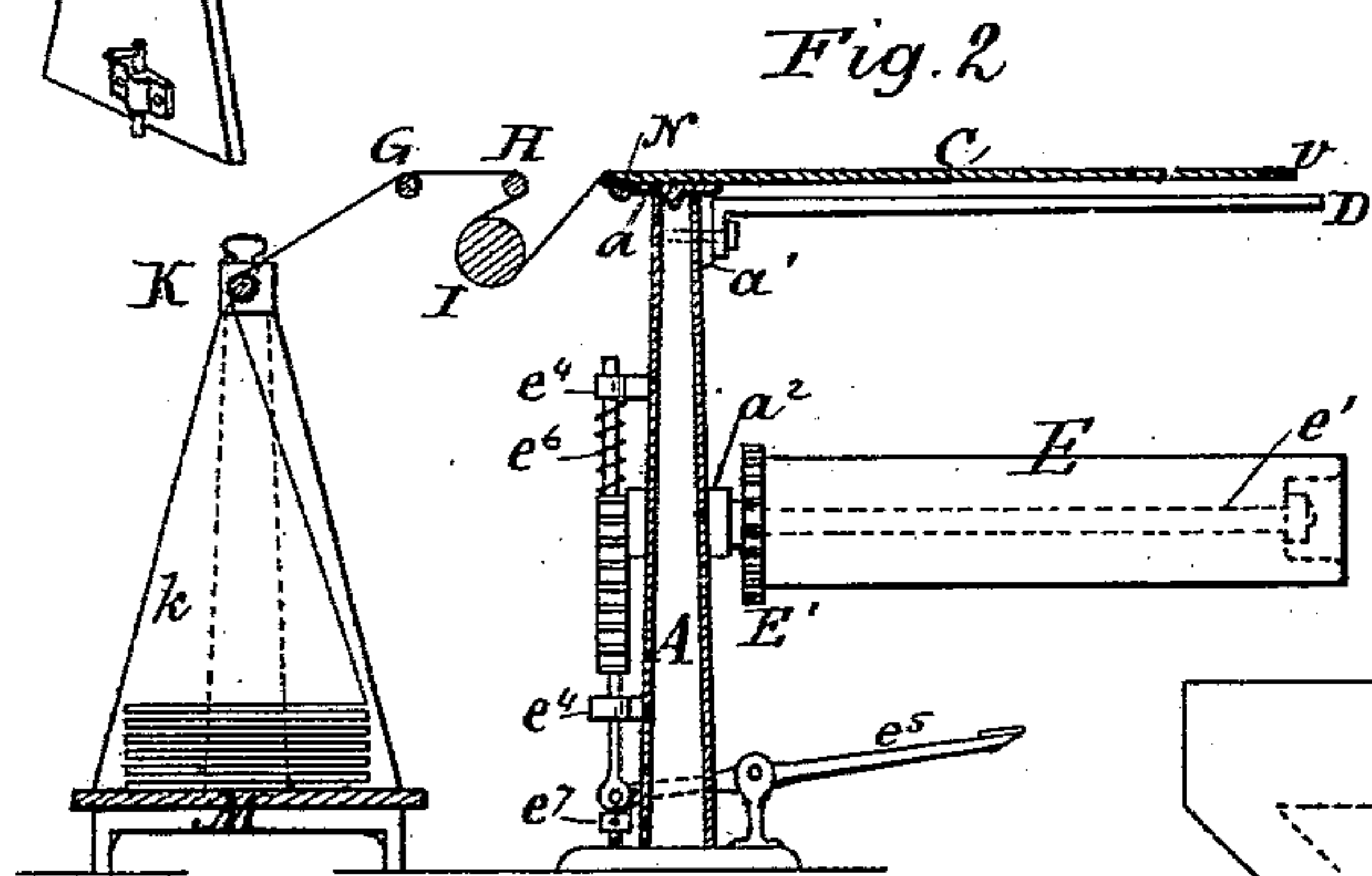
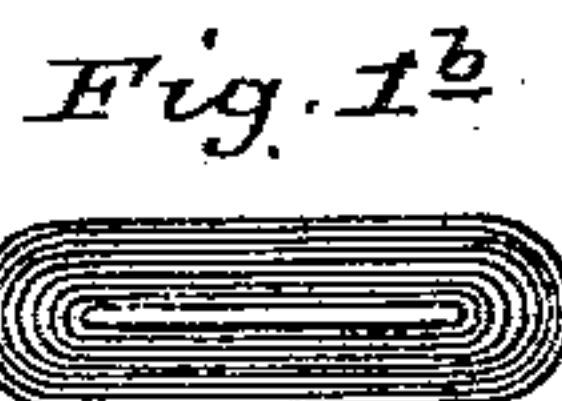
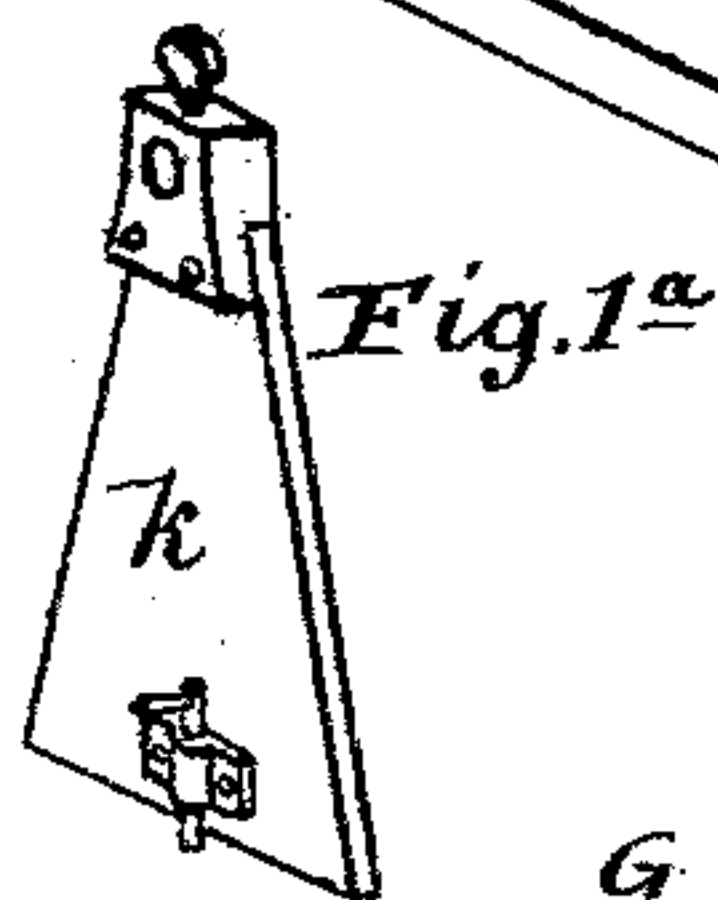
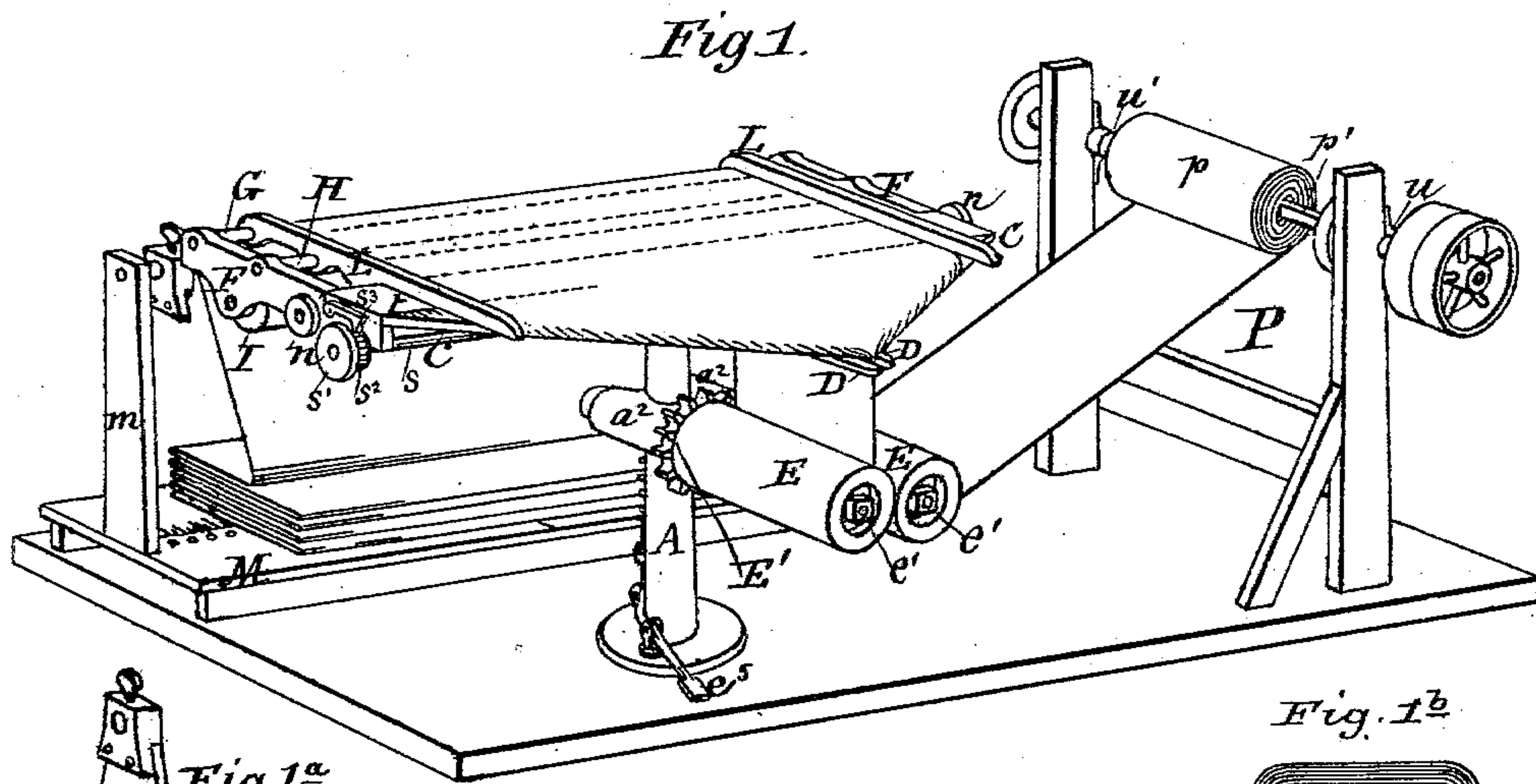


Fig. 5.

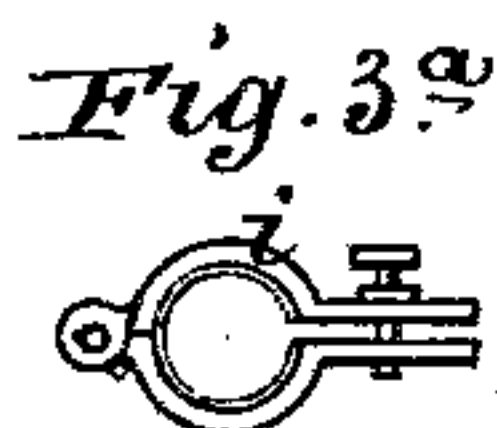
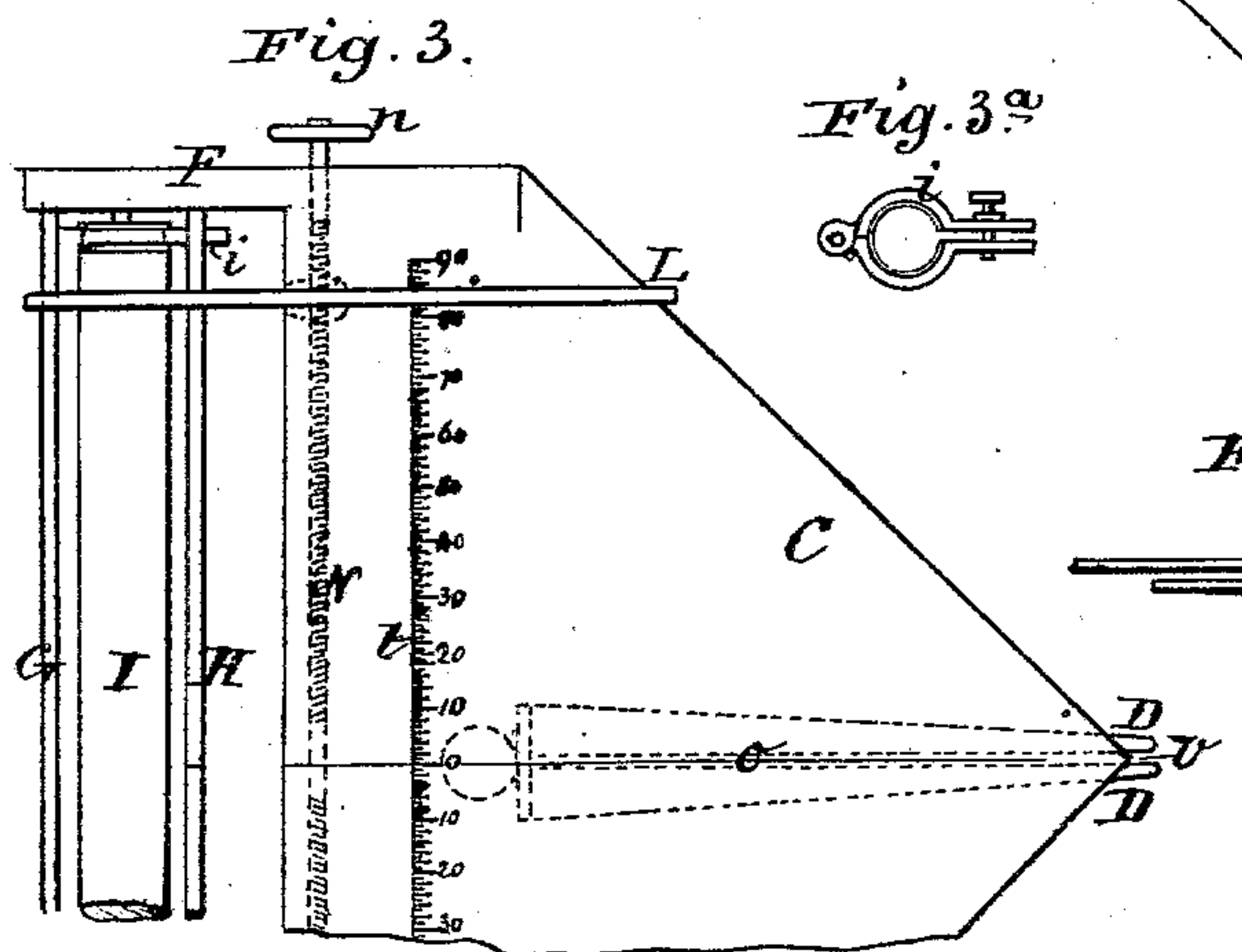
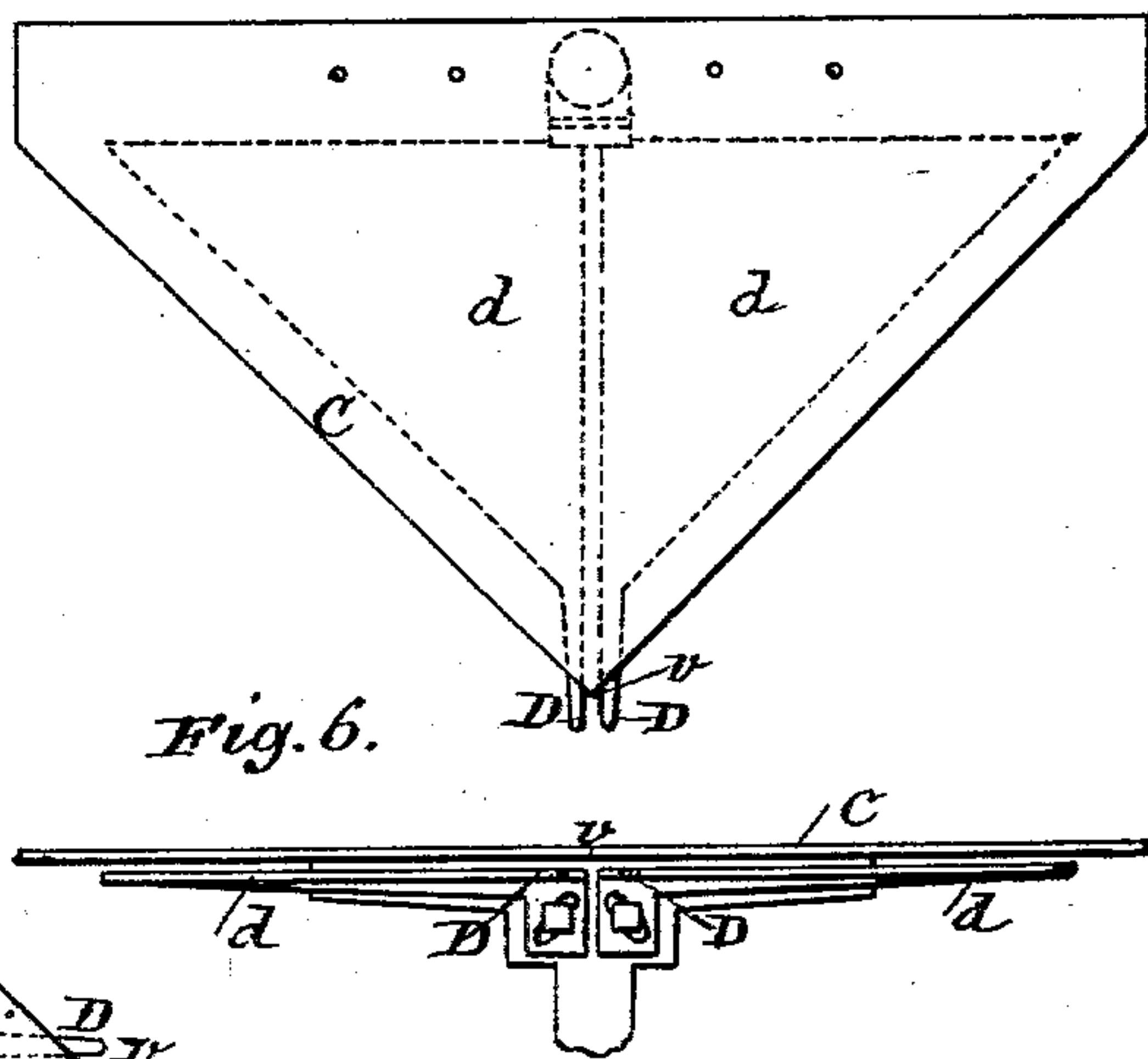
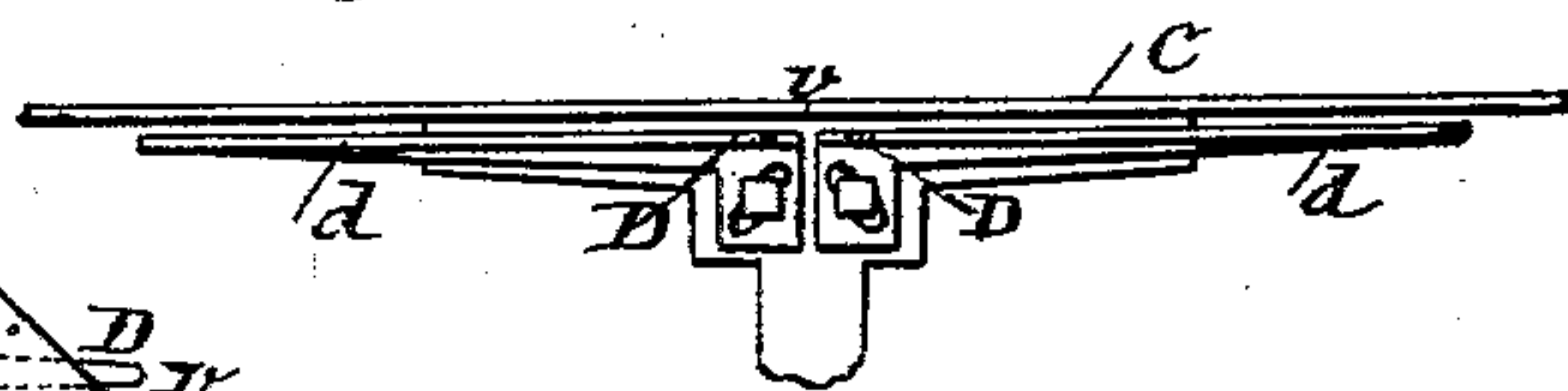


Fig. 6.



Witnesses:
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Fig. 15

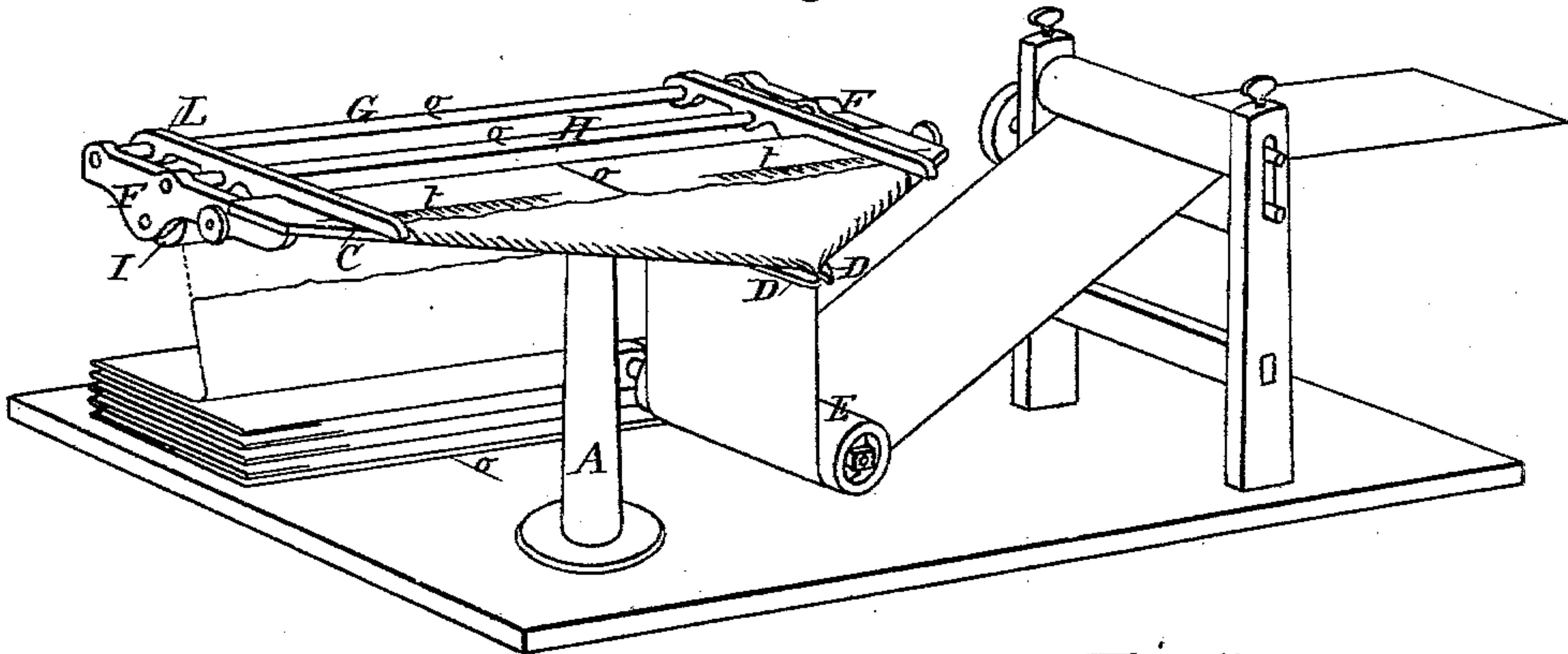


Fig. 12.

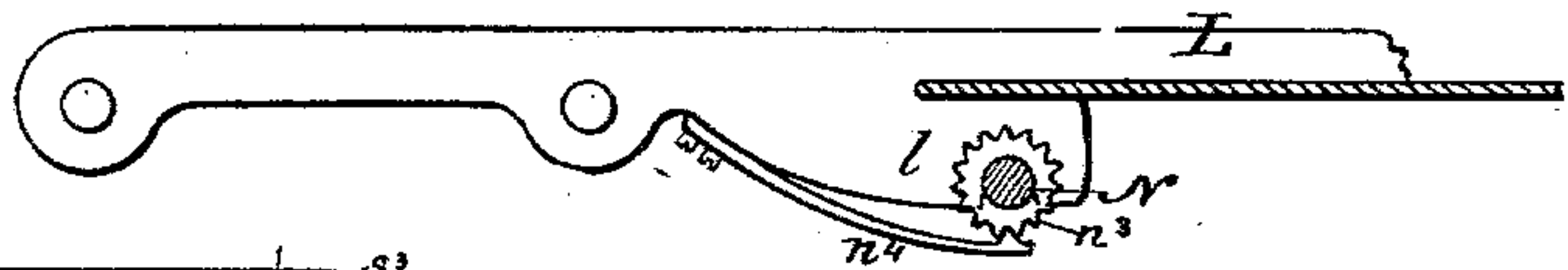


Fig. 11.

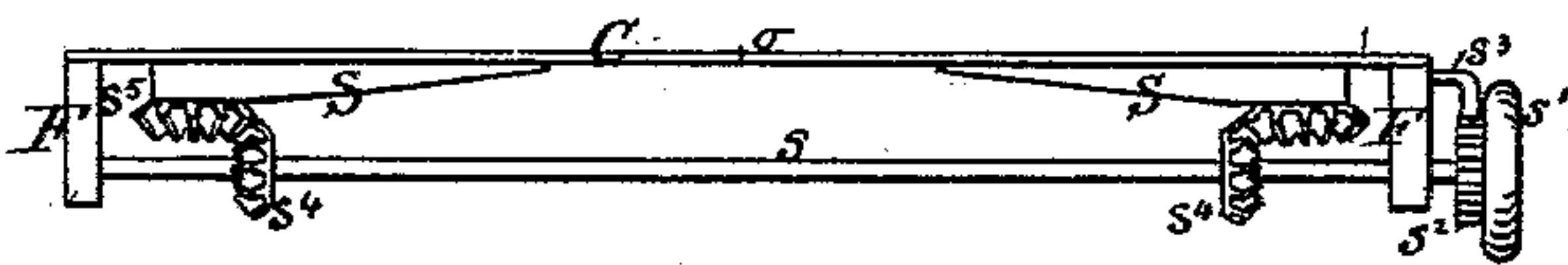


Fig. 10.

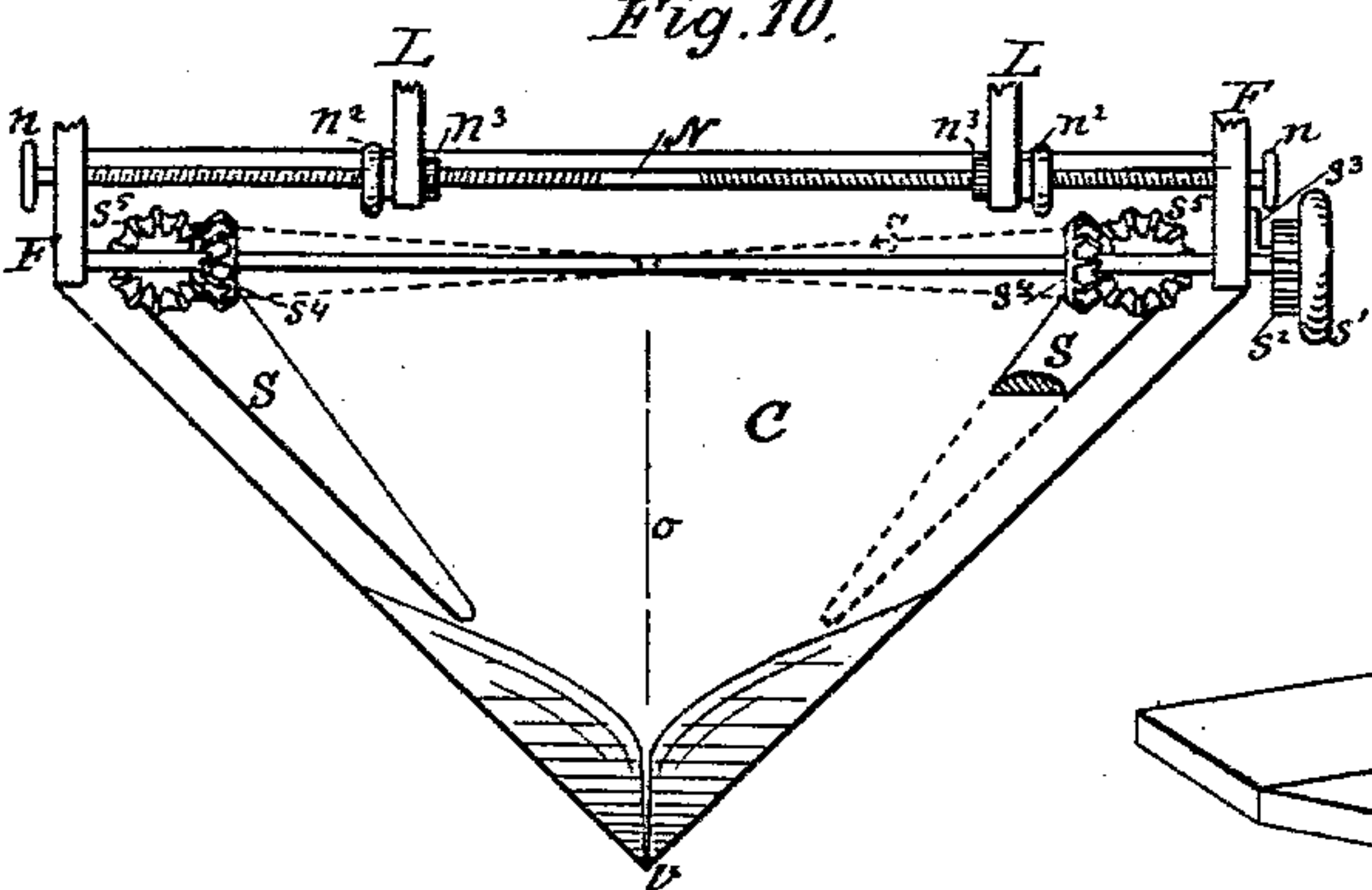


Fig. 13.

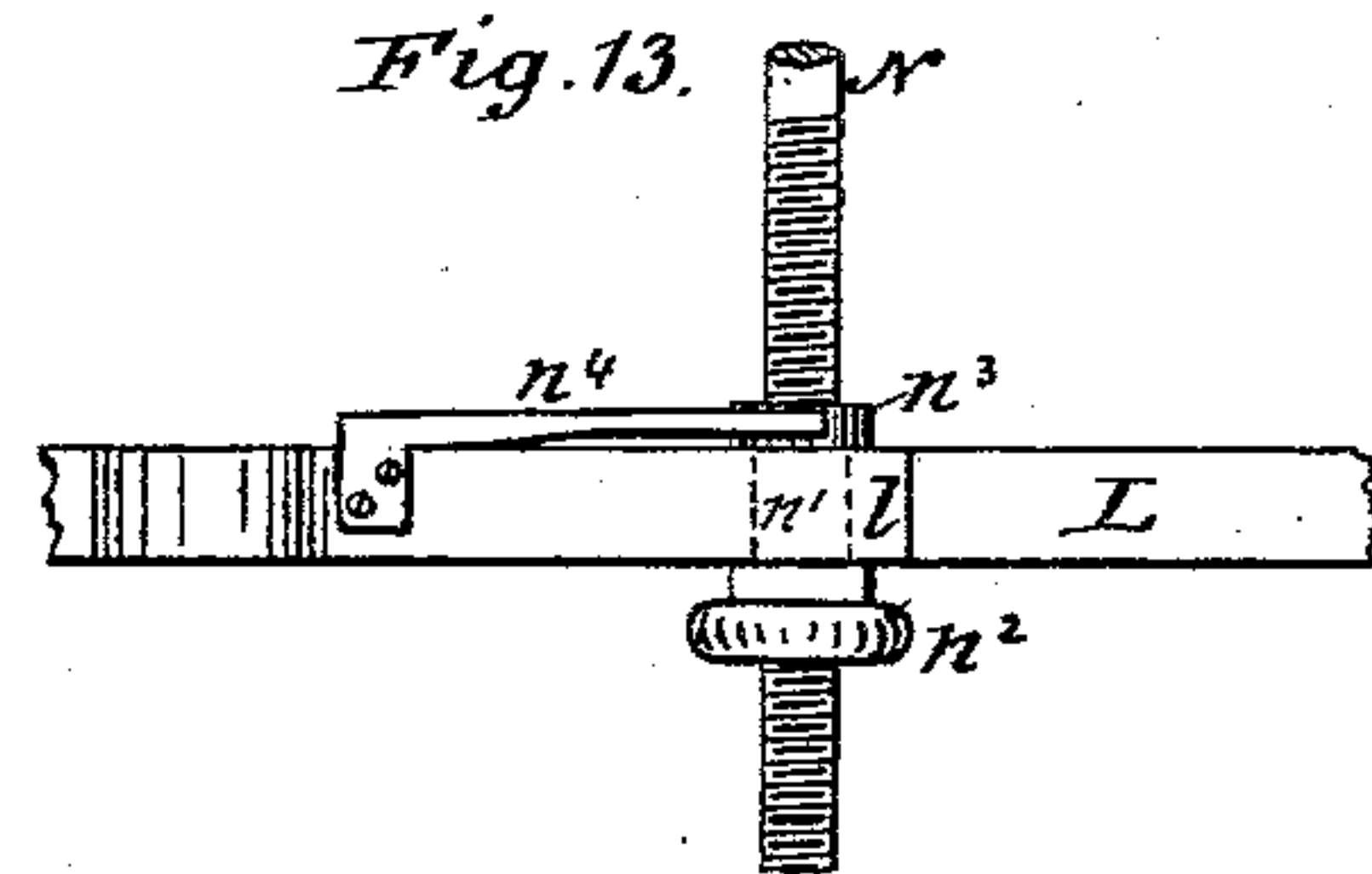


Fig. 14.

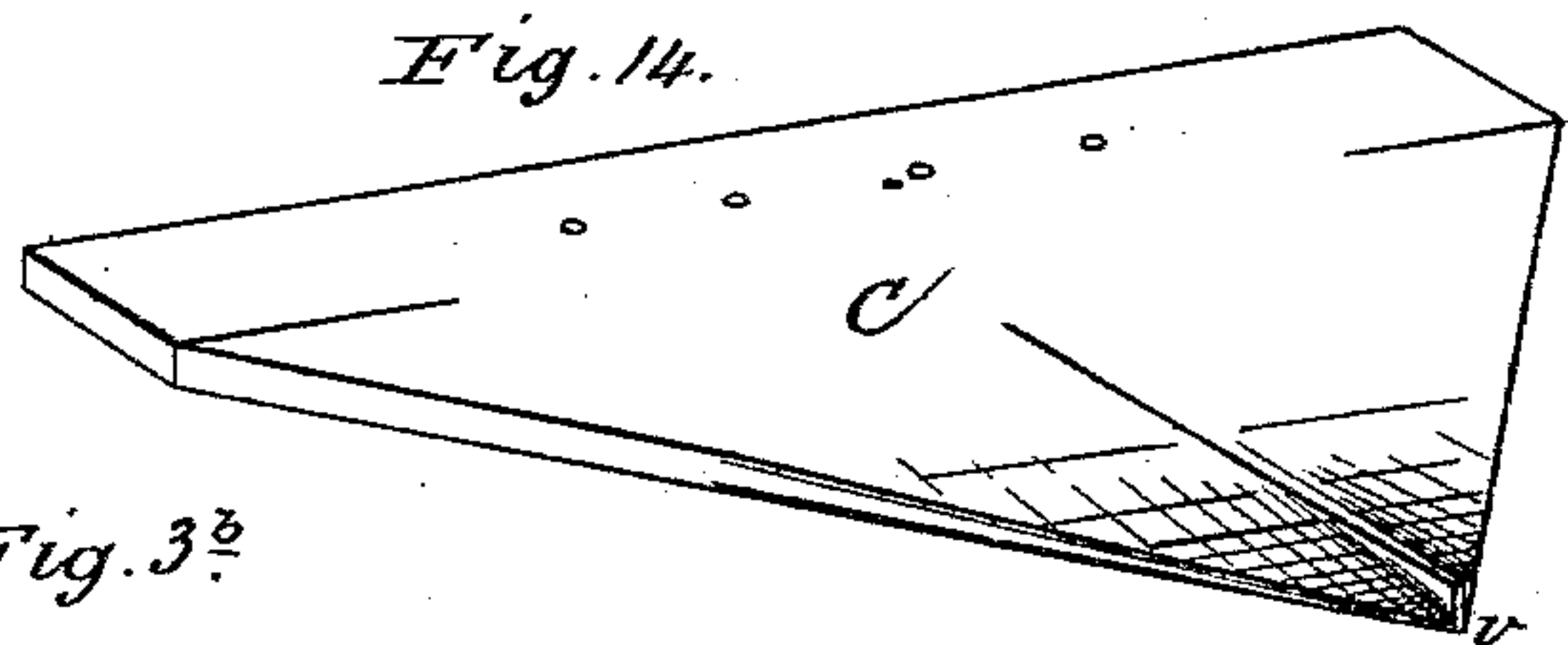
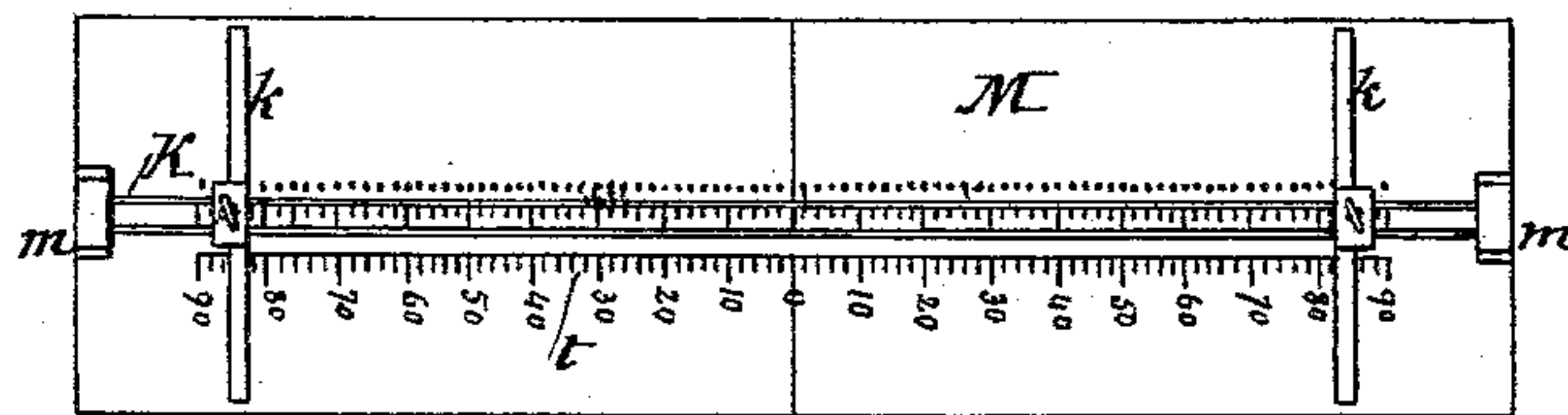


Fig. 3^b.

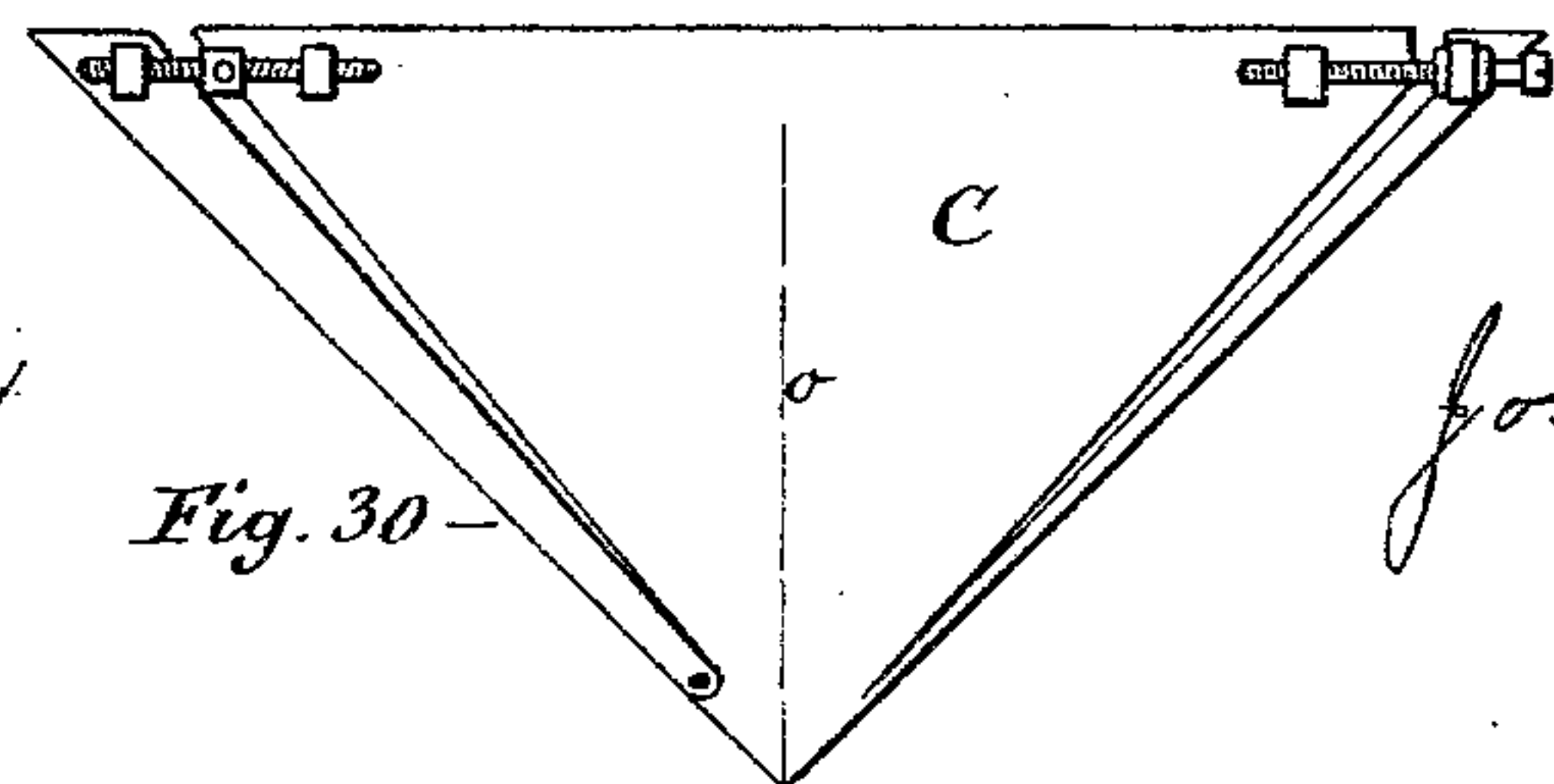


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Fig. 30—



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Fig. 16.

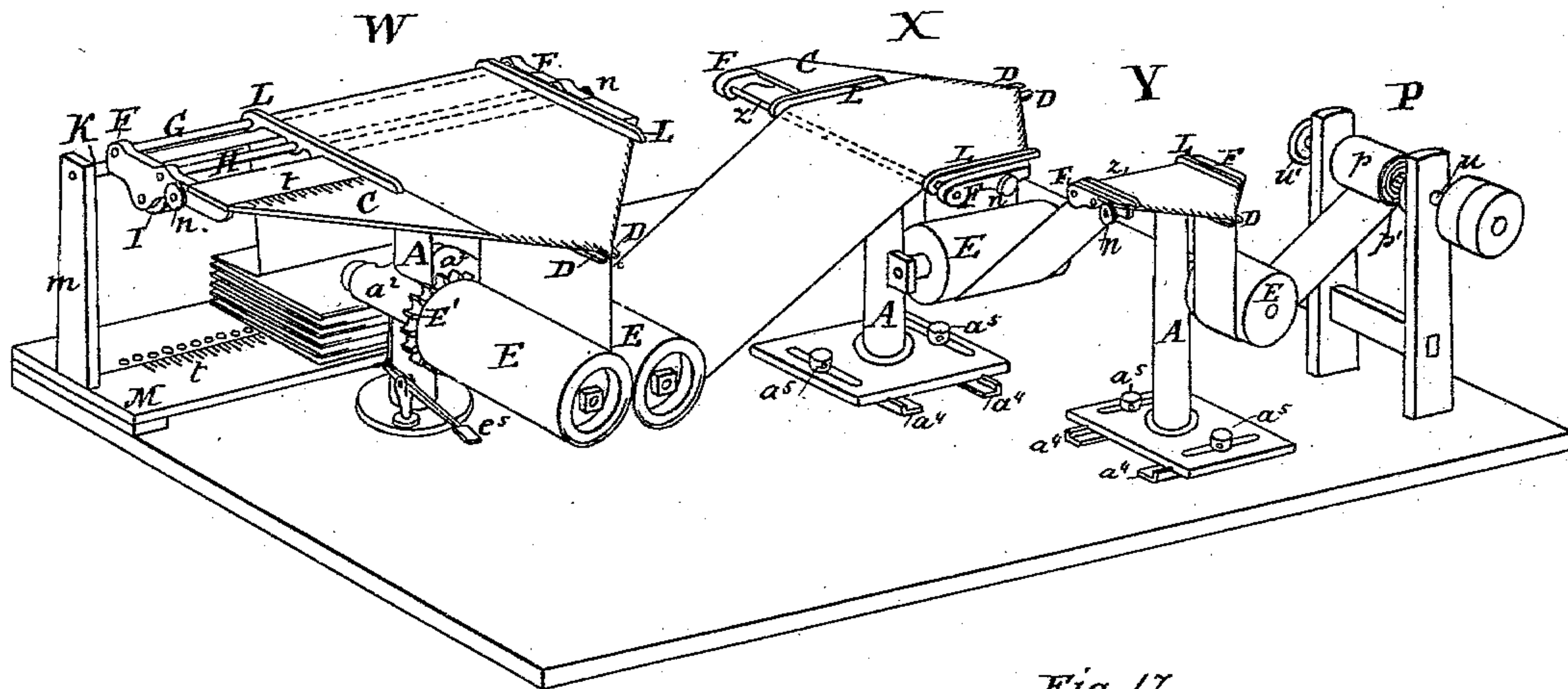


Fig. 17.

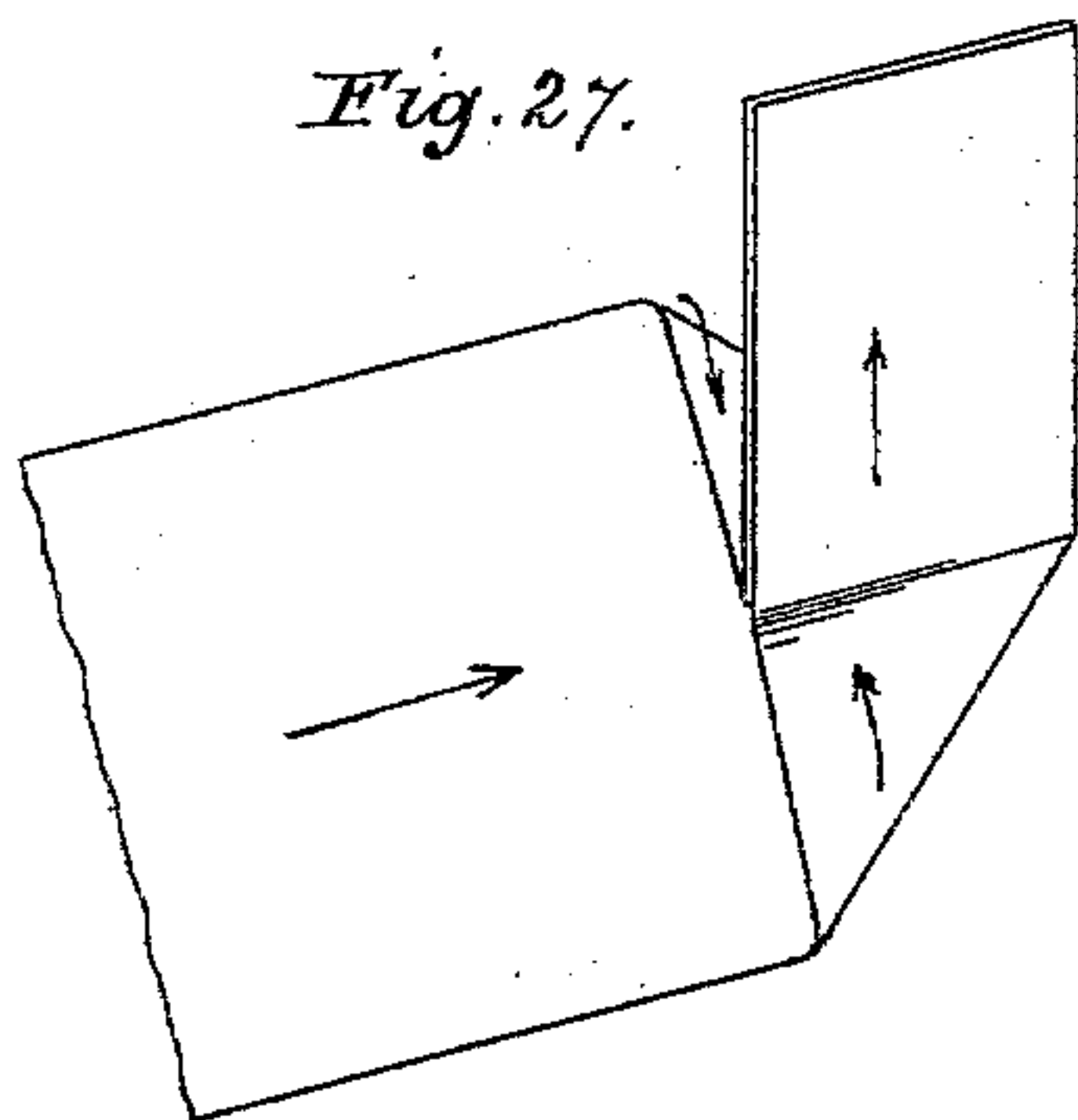


Fig. 27.

Fig. 18. _____

Fig. 19. _____

Fig. 20. _____

Fig. 21. _____

Fig. 22. _____

Fig. 23. _____

Fig. 24. _____

Fig. 25. _____

Fig. 26. _____

Fig. 28. _____

Fig. 29. _____

Fig. 8.

Fig. 9.

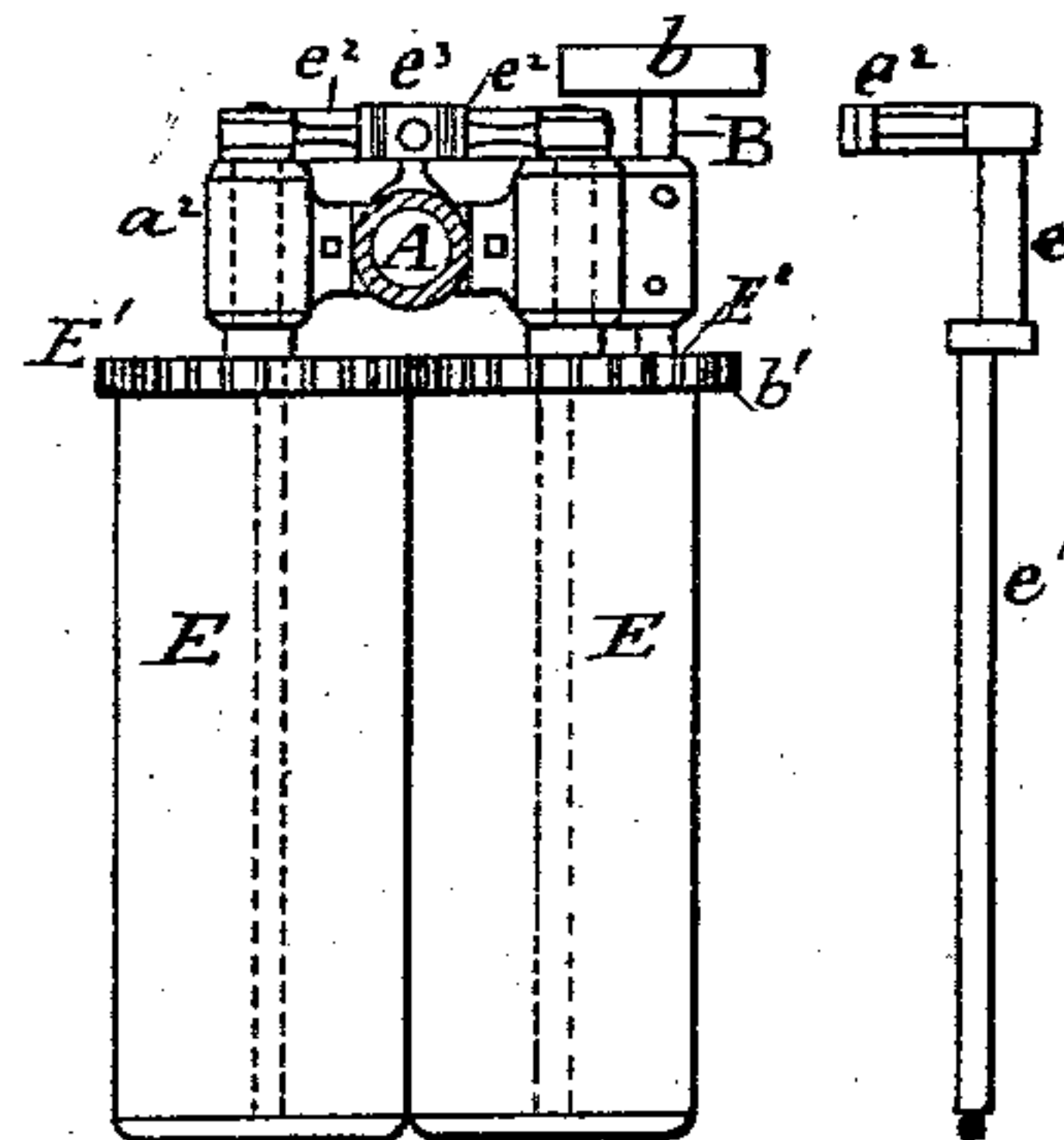
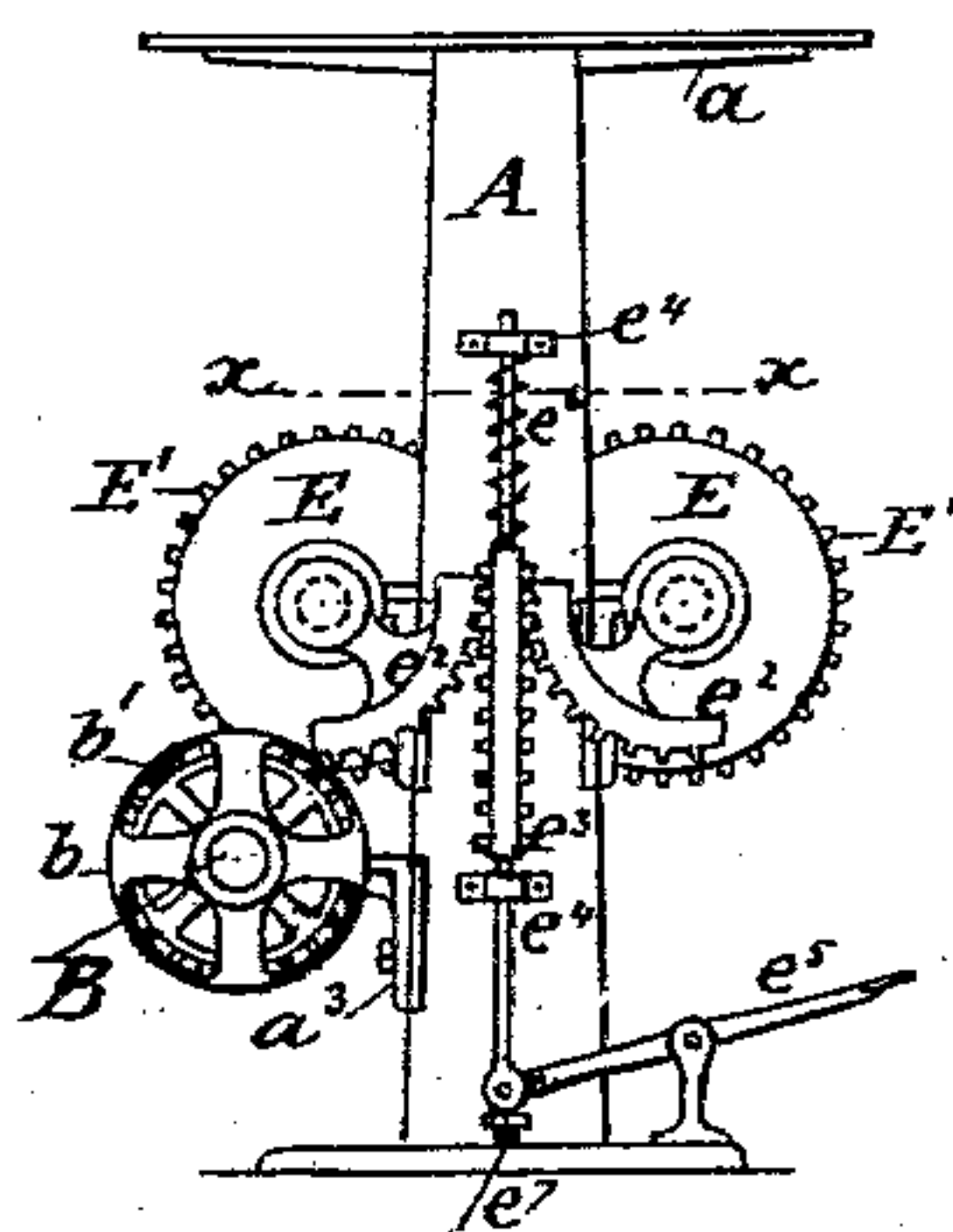


Fig. 7.



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UNITED STATES PATENT OFFICE.

JOSEPH J. SCHOLFIELD, OF PROVIDENCE, RHODE ISLAND.

MACHINE FOR PLICATING FABRICS.

SPECIFICATION forming part of Letters Patent No. 229,479, dated June 29, 1880.

Application filed April 26, 1880. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH J. SCHOLFIELD, of the city of Providence, in the county of Providence and State of Rhode Island, have
5 invented certain new and useful Improvements in Machinery for Folding Fabrics Smoothly and Evenly Lengthwise, and, when desired, Crosswise also, of which the following is a specification.

10 Webs of cloth are woven of various widths, some narrow, others wide, and a large portion of them too wide to admit of being made into conveniently compact parcels or packages by
15 cross folding or rolling without first plicating them lengthwise into two or more plies or folds.

Lengthwise plication of a web or piece of wide fabric, as the initial step of packaging, is generally done by hand. In some cases
20 machinery is employed to do a portion of the work. Like other work, however, performed mainly or wholly by hand, such folding has been a slow and expensive operation, and not executed with the precision which the exigencies of trade demand, more especially for that
25 large class of fabrics which are cut up by wholesale establishments for garments in seldom less than two, and generally many, plies at once, where it is obvious that unevenness
30 of folding would involve corresponding waste, as it is necessary in the cutting trade to utilize the entire width of the fold in cutting the garment without wasting a shred that can be saved.

35 Much thought and labor have been directed to the production of some mechanism that would fold fabrics lengthwise with evenness and celerity, and many ingenious machines have been the result of such effort; but such
40 machines were without any provision for properly folding elastic fabrics, and as all wide fabrics that require lengthwise folding are elastic as well as pliable, they present conditions which such machines are not adapted
45 to meet, and the lengthwise folding of such fabrics, therefore, still continues to be done almost wholly by hand.

To provide a method upon which a positively-acting automatic machine might be
50 constructed and operated to plicate smoothly and evenly elastic and pliable fabrics lengthwise of their webs is a principal object of my

invention, which also includes the construction, arrangement, and combination of mechanism for compact, even, and positive cross
55 folding or rolling of the fabric continuously with its lengthwise folding, and also adapting the several parts of the machine to convenient access and adjustment and the more effective performance of their respective functions. 60

The first step in the lengthwise plication of a web of cloth by the mode of operation upon which I proceed is to place the web in an even
pile on a suitable stand and at the proper position behind the machine, and then pass one
65 end of the web, outspread to its full width, over one or more bars with rounded corners, or over one or more rolls retarded by friction-rubbers, or over both bars and rolls, until sufficient friction is produced between the surface
70 of the cloth and such bars and rolls (either or both) to require enough tractive force applied to the advancing end of the web to pull out its creases and wrinkles and outstretch and
75 outspread it flat upon the face of a triangular table, to which it passes on leaving the front friction bar or roll, as the case may be. This
table at its rear end, where the cloth enters upon it, is parallel to the friction-bars and at
80 right angles to the direction in which the web enters and passes along the table. The table projects, apex forward, from the frame, and I have named it the "plicater." Its apex, the sides
85 of which meet at an angle of ninety degrees, I have named the "point" of the plicater. A pair of adjustable guides are arranged upon
the plicater parallel to the perpendicular drawn from its point to its base. This perpendicular
I call the "crease-line" of the plicater. The
90 guides are adjustable to a greater or less distance from the said crease-line, to leave a space between them just equal to the width of the web to be plicated, which space is for the purpose of directing the course of the web over
95 the point of the plicater in the line at which it is desired the crease of the fold or ply shall run.

The plicater should be made as thin as is consistent with the requisite rigidity, and it
may be made to increase in thickness from
100 the point toward the base, to produce a differential tension upon the plications of the cloth in a manner and for a purpose which will presently be explained.

To make an even two-ply fold from end to end of a web the outspread end of the web is drawn from the feed-table forward over the friction bars and roll and the space between the side guides along the plicater until the end of the web will just bend over the point of the plicater. The corners of the web will now hang down over the sides of the plicater, and if the pendent parts, which constitute the ends of the folds or plies to be made, be drawn up evenly and smoothly against the under side or back of the plicater they will meet in a plane passing through the crease-line and perpendicular to the base of the plicater, which perpendicular plane I call the "fold" plane. The end of the web is now spread evenly and smoothly over both the upper and under sides of the plicater, and if the approximated ends of the two plies be caused to descend together in the fold-plane through a narrow slot, just wide enough to receive them, between two guides, one on each side of the plane and near the under side of the plicater, the initial end of the plication or two-ply lengthwise fold of the web will be complete, and may conveniently be continued by inserting the folded end between a pair of traction-rolls immediately below the slot, and which, in drawing the fold downward, will draw the web forward over and under the plicater and through the fold-slot, thus acting at any given time only upon the two small triangular areas of the web in transit between the table-plane and the fold-plane. The machine plicates the whole web by causing these duplex areas of activity to glide through its whole length, the fabric, from the time it reaches the plicater until completely folded, being kept stretched and free from wrinkles, and the fold made with a straight crease, and the selvages laid evenly and parallel with the crease.

During the transition of the fabric from the face of the plicater through the triangular areas to the fold-plane its parts move through varying distances in alternately sinuous and straight courses and under different strains, the parts nearest the place at which the crease of the folds originates, at the point of the plicater, having the least motion, and those parts on either side of the crease, toward the margins, having their motion gradually increased, so that at the margin it is greatest. The inequality of strain resulting from such inequality of course and motion of the fabric during the process of plication tends, because of the elasticity of fabrics, to distort and wrinkle the plies of the fold and endangers the rupture of the cloth by the point of the plicater; and for these and other reasons such inequalities of strain I have reduced as far as practicable by contracting within the narrowest possible limits the area of fabric at any one time under the actual operation of plication by causing every part of the cloth to pass from the outspread condition on the plicater-plane, by the shortest practical path, to the plicated condition in the fold-plane, which is done by mak-

ing the angle of the plicater ninety degrees and causing the cloth to pass in close contact with its surface from one plane to the other. This path, through which the cloth passes from one plane to the other, although the shortest practicable, is only mathematically the shortest at the center line of the crease of the fold, for there the cloth has only to bend round an angle of ninety degrees over the point of the plicater to pass from the plicater-plane to the fold-plane without having to pass over any intervening space; but from the crease toward the selvage of each ply the cloth, after leaving the plicater-plane, has to pass over the thickness of the edge of the plicater before it can begin to bend round the angle of ninety degrees toward the fold-plane. The path of the cloth toward the selvages is therefore longer than at the crease by the thickness of the edge of the plicater. This greater length of path away from the crease subjects the cloth to greater tension toward the margin of the ply, leaving it at the point of the plicater sufficient to form a smooth crease. Such a differential tension, determined by making the edge of the plicater of the appropriate thickness, prevents all danger of rupturing the fabric by undue pressure of the point of the plicater.

The increased distance which the margin of the ply is made to travel by passing round the edge of a plicater made of a plate of metal a quarter of an inch thick, reduced on both edges at and near the point by beveling or otherwise thinning off the back to shorten the distance round the edge to the fold-plane, and so produce a differential tension, is suited to the folding of goods of moderate elasticity and thickness, only requiring moderate tractive force to outspread it, smooth out its wrinkles, and draw it through the machine; but where, from the increase of elasticity of the fabric, or of tractive force necessary to be employed, or from any other cause, the crease of the fabric bears too strongly upon the point of the plicater, notwithstanding the thinning of the edge, as aforesaid, the pressure may readily be relieved by inserting the end of a tapering stretcher a greater or less distance between the marginal portion of each ply and the back of the plicater, to increase as much as may be required the length of the path of the margin of the ply between the face of the plicater and the fold-plane, to increase the marginal and correspondingly diminish the crease tension.

It is important that the cloth should not be subjected to greater tension than is necessary to fold it smoothly and evenly, as undue stress will impair its elasticity and strength and subject it, as well as the machine, to unnecessary wear and tear, and in doing so will consume unnecessary motive power.

By making the angle of the plicater ninety degrees I am enabled to make the folding mechanism the most compact which this principle and mode of operation admits to reduce to a minimum the area of fabric at any given

moment undergoing actual doubling or plication, and to make the entire action of the machine in producing the fold so direct and immediate that the movements of the fabric are hardly less positive than those of the machine itself, and so accomplish the work of folding with uniformity, precision, celerity, the least practicable stress upon the fabric, and without waste of power.

10 In the accompanying drawings, which make part of this specification, Figure 1 represents a view, in perspective, of a machine which embodies my improvements in folding fabrics lengthwise and rolling them into compact parcels or packages. Fig. 1^a represents one of the side guides of the feed-table detached, that its construction may be the better seen. Fig. 1^b represents a web of fabric cross-folded round a flat board, the cross-folding shown in Fig. 1 being a nearly cylindrical roll formed by winding the fabric on a slightly tapering rod of the form in common use for that purpose. Fig. 2 represents a vertical section of the machine shown in Fig. 1 in the plane of the crease-line of the plicater. Fig. 3 represents a top view of a fragment of one side of the machine upon an enlarged scale, to show more clearly the device for adjusting the friction of the tension-roll and the arrangement and graduation of the scale for setting the side guides, the dotted lines in the plicater showing a top view of the fold-guides. Fig. 3^a represents, upon an enlarged scale, a side elevation of the friction-strap of the tension-roll. Fig. 3^b represents, on an enlarged scale, a top view of the feed-table and the stretching-bar, showing the scale upon both. Fig. 4 represents a front elevation of a fragment of the plicater, the upper part of the main pillar of the machine, and the guide-bars, showing mode of attaching the guide-bars to the upper part of the pillar, which admits of one kind of bars being detached readily and others substituted, and of adjusting the bars toward and from each other and toward and from the back of the plicater. Fig. 5 represents, in plan, the plicater with fold-guides at its back, having wide wings, which are shown by the dotted lines. Fig. 6 represents a front elevation of the parts shown in Fig. 5, together with the upper portion of the pillar and the means for fastening the fold-guides in place and admitting of their adjustment. Fig. 7 represents a rear elevation of the main pillar of the machine and of the mechanism below the plicater, which it carries. Fig. 8 represents a section at the line *x x* of Fig. 7. Fig. 9 represents one of the shafts for carrying on its eccentric-spindle one of the traction-rolls, its toothed sector being shown on the end opposite to the spindle. Fig. 10 represents, in plan, the back of a horizontal plicater with a pair of tapering selvage-stretchers adjustable by means of a shaft and bevel-wheels, with a detent to hold them in any position to which they may be adjusted. This figure also shows the rod provided with right-hand and left-hand

screw-threads and accessories for the adjustment of the side guides. Fig. 11 represents, in elevation, the parts shown in Fig. 10, excepting the adjusting-screw and its accessories, inverted and looking at their rear. Fig. 12 represents, in elevation and upon an enlarged scale, one of the adjustable side guides with its spring-detent and wheel, to hold its revolving adjustable nut. It also shows, in section, the adjusting-screw and the plicater. Fig. 13 represents a plan of the under side of the parts shown in Fig. 12, except the plicater, which is removed. Fig. 14 represents, in perspective, the back of the plicater, to show the manner in which its converging edges are thinned off. Fig. 15 represents, in perspective, a folding-machine more simple in construction than that shown in Fig. 1, but well adapted to folding a large class of wide fabrics. Fig. 16 represents a multiplying and packaging machine, by which, at a single operation, the fabric is triplicated lengthwise and folded crosswise into a compact cylindrical package. Fig. 17 represents, in cross-section, a piece of fabric outspread, preparatory to being plicated in the different forms shown by Figs. 18, 19, 20, 21, 22, 23, 24, 25, and 26; and Fig. 27 represents, in perspective and in an inverted position, a fragment of the fabric removed from the plicater, fold-guides, and traction-rolls while in process of being folded with equal plies, to show the positions, areas, and directions of movement of the parts of the fabric under process of plication, in relation to the parts plicated immediately before and to those to be plicated immediately afterward. Fig. 28 represents a view of the edge of the plicater and of a wedge-shaped piece capable of being attached to and detached from said edge, to vary the stretch of the margin of the fabric passing over the plicater. Fig. 29 represents a view of the edge of the plicater, with an adjustable strip on its under side, to expand the edge of the plicater perpendicularly to its face; and Fig. 30 represents the plicater in plan, with its edges adapted to be expanded parallel to its face.

The end of the machine at which the fabric to be folded enters is herein called its "rear," and the opposite extremity its "front."

The same letters of reference indicate the same parts of the machine in all the figures of the drawings.

The mechanism for lengthwise folding, as represented in the drawings, is supported on a frame consisting chiefly of a base, from which a pillar, A, rises, that supports at its top a flat oblong cap or platform, *a*. On this platform the plicater C is placed and held by suitable fastenings.

On the front side of the upper end of the pillar a flat boss, *a'*, Figs. 2 and 4, is formed, to which the fold-guides D D are bolted. The holes in the shoulders of these guides, through which the supporting-bolts pass, are oblong and oblique, as shown in Fig. 4, so as to permit the guides to be raised and brought nearer

together, to narrow the slot between them and bring them nearer to the back of the plicater, or allow the guides to be lowered and the slot between them widened as the different kinds of goods to be folded may require.

The oblong holes are wider than the bolts, to permit widening or narrowing the slot to some extent without raising or lowering the guides, or vice versa. These guides extend a short distance beyond the point of the plicater, and are rounded at their ends and corners and made smooth to facilitate the passage of fabrics over them.

On opposite sides of the pillar A there are brackets a^2 a^2 , fitted with suitable bearings to support rock-shafts e e parallel to the crease-line of the plicater. These shafts at their forward ends carry eccentric-spindles e' e' , on which the geared traction-rolls E E are mounted. The rear ends of the rock-shafts carry toothed sectors e^2 e^2 , which gear into a double rack-bar, e^3 , arranged between them in guides formed in the brackets e^4 . At its lower end this rack-bar is jointed to a foot-lever, e^5 , by pressure on which the rack is raised and the sectors and shafts turned to separate or open the rolls, which, on removing the pressure from the foot-lever, shut again by their own weight, aided by the resilient force of a spring, e^6 , compressed by the raising of the rack-bar. An adjusting-screw, e^7 , limits the descent of the rack and the approximation of the traction-rolls, and thus regulates the pressure or gripe of the rolls upon the fabric between them.

Below the rock-shafts, on one side of the pillar A, a driving-shaft, B, Fig. 8, is journaled. This driving-shaft carries on its rear end a pulley, b , driven from any convenient motor, and on its front end it carries a spur-wheel, b' , which engages with one of the spur-wheels E' E' that gear the traction-rolls E E together.

The teeth of the wheels E' E' and b' should be made of such pitch and length and so arranged as to admit of the rolls being separated far enough to allow the folded end of a thick web to be inserted between them, and to approach close enough to grasp firmly the thinnest piece of fabric to be plicated without so far changing the intermeshing as to prevent the cog-wheels from driving or being driven by each other.

The plicater C is in the form of a triangular table, of thin metal, extended on the rear side to form a rectangular margin convenient for securing the tabular triangle to the cap a of the pillar A, and for carrying accessory mechanism.

I make the plicater preferably of cast-iron; but it may be made of boiler-iron, steel, wood bound at the edges with metal, or other fit materials. If made of metal, it should be polished on the face, back, and wherever the fabric moves over it, to diminish friction, and it might with advantage be nickel-plated. The back of the plicater should be beveled at

each side of the point for some distance toward the base, to thin the edges, as shown in Fig. 14.

The crease-line o of the plicater is at right angles to its base and in the vertical plane through which the crease or turn of the lengthwise plies of the web are always to be made. It is also the datum-line, to which, in constructing the machine, the position of all its parts directly concerned in making the plication must be referred.

To each side of the marginal extension of the plicater C, at its rear, a side piece, F, is secured to support the bearings of the stretching-roll I and the ends of the stretching-bars G H. The corners of the stretching-bars should be rounded, while the surface of the roll may be covered or roughened to increase the adhesion between it and the fabric to be outstretched. The roll is formed with a groove near one end, to which a friction-strap, i , Figs. 3 and 3^a, is adapted, lined with felt cloth properly lubricated, and held with the requisite pressure against the bottom of the groove by means of a tightening-screw through the arms of the strap. By this means the friction of the roll can be increased or diminished to vary correspondingly the tension to which the fabric is subjected while being drawn through the machine.

Within the side bars, F F, two adjustable side guides, L L, are placed. These guides are arranged parallel to the crease-line o , and extend forward upon the plicater and backward to the stretching-bars G H. Each side guide may simply rest on the top of the stretching-bars, or have downward projections to embrace the bars, or, which is preferable, may be perforated with apertures to slide like a sleeve over the bars to widen and narrow the space between the guides, to adapt it to the exact width of the cloth, and to so adjust that space on the bars and plicater that it will direct the cloth over the point v in the line in which it may be desired to make the crease, whether that line happens to be equidistant from the selvages, as in the case of making a two equal ply fold, as shown in Fig. 18, or at any other relative distance from the two selvages—as, for instance, the width of the listing or selvage farther from the margin of the ply on one side than on the other—to fold the cloth with the outer edge of the listing or selvage of one ply even with the inner edge of the listing or selvage of the other ply, as shown in Fig. 19. This is done in cases where the selvages are made thicker than the body of the web. Such adjustment of the side guides is much facilitated by graduated scales t t on the base of the plicater—one on each side of the crease-line—the units of each of these scales being half-inches and the subdivisions fractions thereof, so that when both side guides, L L, are set at any given number on the opposite scales the guides will be the same number of inches apart. Such adjustment of the guides to the scale may be made, one at a time, by hand, and

the guides, when set, may be held by thumb-screws.

Much of the adjustment of the side guides, L L, will be to positions equidistant from the crease-line *o*, and in all such cases it would save time and labor to adjust the two guides simultaneously by connecting them with right and left hand screw-threads of equal pitch on a rod, N, Fig. 10, extending across the machine beneath the rear edge of the plicater C, journaled to the side bars, F, and having a hand-wheel, *n*, on each end to render adjustment by an attendant on either side of the machine equally convenient.

When the guides L L are properly adjusted for folding a web of a given width in two equal plies they can in a moment be changed for folding in like manner a web of any other width by simply turning the adjusting-screw by its hand-wheel *n* to move the guides simultaneously to the number on the graduated scales *t t* on the plicater corresponding to the width in inches of the web to be folded.

An apt means of varying the position and relative adjustment of the two side guides, L L, to the crease-line *o* of the plicater C, I have found to be a nut formed in a short revolving hollow shaft, *n'*, Fig. 13, the shaft having a milled head, *n''*, on one end and a toothed detent-wheel, *n'''*, on the other end, which form shoulders for a journal of less diameter between them, that fits in a corresponding bearing in the depending arm *l* of the side guides.

The detent-wheel is fitted with a spring-detent, *n¹*, that will yield to permit the nut-shaft to be turned in adjusting the guide, but is sufficiently rigid to hold the nut from turning by the friction of the adjusting-rod N. The arm *l* of each guide is fitted with such a hollow shaft or nut, one having a right-hand and the other a left-hand thread, for the corresponding right and left hand screw-threads of the adjusting-rod N, which passes concentrically through the hollow axes and nuts of these shafts.

To adjust each guide L L to correspond to the lengthwise plies of different widths required to be made in a web, the attendant, applying his hand to the milled head *n''* of one of the nut-shafts, turns it, and the nut running over the screw-thread of the adjusting-rod moves the guide L to the width of the required fold, as indicated in the scale *t*. The attendant then, in like manner adjusts the opposite guide L to the required width of the opposite fold, as indicated on the opposite scale, and the proper adjustment is thus completed.

The web of cloth to be folded may be placed on a feed table or stand, M, immediately behind the plicater. I prefer to arrange the fabric upon the table in a pile of alternate right and left cross-folds, as shown in Fig. 1, and I have adapted the table to receive the fabric in that condition; but it might be adapted readily to receive the fabric in a roll or simply outstretched.

The table has a crease-line marked across its middle from front to rear, which is in the same vertical plane with the crease-line on the plicater. On each side of the crease-line a scale extends toward the sides of the table. These scales are graduated to correspond with the scales on the plicater. A row of holes parallel to the scales is also made in the table, the holes being the same distance from center to center as the graduation-marks on the scales.

On each side of the table a standard, *m*, is erected to support a stretching-bar, K, arranged parallel to the base of the plicater and immediately above the scales on the feed-table. The top of this bar has a crease-line and scales corresponding to the crease-line and scales on the table.

Two adjustable pendent guides, *k k*, are hung upon the bar K, each provided at the top with a set-screw to hold it at any graduation-number of the scale to which it may be set. The lower end of the guide extends to the table, and is provided with a bolt to enter the holes at the side of the scale and hold it at the graduation of the table-scale corresponding to that to which it is set at the top on the bar-scale. These pendent guides are to be set to the same graduation-number on the scales as the side guides of the plicater are set, and by this means the center line of the feed-table and its side guides are kept in line with the crease and side guides of the plicater, and thus the fabric is started in the right position from the feed-table and guided in the right direction as it moves forward toward the place where it is to be folded, and therefore is subjected to no lateral or oblique pulling, and the aggregate strain upon it is determined by the friction on the stretching-bars and roll and on the plicater, and is not greater than is required to smooth out its wrinkles and outspread and outstretch it evenly to insure smooth and even folding.

Of course the side guides on the feed-table may be adjusted by means of right and left hand screws, as already described for the side guides of the plicater and stretching-bars. The lengthwise plication of fabrics may be made with numerous variations in the relative width, number, and arrangement of the plies. Some of the most useful of these variations are represented by Figs. 17 to 27, inclusive, of the drawings, which, for more convenient comparison, are all made from a web of the same width. The width of the plicater, and therefore of the machine, has to be determined not merely with reference to the width of the fabric to be folded, but also with reference to the relative width, number, and arrangement of the plies.

When the first fold to be turned is narrow a web of given width will require a wider plicater than when the first fold is nearer to half the width of the web, and of the several kinds of folds shown by Figs. 17 to 27 those shown in Figs. 21, 22, and 23 require the widest plicater.

The width of the clear space between the side guides, L L, of the plicater for making the kind of folds shown in Figs. 21, 22, and 23 will be one and one-half times the width of the fabric. The width required for the kind of folds shown in Figs. 24, 25, and 26 will be one and one-third time the width of the fabric. The width required for the kind of fold shown in Fig. 19 will be the width of the fabric plus one-half the width of the selvage. The width for the kind of folds shown in Figs. 18 and 20 will be the width of the fabric.

In adjusting the side guides to adapt the machine to folding fabrics of different widths and with different kinds of plicature the graduated scales on the plicater and feed-table not only save much labor, but also render the work more exact and prevent much misfolding.

To adjust the machine for the plicature of a web with equal folds, as shown in Fig. 18, the side guides, L L and k k, should be set at the number on their respective scales corresponding to the width of the web in inches.

To find the numbers at which the guides are to be set for making plies of unequal width, for the wide ply there must be added to the scale-number corresponding to the width of the web a number corresponding to the number of inches that this ply is required to be wider than the other, and the same number must be deducted from the scale-number corresponding to the width of the web to find the proper scale-number at which to set the guide for the side of the web corresponding to the narrow ply. For example, if the width of the web is fifty-four inches, and it is to be folded into two plies, one eighteen inches wide, the other thirty-six inches wide, one guide must be set to $54 + 18 = 72$ on its scale, and the other guide must be set to $54 - 18 = 36$ on its scale; or, if the web be fifty-four inches wide, with two selvages, each one inch wide, and it be required so to fold the web that the outer edge of one selvage will lie even with the inner edge of the other selvage, then the guide for the ply on which the selvage is to lay out must be set to $54 + 1 = 55$ on its scale, and the other guide must be set to $54 - 1 = 53$ on its scale.

To adjust the side guides, L L k k, of the feed-table, stretchers, and plicater to form the first ply of the four-ply fold shown by Figs. 21, 22, and 23 of a web fifty-four inches wide, the guides on one side should all be set to the number $40\frac{1}{2}$ plus the thickness of the fabric on the scale, and on the other side the guides should be set to the number $13\frac{1}{2}$ less the thickness of the fabric on the scale.

The web should now be passed, face downward, through the machine as adjusted, to make the first plication, which will reduce its width to about forty and one-half inches, as shown in Fig. 21, or about three-quarters of its outspread width. The guides must now all be readjusted. Those before set at $40\frac{1}{2}$ must now be set into the scale-number $13\frac{1}{2}$ less the thick-

ness of the fabric, and those before set to $13\frac{1}{2}$ must now be set out to the scale-number 27 plus twice the thickness of the fabric. The web must then be run through the machine a second time face downward, with the double edge next the side guide farthest from the crease-line, and it will now come out folded, as shown in Fig. 22, reduced to about one-half its original width. The two narrow plies will not quite approach at the middle of the web, but there will be a space left between them of about four times the thickness of the fabric. The machine will now require readjustment for the third time, and all the guides must now be set to the scale-number $13\frac{1}{2}$ plus twice the thickness of the fabric, and the doubled fabric, with the two plies downward, must now be passed through the machine again, when it will come out smoothly folded, as shown in Fig. 23, provided due attention has been paid to the proper adjustment of the selvage-tension of the plies, in addition to the adjustments as to other things already mentioned. The adjustment of the ply-tension is only to be accomplished by tentative methods, for different fabrics, as they vary in thickness, strength, and elasticity, require different degrees of stretching to maintain sufficient and not too much tension at and near the crease. If the tension at the crease becomes greater than is needed to make it sharp, smooth, and even, then the hinged tapering stretchers S S, Figs. 10 and 11, should be turned from their position of inaction, where they lie parallel to the base of the plicater and behind the area in which the plies are turned, with their thin ends toward the point of the plicater and between the selvage of the ply and the back of the plicater, until the path of the selvage is elongated enough to lessen sufficiently the tension on the crease. This turning of the stretchers is effected by means of a shaft, s, extending across the base of the plicater and resting in bearings in the side bars, F, one end of the shaft being provided with a hand-wheel, s', and a toothed detent-wheel, s², with a detent, s³, hinged to the bar F, Fig. 11, which holds firmly the shaft s in any position to which it may be turned by the hand-wheel. Near each end of the shaft a small miter-wheel, s⁴, is mounted, which gears into corresponding miter-wheels s⁵. Each stretcher S is shaped like the smaller section of a cone divided by a plane parallel to the axis and about one-eighth of the diameter therefrom, and lies with its flat side against the back of the plicater. The heel of each stretcher, with its miter-wheel, turns on a stout pivot extending downward from the back of the plicater. Thus constructed and arranged, the stretchers may be turned forward nearly parallel to the sides of the plicater, as shown in Figs. 10 and 11, or back beneath the shaft s, as shown by dotted lines in Fig. 10. This arrangement admits of the simultaneous adjustment of both stretchers by a single movement of the attendant of the machine.

I prefer to make the stretchers of cast-iron,

hollowed out on the back to diminish the weight and polished where the cloth rubs on them.

The slopes produced by thinning off the edges of the plicater on the back near the point are continued up the inclination of the stretchers, to produce the effect of almost any variation in the thickening of the edges of the plicater toward the base that could in practice be required.

Numerous ways are available for thickening the edges of the plicater—as, for instance, removable tapering strips, as shown in Fig. 28; a compound edge expanding vertically, as shown in Fig. 29; a movable margin on each edge of the plicater to expand and contract like a fan, to increase or lessen marginal tension on the ply, as shown in Fig. 30.

When a web is to be so folded as to require more than one pair of plies to be turned, instead of attaining that end by running the fabric more than once through the same machine readjusted properly after turning one pair of plies, for turning the next pair a second plicater with necessary accessories may be added to the machine to receive the two-ply fabric as it leaves the first plicating mechanism and give it an additional fold. If required, a third plicater and accessories may be combined with the second to receive the twice-folded fabric direct from the second plicater and give it a third fold; thence the fold made of from four to eight plies, as the case may be, at a single operation would pass direct to the packaging-machine and be rolled or folded up, without relaxing the tension, into an even and snug parcel. Such a triplicater and packager combined is shown in Fig. 16, W X Y, respectively, being the folders and P the packager.

The plicaters C C C and side guides, L L, are adjusted for folding a piece of fabric in the manner represented by Figs. 21, 22, and 23. In this compound machine only the mechanism for making the initial fold requires a feed-table, and only that for making the final fold requires traction-rolls, which, even in it, may be dispensed with by causing the packager to draw all the cloth through the plicaters, as shown in the drawings.

When the traction-rolls are dispensed with one or a pair of guide-rolls will be required in their place. In the drawings one guide-roll is shown, except in the first machine, W, of the series, in which two are represented.

The traction-rolls could be converted into guide-rolls by simply removing the driving-shaft with its wheel and pulley, and this arrangement in many cases would be preferable to the single roll.

The plicaters of the three machines should be placed on the same level, the base of each succeeding plicater being at the side and parallel to the crease-line of that which immediately precedes it, to receive therefrom the issuing end of the partially-folded fabric.

The second machine has its foot fitted like the tail-block of a lathe, to rest on ways $a^4 a^4$, Fig. 16, on the base upon which the compound

machine is placed. These guide-rails are parallel to the crease-line of the preceding plicater and at right angles to that which they carry. The purpose of these rails is to allow the second plicater to be adjusted laterally to bring its crease-line into the plane of the crease for the next ply it is required to turn on the fabric, which is always at right angles to the fold-plane of the ply immediately preceding. When the second machine, X, is thus adjusted it is held in place by clamp-screws $a^5 a^5$ passing through its foot.

The side guides, L L, of the plicater must be adjusted to the width of the entering fabric in its partially-folded state and to guide it in the proper position to direct it over the point of the plicater in the line of the course of the fold next to be made.

A rounded bar or roll, z , to lessen friction, is placed across the base of each of the plicaters X and Y. The end of the fabric being carried through the plicater X, the second narrow ply is turned, and the two margins meet near the middle of the web, which, so folded, is reduced to one-half of its original width, and is ready to enter the third plicater, Y, to receive its final fold.

The third plicater is ranged at the side of the second, as the second was ranged at the side of the first. The size of the third plicater is less than that of the second, as the second is less than that of the first, in the proportion that the width occupied by the fabric has been reduced by the successive folds, this plicater having only one-half the width of base of the first. The plicator Y must be adjusted on its ways $a^4 a^4$ with its crease-line in the same perpendicular plane with the middle line of the twice-folded fabric issuing from the second plicater, and fastened in this position by the clamp-screws passing through its foot. The side guides, L L, of the third plicater being adjusted to the width of the twice-folded fabric and equidistant from the crease-line, the end of the folded fabric is now carried forward over the bar or roll z , the plicater, through its fold-guides and traction or guide rolls E, as the case may be, and forward to the packager, to the central rod, p' , of which its end is connected, to be wound thereon to form a cylindrical package. This completes the plication of the fabric and brings it to the point where the packaging is to begin.

When a web has been neatly and evenly plicated lengthwise, and the creases of its folds fixed, and its plies laid flat by the gripe of the rolls E E, as if by a process of mangling, it is highly important that the cloth thus plicated and smoothed, while under tension by pressure, should, without relaxation of the tension, be at once and continuously with the plication rolled or folded into a package, which then can be made more dense, even, and neat, and a more perfect and desirable piece of merchandise, than if after plication under tension and subsequent compression it were suffered to rest, relax its tension, expand its bulk, and change its shape before being packaged by a

separate and subsequent operation. For these and other reasons I have combined with my folding mechanism a packaging mechanism, so that the folded fabric will pass from the folder
5 directly into the packager, to be made up into a package as fast as folded.

I deem it unnecessary here to describe particularly my improvements in the mechanism for making either cylindrical or flattened packages, as they are the subject of claims by me
10 under another patent, applied for January 15, 1880. It is sufficient to say, in a general way, that the packager, as represented in Figs. 1 and 16, consists principally of a frame erected
15 upon the same base with the plicater; having two standards suitably connected and braced. Near the top of each standard stout mandrels or short shafts *u u* are arranged in suitable bearings to support the rod, board, or other
20 core for the package to be rolled on. The outer end of one of the mandrels carries a driving-pulley, which is driven by a belt from any suitable motor. The opposite mandrel is
25 fitted with a screw and hand-wheel for turning it in or out, to facilitate the insertion or withdrawal of the rods, boards, or rolls on which to wind the plicated fabric to form the package.

In the drawings I have shown a rod, *p'*, to
30 wind the cloth on. This rod tapers sufficiently to admit of its being withdrawn from the finished package. The cores should be provided with devices for holding the end of the fabric to prevent it from slipping while winding.

When a lot of webs of equal width of any fabric is to be folded, I prefer to stitch together the ends of as many of them as the feed-table will hold at once, piled up in back-and-forth plications, the last end of the web, at the bot-
40 tom of the pile, being allowed to hang over the rear side of the table in a position convenient for stitching it to the front end of a pile of another like series of webs. Thus any number of webs of one width may be connected and
45 run through the machine without the necessity of stopping to perform the troublesome operation of threading the end of each web through the stretchers, guides, round the plicater, through the fold-slot, and between the
50 traction-rolls, as would be necessary if each web were separately entered and folded.

When the first web of such a connected series has reached its terminal fold in the package and brought up to the packager, the forward
55 end of the next web, the machinery is stopped a moment to sever the connection of the two webs, fasten the completed package, remove it from the packager, place in the latter another core, and attach thereto the forward end of
60 the next web, when the machinery is again started, and the next web in its turn packaged as it issues from the folder.

I have deemed a horizontal position the most convenient, both as respects construction and working, for the triangular plicater
65 for general use, and have therefore described my folding-machines as organized with it in

that position; but as the movement of the fabric in my method of folding is positive and constantly under considerable tension, with no
70 reaches unsupported long enough to sag and be flapped about by rapid motion, while the longest reaches are always under the greatest tension, the machine would work efficiently, with the plicater pointing either upward or
75 downward, if the construction and organization of the machine otherwise were made to correspond to such changed position and such as to bring into operation the improved devices and methods of operation which are the sub-
80 ject-matter of this specification.

The triangular plicater might also be made more acute than ninety degrees, and consequently of greater length, or it might be made more obtuse, and therefore shorter; but such
85 changes necessarily require an increased area of fabric to be placed at any given time under the action of plication, and require many changes in the organization of the mechanism with an increase in the bulk of the machine.
90 Such changes also change the strain upon the fabric under plication, and especially increase those which are unfavorable to even and smooth folding, and such unfavorable changes increase in a ratio far greater than the departure of
95 the angle of the plicater from ninety degrees—the angle which I have discovered to be the best. While such changes would thus be detrimental and under most circumstances inexpedient, yet, combined with the improvements
100 which I have herein described, they would be consistent with the production of a fairly efficient plicater that would save much labor and do superior work by comparison with the best methods heretofore known; but I deem it un-
105 necessary to describe the construction and mode of working these inferior arrangements, as I have already described others which are better.

When very 'elastic, heavy, wide, and not
110 very strong cloth is to be plicated, the distance between the edge of the plicater and the usual fold-guide may be so great that the margins of the plies will sag and flap, or undulate, to a degree that cannot be counteracted by mere
115 tension without subjecting the cloth to injurious strain. In such a case a positive support for the ply, to prevent sagging, must be resorted to by detaching the narrow fold-guides most suitable for ordinary fabrics and replacing them by the wing fold-guides shown in
120 Figs. 5 and 6. This will keep up the margins and make the plies run steadily. The wings *d* of these guides should be very smooth on the surface over which the cloth passes. They
125 may be made of sheet metal, or of smooth parallel rods stretching out, like the teeth of a comb, at right angles from the fold-slot toward the edges of the plicater. The ends of the rods should be blunt and round.
130

The cloth might be measured and the measure registered upon it between the plicater and the packager by means of a machine which I have invented for that purpose; but as I have

described that machine in another patent, applied for January 15, 1880, it is unnecessary to repeat that description here.

In order to plicate a web properly its end must be outspread and threaded through the machine with skill and care to generate a true and even fold, as upon this the accuracy of the subsequent plicature will largely depend; hence it is of great importance that the construction and arrangement of the parts of the machine with which the attendant has more immediately to deal in beginning the fold should be such that the fabric can be introduced under the best conditions with little, if any, more difficulty and labor than its improper presentation would involve. To this end I have constructed the fold-guides in such manner that the slot between them in which the opposite plies meet shall be open at one end to admit of the convenient insertion and proper adjustment of the plies to form the fold. To the same end I have so constructed and mounted the rolls E E that they can readily be separated to leave an unobstructed opening for the safe and convenient insertion edgewise between them of the end of the plicated web coming from the fold-guides and adjusting the same in the proper position between the rolls. To this end, also, I have adapted the graduated scales and adjusting-screws to the plicater and side guides, that the machine may easily be arranged for fabrics of different widths and plicature. With the same object I have fitted the tension and stretching roll with an easily-regulated friction-band, by means of which the tension can be properly regulated without the need of more skill or care than the ordinary attendants of similar kinds of machinery are accustomed to bestow.

The open end of the slot between the fold-guides and the open end of the space between the traction-rolls are labor-saving improvements, and otherwise highly useful, but not indispensable, as the machine would do good work if they were closed. I do not, therefore, restrict myself to the use of either form, although I prefer, and generally use, that which is open.

What I claim is—

1. The improvement in the art of plicating fabrics lengthwise of the web in machines in which a triangular plicater and a folding-guide are employed, which consists in applying differential tension lengthwise of the web to the portion of the fabric being formed into plies, such tension increasing from the crease toward the margins of the plies, substantially as described.

2. The combination of a plicater whose opposite sides converge at an angle of ninety degrees, or thereabout, with fold-guides and guide or traction rolls arranged substantially parallel to the plicater, whereby the plicature is effected by action upon a minimum area of the web of fabric at any given time, substantially as described.

3. The combination, with a pointed plicater, C, of the fold-guides D D, the plicater being constructed and arranged with respect to the fold-guides as described, whereby the path of the fabric from the converging edges of the face of the plicater to the slot between the fold-guides is shorter relatively to the convergence of those edges from and near their apex than from those portions more remote therefrom, substantially as described.

4. The combination of the plicater C with margin-stretchers S and means for adjusting said stretchers, substantially as described.

5. The combination of the plicater C with fold-guides D D, arranged near its back and parallel thereto, substantially as described.

6. The combination of the plicater C with fold-guides D D, adapted to be adjusted toward and from each other, substantially as described.

7. The combination of the plicater C with fold-guides D D, adapted to be adjusted toward and from the back of the plicater, substantially as described.

8. The combination of the plicater C and guide-bars D D with traction-rolls E E, the guides and rolls being arranged substantially parallel to and immediately below the plicater, and means for operating such rolls, substantially as described.

9. The combination, with the plicater C, of the fold-guides D D, provided with wings *d d*, to support the plies of very elastic wide and heavy fabrics against a tendency to bag and flap, between the edge of the plicater and the fold-guides, substantially as described.

10. The combination of the plicater C and side guides, L L, having arms *l l*, with the adjusting-rod N, having a right-hand screw on one end, a left-hand screw on the other end, and corresponding nuts in the arms *l l* of the guides, substantially as described.

11. The combination of the plicater C and stretching-bars H G with adjustable guides L L, common to both, and means for adjusting said guides simultaneously and by one operation, substantially as described.

12. The combination of the graduated plicater C and right and left hand screw-adjusting rod N with the side guides, L L, adapted to be separately adjusted on the adjusting-rod, as well as simultaneously adjusted thereby toward and from the crease-line, substantially as described.

13. The combination of the graduated plicater C with the graduated feed-table M, having side guides, *k*, adapted to be adjusted on said table, substantially as described.

14. The combination of the plicater C with fold-guides D D, unconnected at one end, to facilitate the threading of the fabric through the slot between them in generating the lengthwise plicature, substantially as described.

15. The combination of the plicater C with traction-rolls E E and mechanism whereby they are adapted to be opened and shut and

to seize and carry forward the folded fabric with a graduated gripe, substantially as described.

16. The combination of the plicater with 5 fold-guides, unconnected at one end, and traction or guide rolls, also unconnected at one end, substantially as described.

17. The combination of a series of two or more parallel plicaters and their respective 10 accessories, made adjustable to each other, as described, co-operating to turn a corresponding number of lengthwise folds in a web at one operation, substantially as described.

18. The combination of a series of two or 15 more plicaters and their accessories, adapted to be adjusted to each other, as described, and co-operating to turn a corresponding number of lengthwise plies in a web, with a cross-folder or packager, and driving mechanism for operating the whole, whereby at one operation the 20 web is multiplied lengthwise and made into a compact merchantable package, substantially as described.

19. The improvement in the art of plicating 25 fabrics lengthwise of their webs and then cross-folding them in machines in which a triangular plicater and fold-guides are employed, which consists in uniting the webs to be plicated in a series or chain, as described, and 30 applying to them an increasing tension at and toward their margins as they pass over the sides of the plicater to the fold-guides, where-

by the ends of the webs in the intervals between the stitches or other means of joining them may pass over the point of the plicater 35 without catching thereon, so that the plicature may, as described, be initiated in all the webs after the first automatically and their lengthwise and cross folding may both be done more evenly and with a saving of time and labor, 40 substantially as described.

20. The combination of the feed-table M, friction-bars H G, tension-roll I, and means by which its resistance may be adjusted, side 45 guides, L L, and means for adjusting them, with the plicater C, fold-guides D D, traction-rolls E E, and means for actuating said rolls, substantially as described.

21. The combination, with mechanism for 50 outspreading the fabric preparatory to plication, a plicater, and fold-guides, constructed substantially as described, of mechanism for applying substantially equal tension to the entire web of fabric as the same is passing to the 55 plicater, whereby the said fabric is both plicated lengthwise of the web and cross-folded into a tight and even package automatically, at a single operation and while subjected to such tension, substantially as described.

JOSEPH J. SCHOLFIELD.

Witnesses:

E. E. MASSON,
W. B. MASSON.