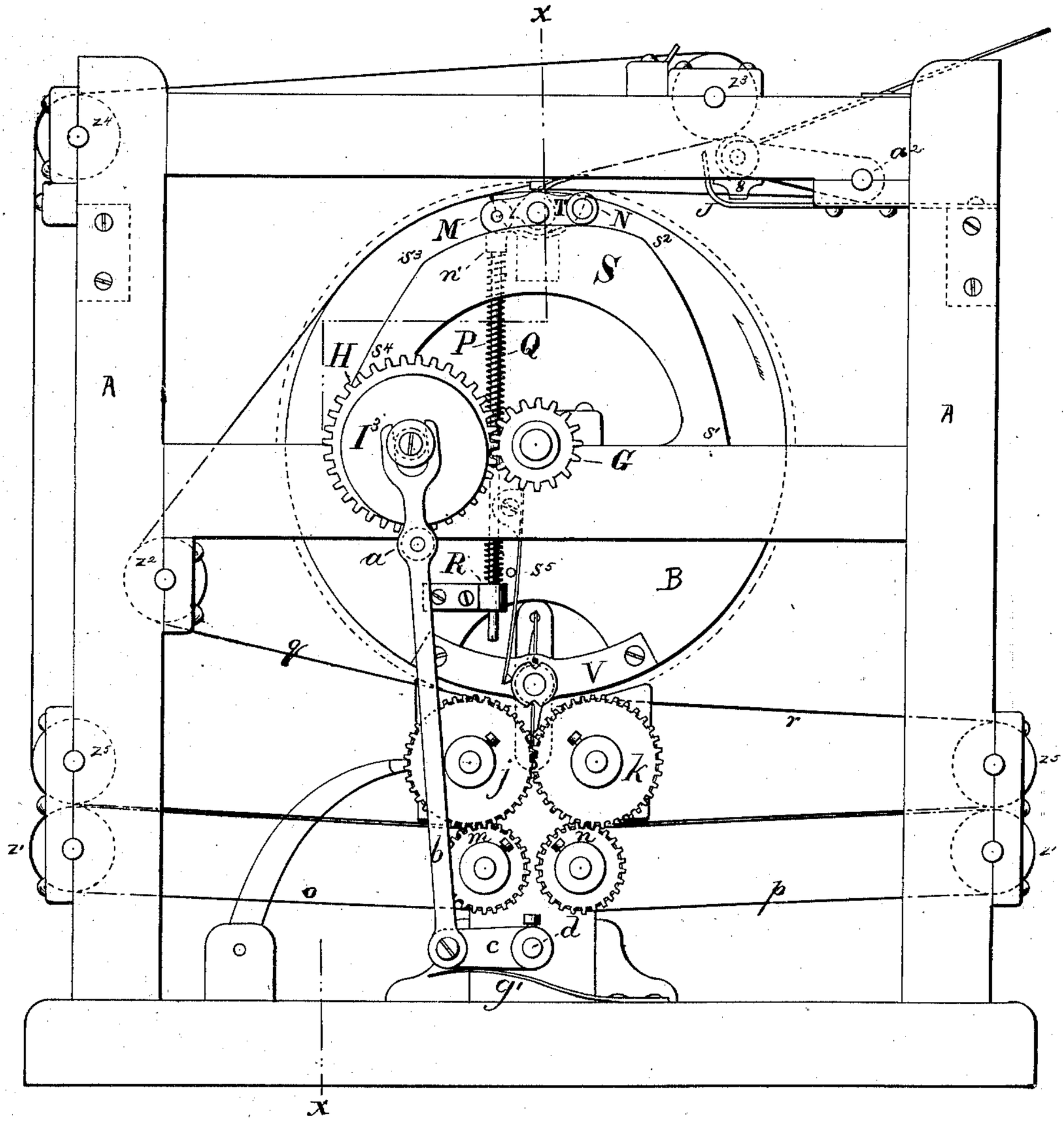
12 Sheets—Sheet 1.

S. D. TUCKER.

ROTARY PAPER FOLDING MACHINE.

No. 171,196. Patented Dec. 14, 1875.

Fig. 1.



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12 Sheets—Sheet 2.

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ROTARY PAPER FOLDING MACHINE.

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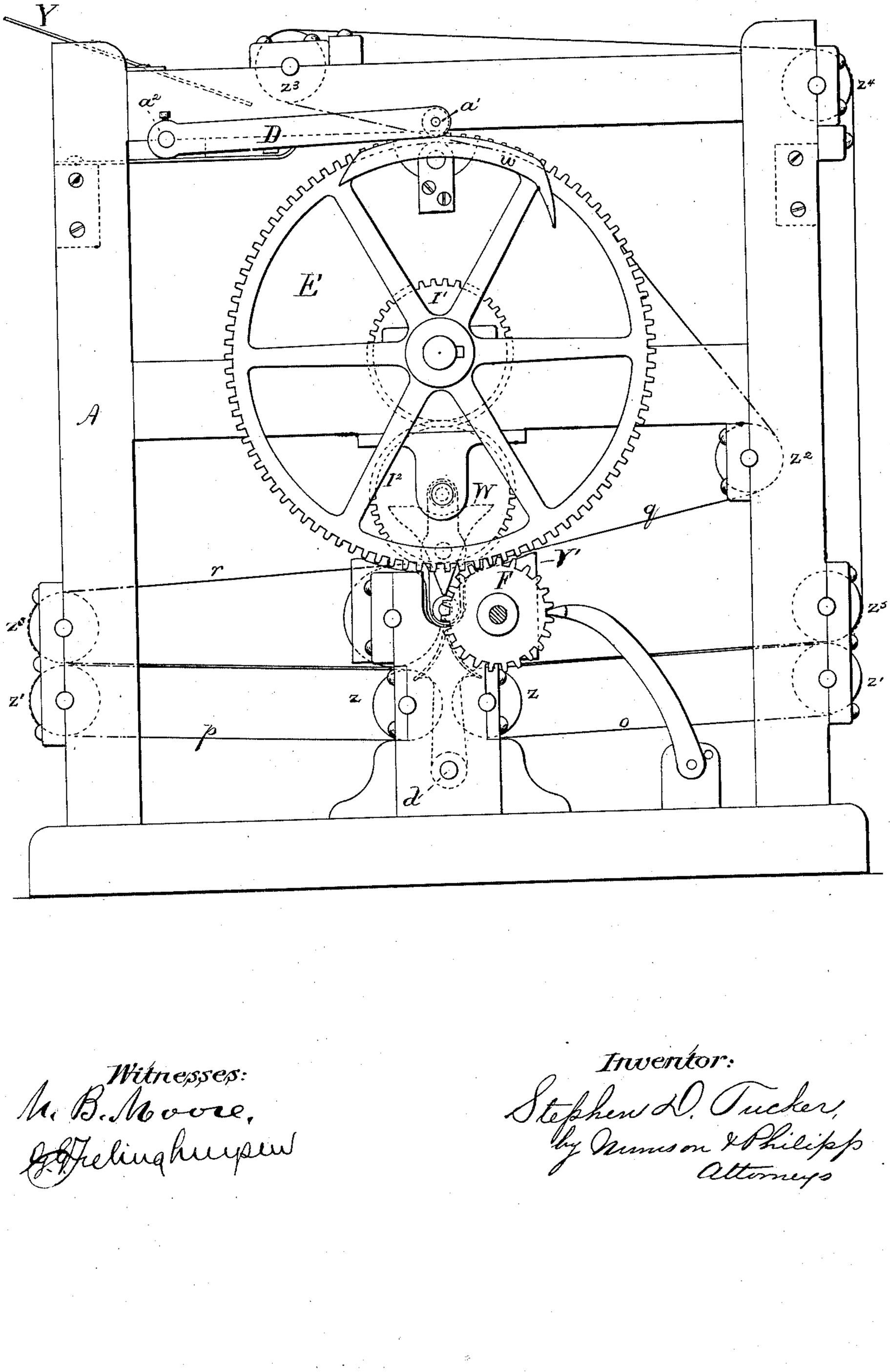
Fig. 2.



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12 Sheets—Sheet 3.

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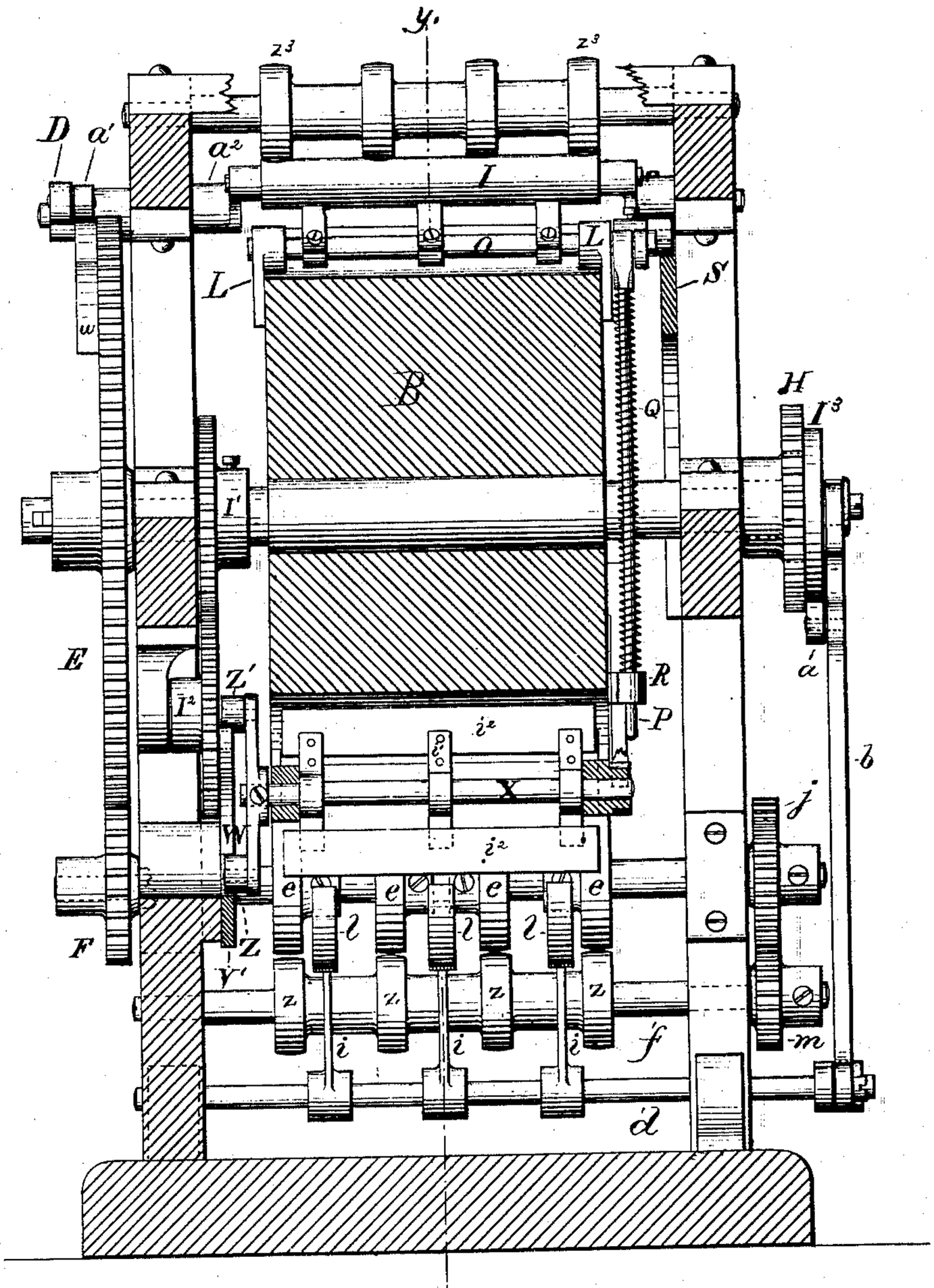
ROTARY PAPER FOLDING MACHINE.

No. 171,196. Patented Dec. 14, 1875.

Fig. 3.



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12 Sheets—Sheet 4.

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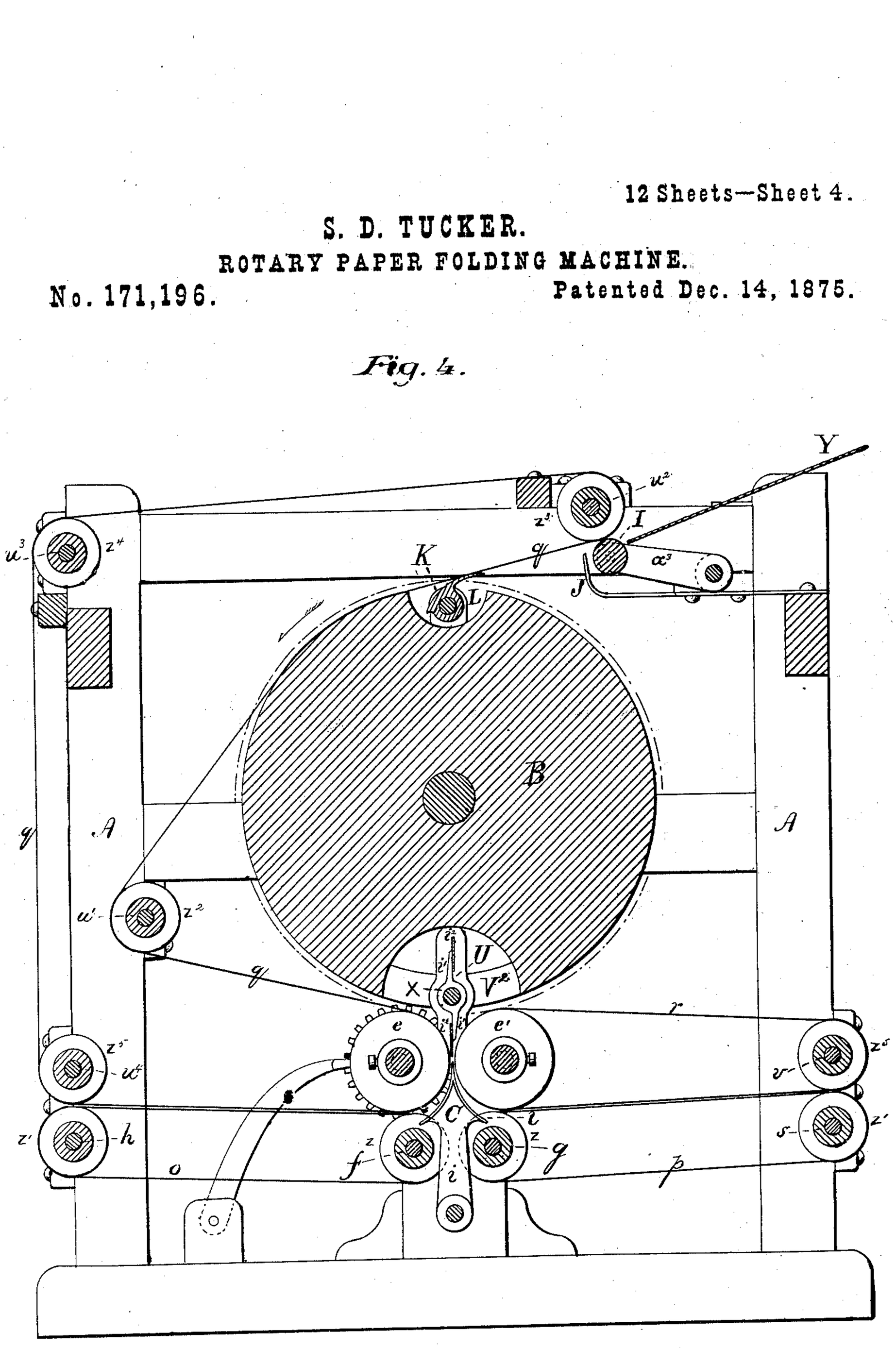
Fig. 4.



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12 Sheets—Sheet 5.

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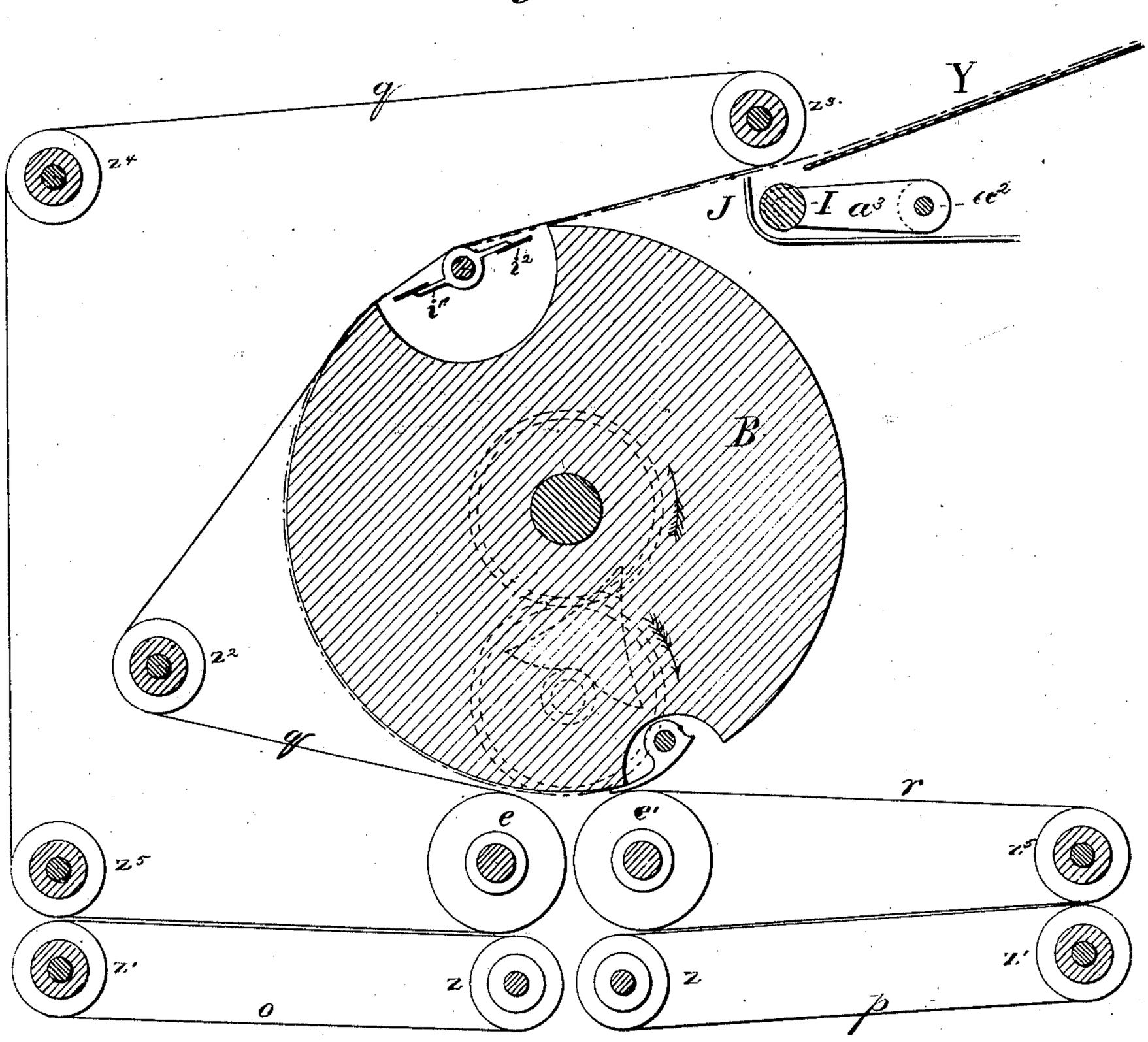
ROTARY PAPER FOLDING MACHINE.

No. 171,196. Patented Dec. 14, 1875.

Fig. 5.



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12 Sheets—Sheet 6.

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ROTARY PAPER FOLDING MACHINE.

No. 171,196. Patented Dec. 14, 1875.

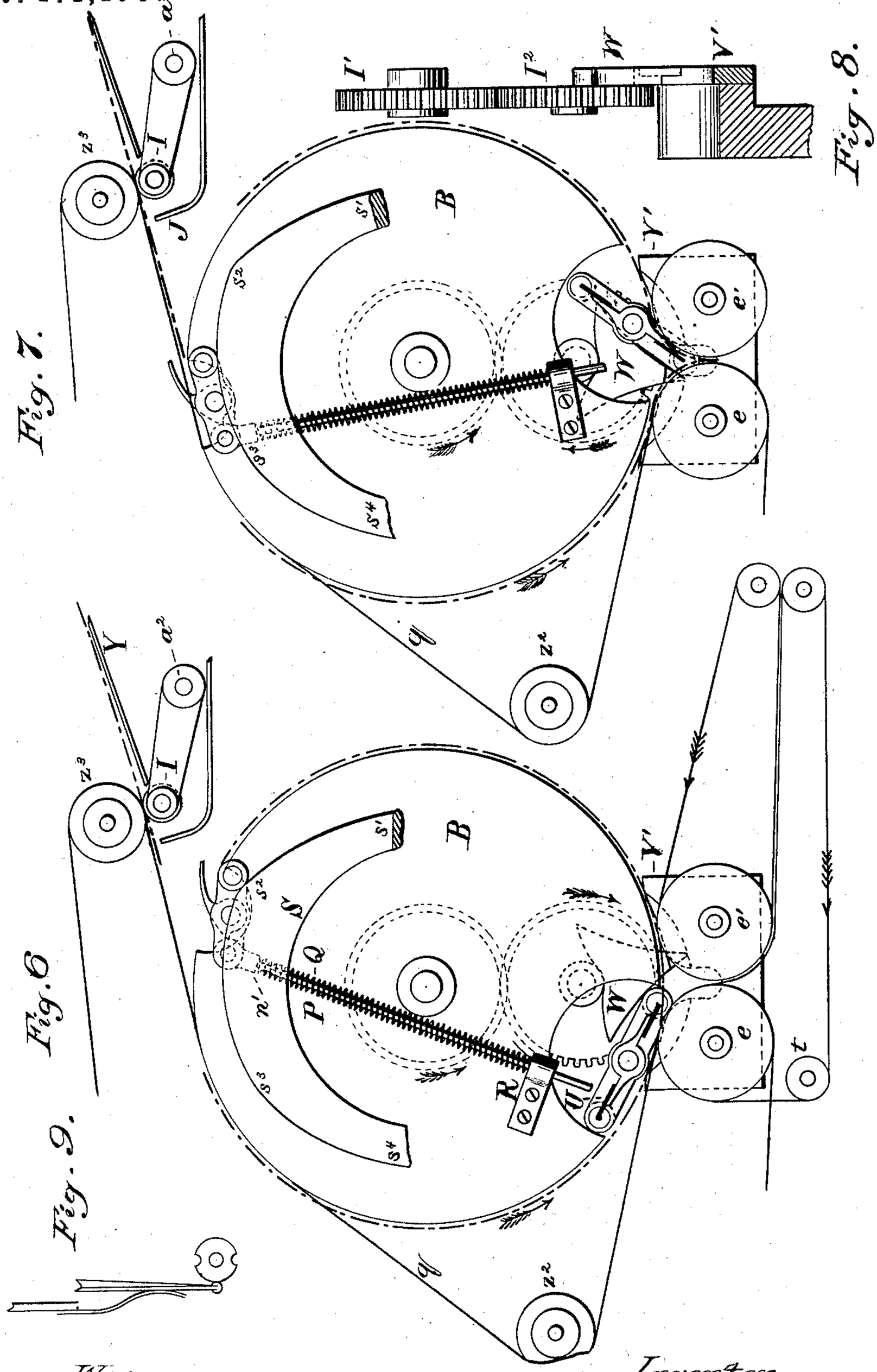

Fig. 8.

Fig. 7.

Fig. 6

Fig. 9.

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12 Sheets—Sheet 7.

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ROTARY PAPER FOLDING MACHINE.

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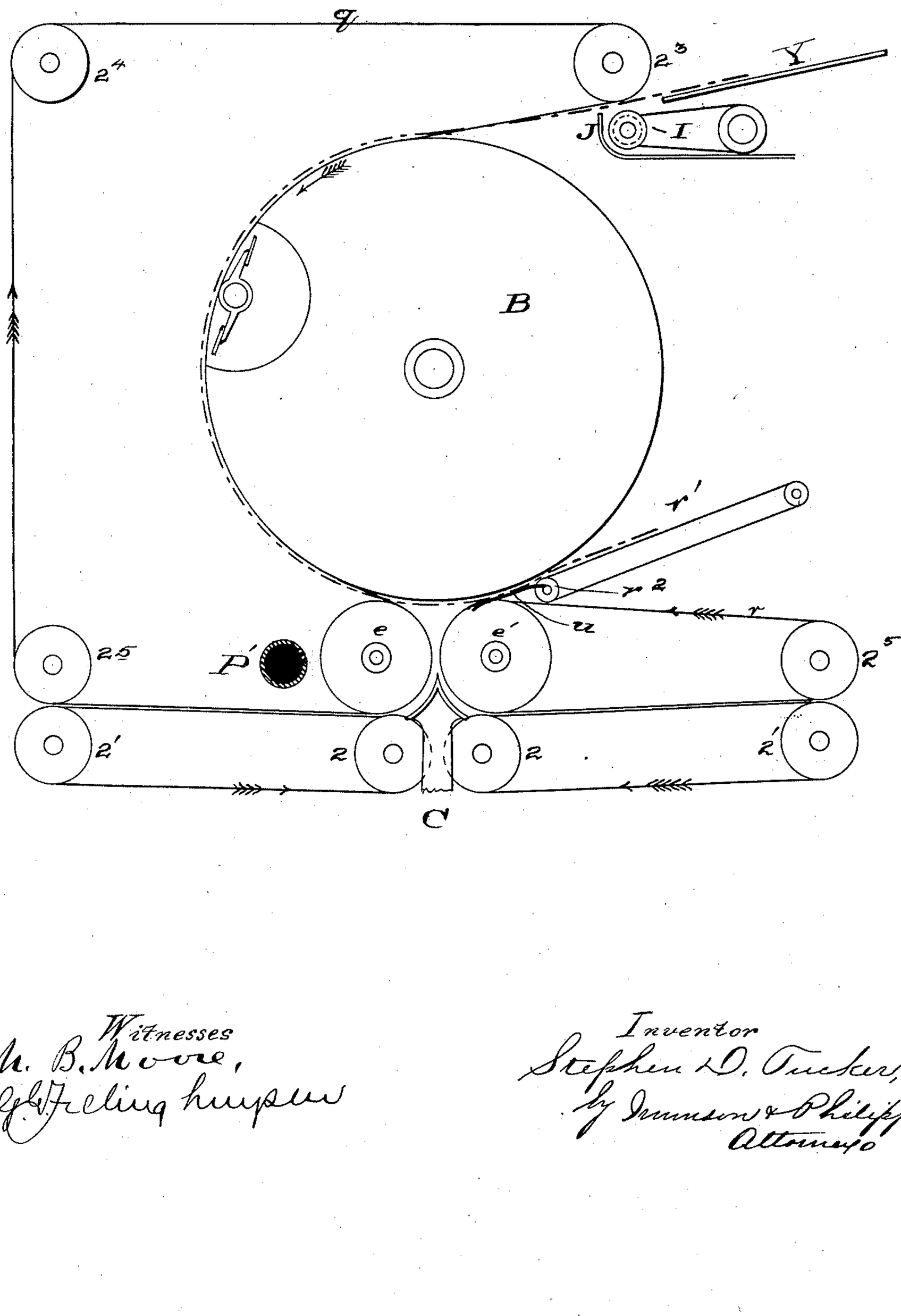
Fig. 10.



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12 Sheets—Sheet 8.

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ROTARY PAPER FOLDING MACHINE.

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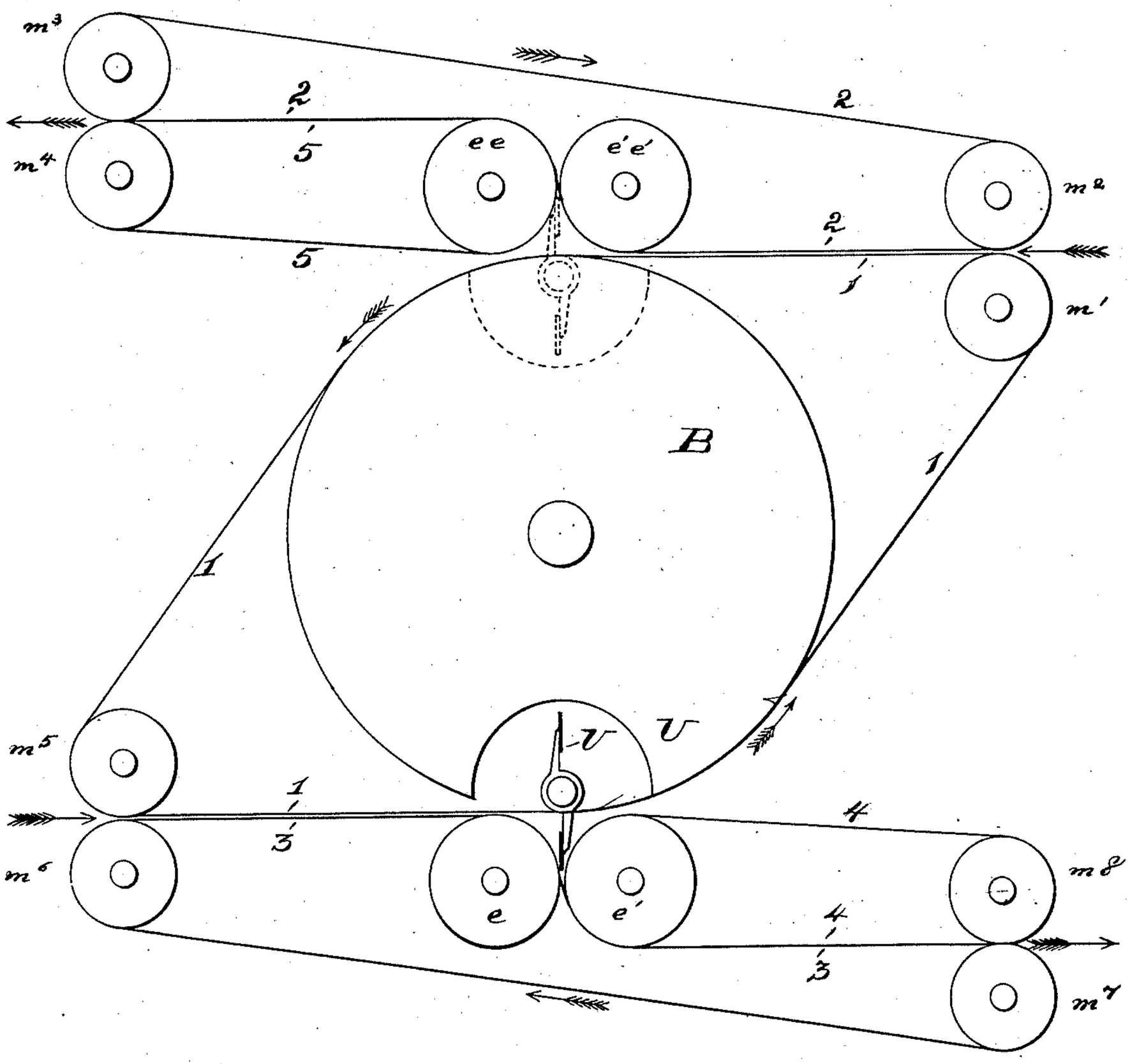
Fig. 11



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12 Sheets—Sheet 9.

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ROTARY PAPER FOLDING MACHINE.

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Fig. 13.

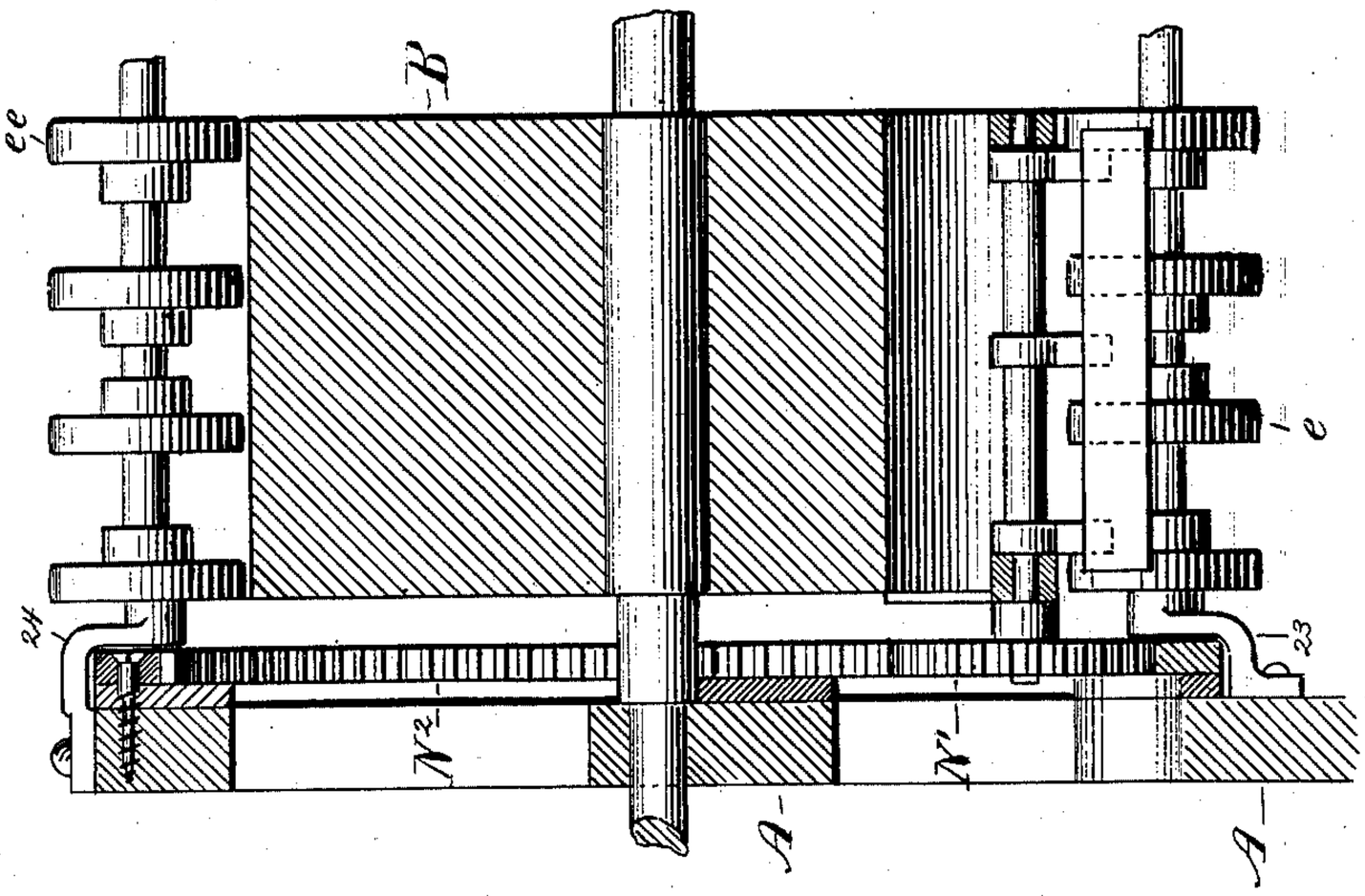
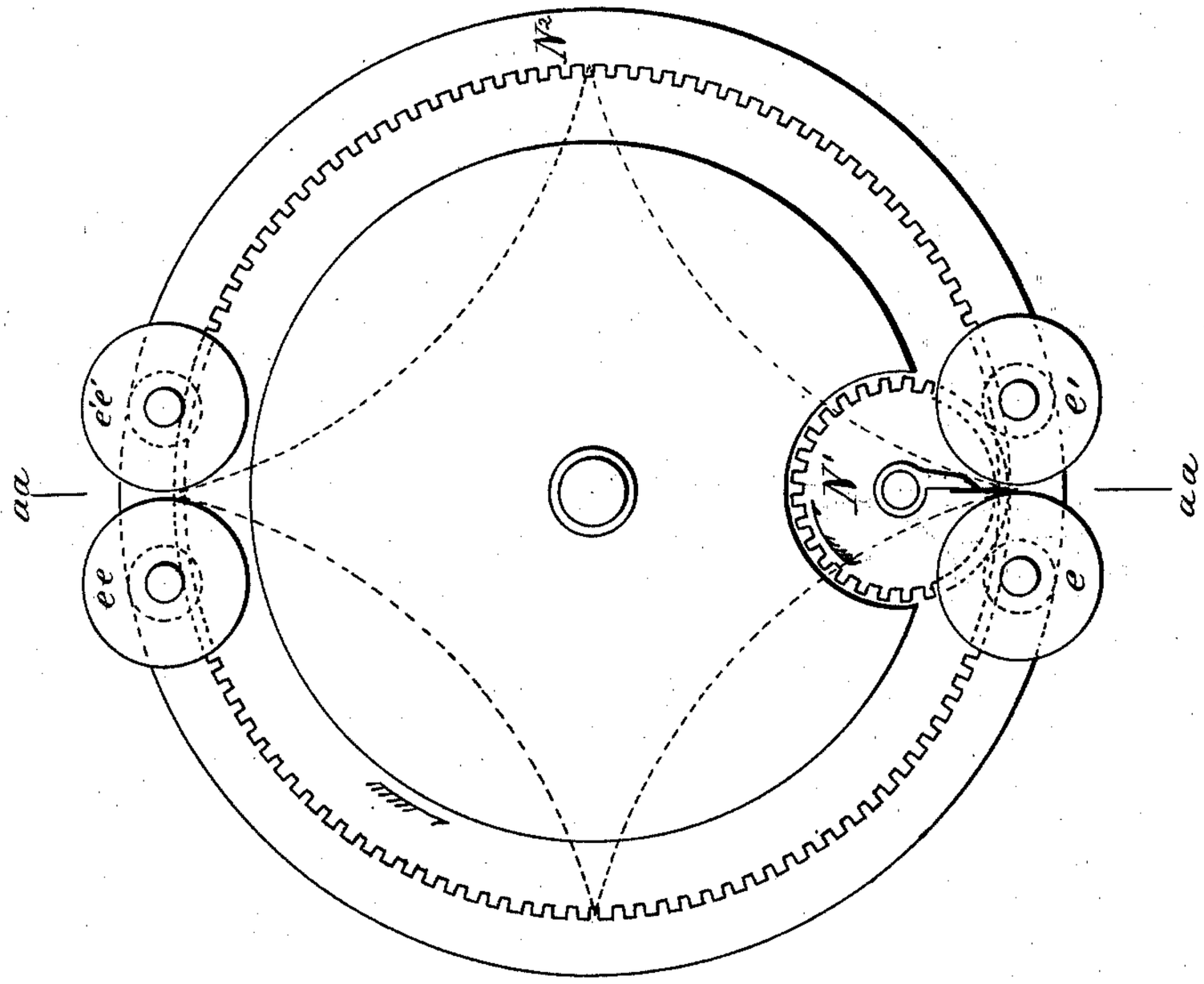


Fig. 12



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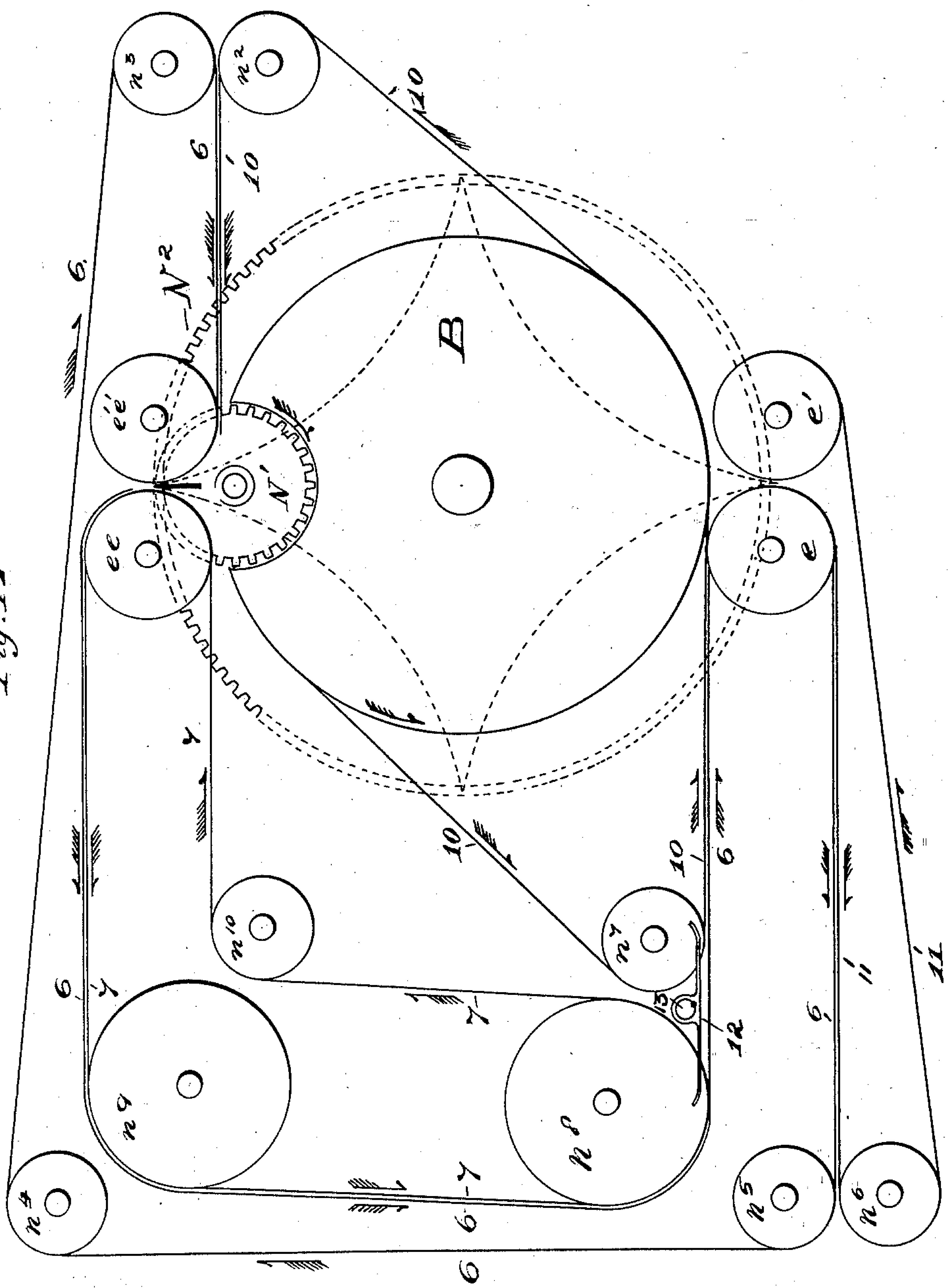

Fig. 14

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12 Sheets—Sheet 11.

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ROTARY PAPER FOLDING MACHINE.

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Fig. 16

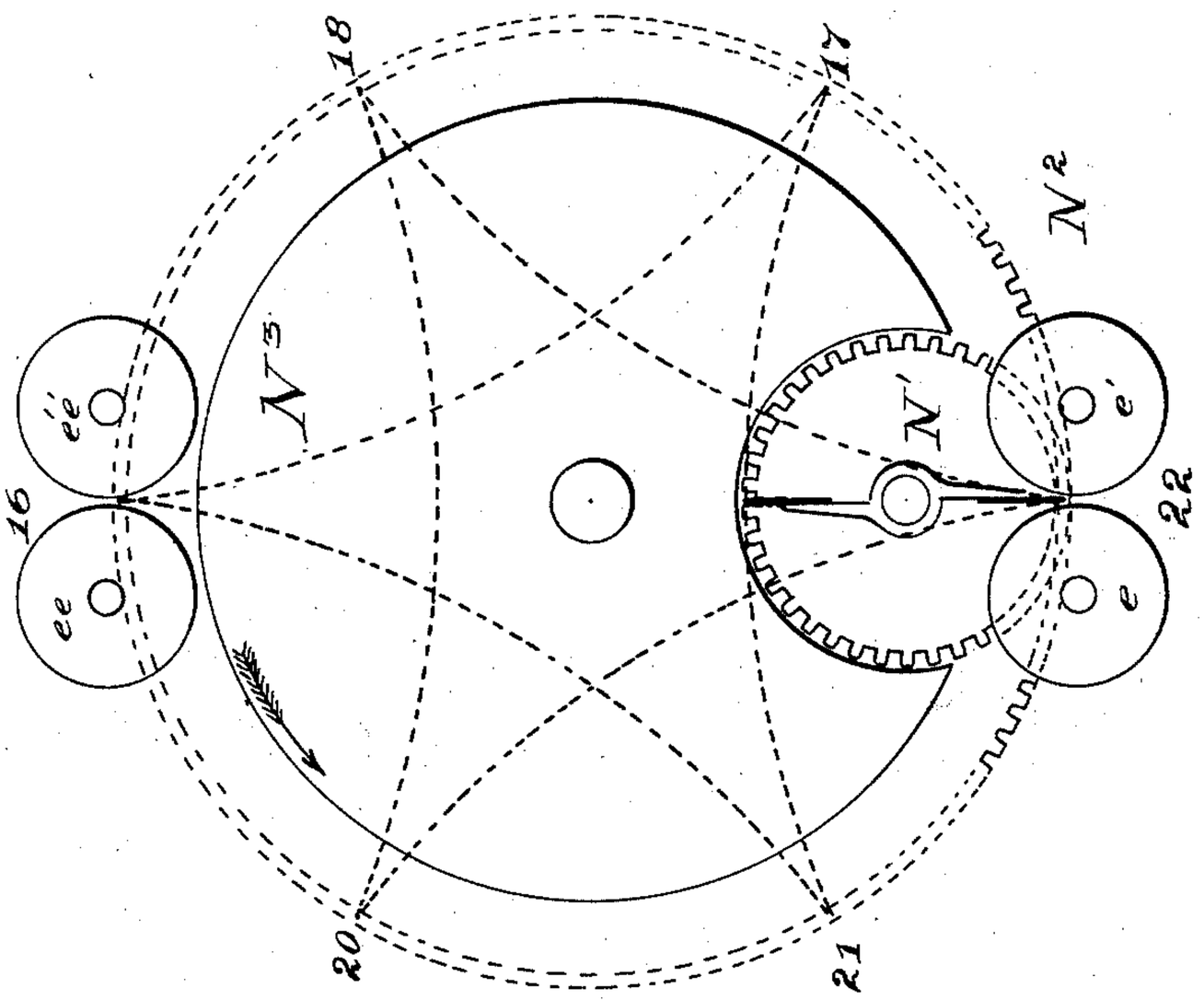
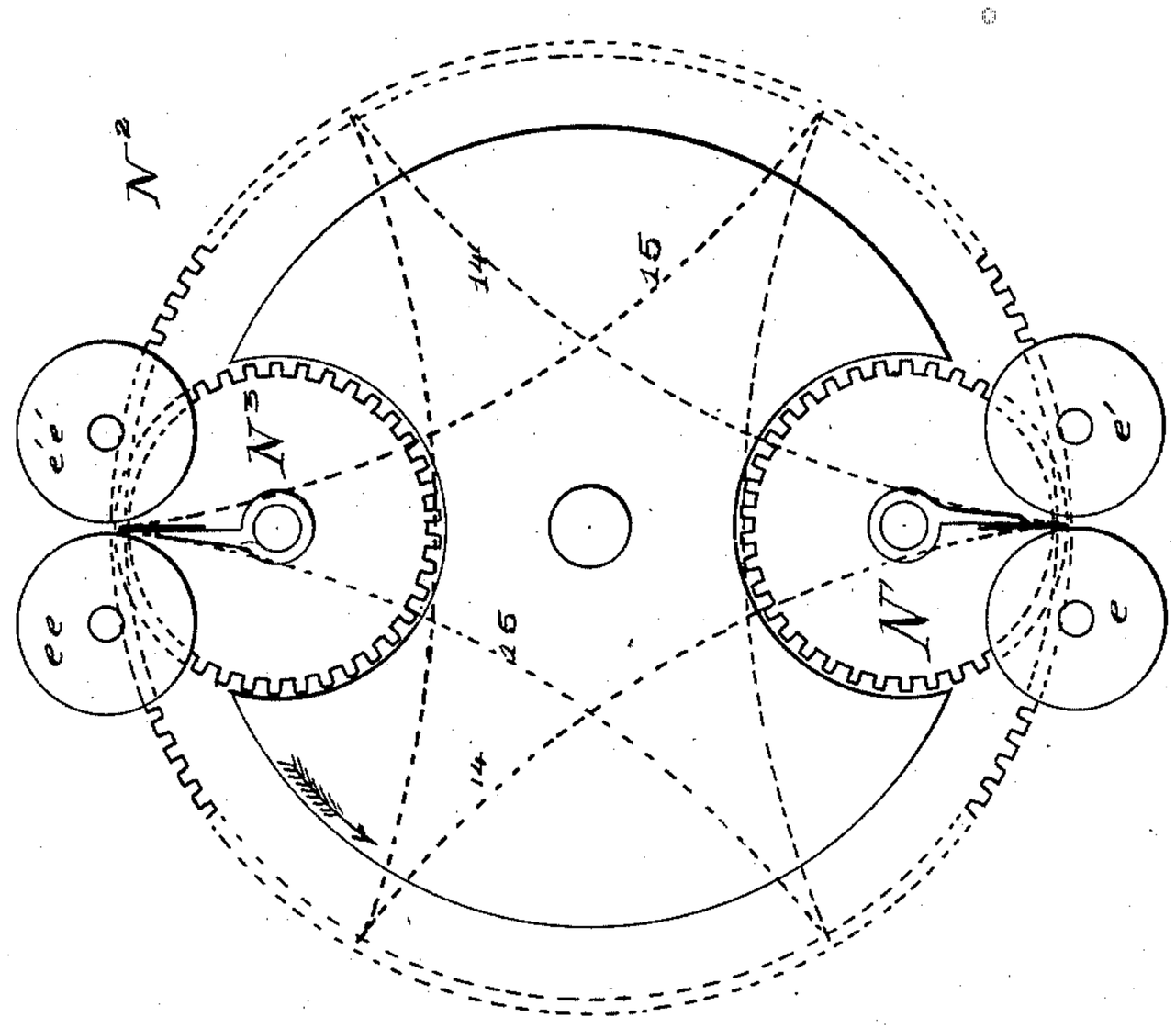


Fig. 15



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12 Sheets—Sheet 12.

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Fig. 16

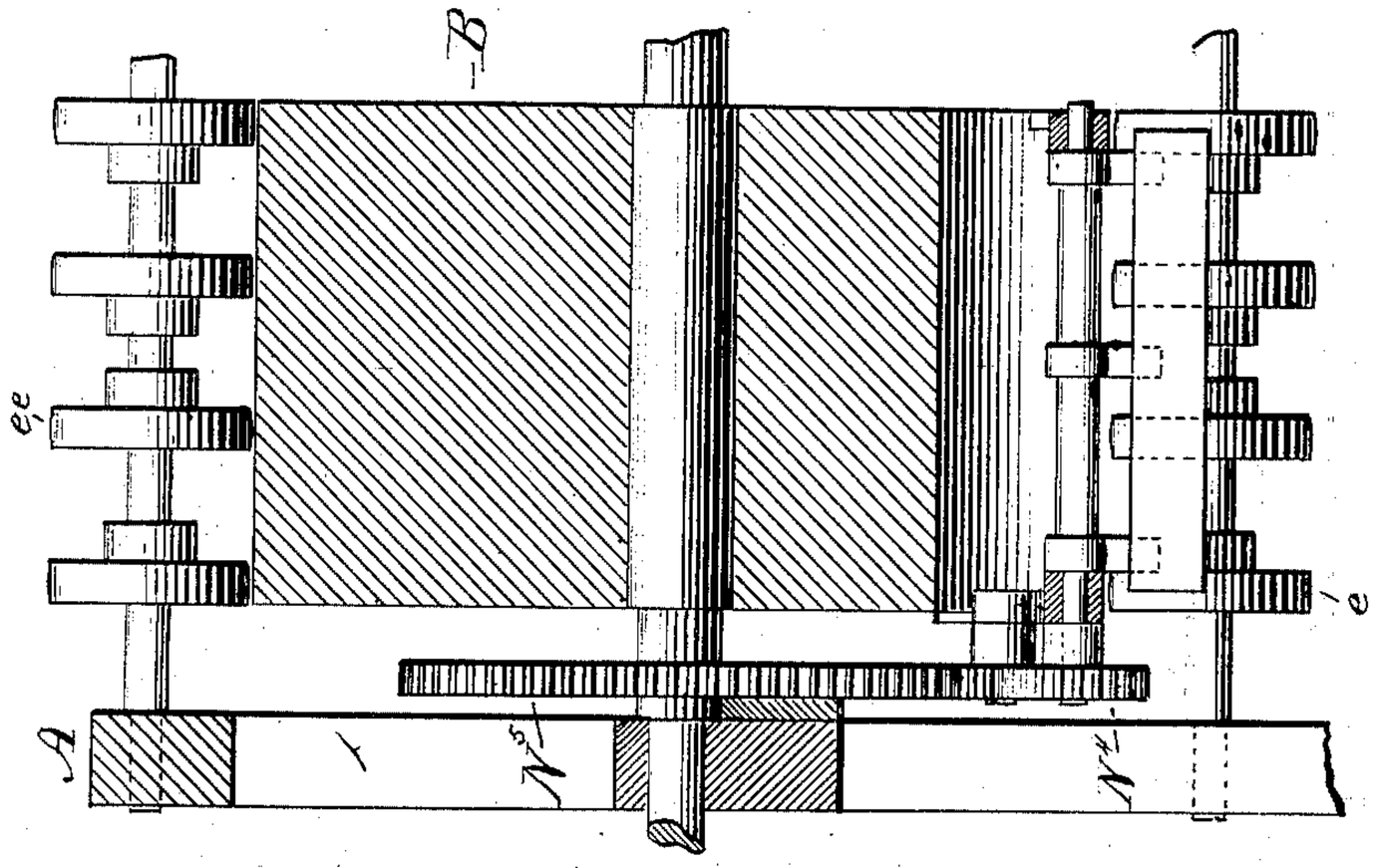
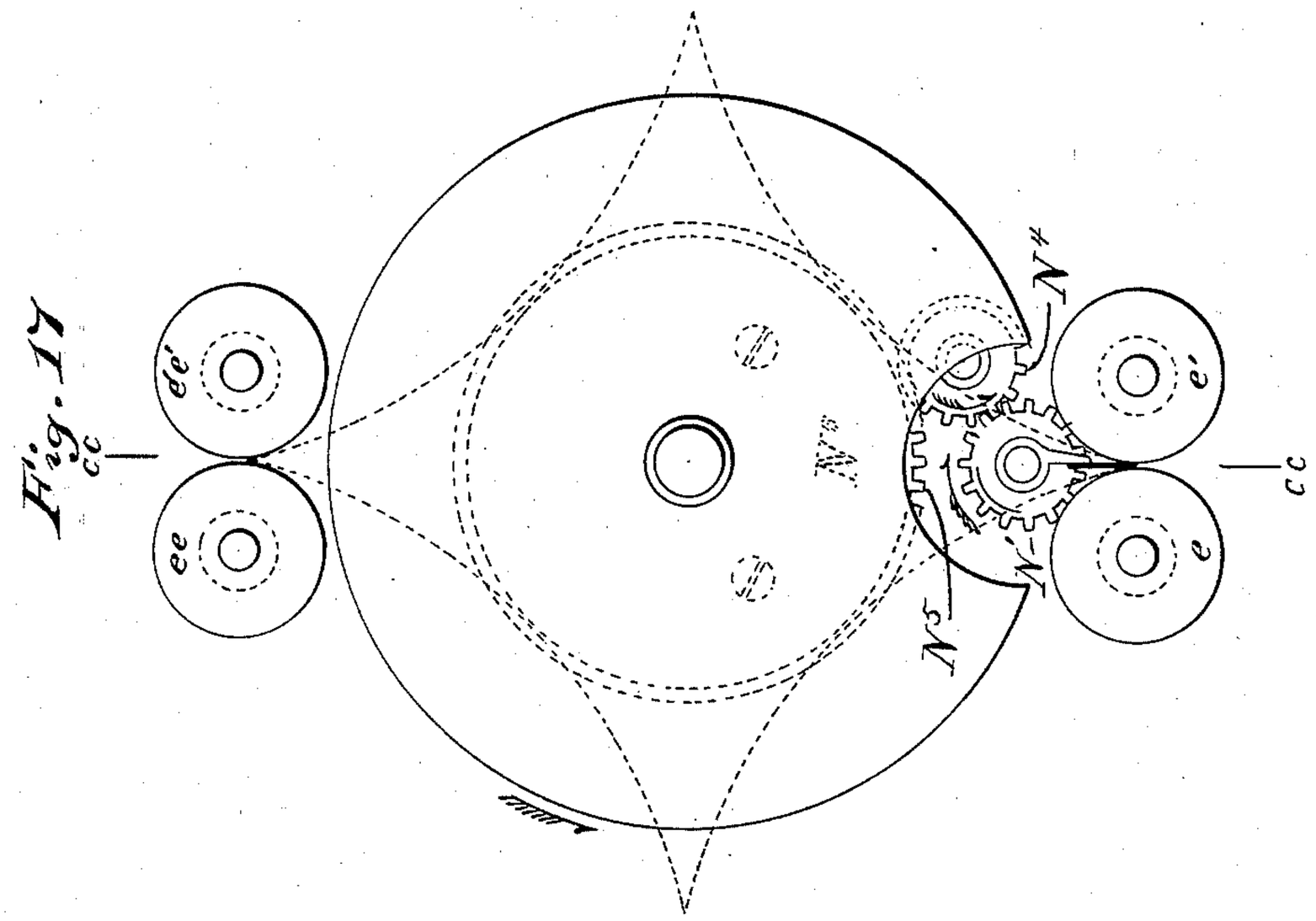


Fig. 17



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UNITED STATES PATENT OFFICE.

STEPHEN D. TUCKER, OF NEW YORK, N. Y.

IMPROVEMENT IN ROTARY PAPER-FOLDING MACHINES.

Specification forming part of Letters Patent No. **171,196**, dated December 14, 1875; application filed September 7, 1875.

To all whom it may concern:

Be it known that I, STEPHEN D. TUCKER, of the city, county, and State of New York, have invented an Improvement in Rotary Paper-Folding Machines, of which the following is a specification:

In the accompanying drawings, in which like letters indicate like parts, Figure 1 is a left-hand side elevation; Fig. 2, a right-hand side elevation; Fig. 3, a sectional view on line *x x*, Fig. 1; Fig. 4, a longitudinal sectional view on line *y y*, Fig. 3; Fig. 5, a diagram showing the position of the folding devices while the sheet is being carried into a proper position to be folded; Figs. 6 and 7, diagrams showing the positions of the folding-blade and its operating mechanism at two stages of the folding operation; Fig. 8, a plan view of folder-actuating cams, and the driving-gears of one of them; Fig. 9, a modification of the means for retaining the folding-blade in its state of rest, or normal position; Fig. 10, a modification of the apparatus in which the gripers are dispensed with; Fig. 11, an arrangement of the devices whereby two sheets are fed to and operated upon by the same folding-blade; Fig. 12, devices for continuously rotating a folding-blade while it travels in a circular path, and projecting it out and beyond the periphery of its carrier, to co-operate with folding-rollers; Fig. 13, a sectional view on line *a a*, *a a* of Fig. 12; Fig. 14, an arrangement of devices whereby a single sheet is once folded, conveyed away, and returned to the action of the folding-blade, and a second time folded, while passing once through the machine; Fig. 15, an arrangement of two continuously-rotating single folder-blades, which operate simultaneously at opposite sets of folding-rollers; Fig. 16, a similar arrangement of two continuously-revolving double folding-blades; Fig. 17, a modification of the devices for continuously rotating the folding-blade and projecting it beyond the periphery of its carrier; and Fig. 18, a sectional view on line *c c*, *c c* of Fig. 17.

The invention relates to a folding mechanism for folding sheets of paper; and it consists in a revolving sheet-supporting drum or carrier, in which is hung a folding-blade having an independent part rotation upon its axis in its operation of folding the sheet; in mechanisms co-operating with said blade in completing the fold; in mechanisms for controlling the various motions of the folding devices; and in various details and methods of operation, all of which will be more specifically hereinafter pointed out.

The sheet supporting and carrying drum B is, together with the main elements of the machine, supported in an open frame-work, A. The shaft of said drum is journaled upon a cross-bar of the frame, through which it projects, and has suitably keyed to it on one end a gear-wheel, E, engaging a pinion, F, which imparts rotary motion to the folding-rollers *e* and *e'*, while at its opposite end it is provided with a pinion, G, which in like manner, gearing with, imparts rotary motion to a gear-wheel, H, and a cam, I^3, secured fast to the outer face thereof. A rod, *b*, whose bifurcated end straddles the extended shaft of the gear-wheel H, is pivoted to an arm, *c*, fast upon shaft *d*, which it rocks by its reciprocations, imparted by the cam I^3 through a friction-roller, *a*, seated on a stud or pin extending from the rod *b*, the said friction-roller being held in working contact with the cam I^3 by a spring, *g'*, bearing against the lower end of the rod *b*. The shaft *d* vibrates a switch, C, which consists of a number of arms, *i i*, fast upon it, which carry at their upper ends shoes or plates *l*, curved to approximately coincide with the contour of the folding-rollers *e* and *e'*. One such curved plate or shoe may be made to extend to a length equal to that of the drum B, or of the width of the sheet to be folded, in which case two or more arms, *i*, may support it. The folding-rollers *e* and *e'* are provided with pinions *j k* at this end of the machine, which, being jointly geared, impart uniform motion to each other, and, being severally geared to the pinions *m* and *n* on the tape-pulley shafts *f* and *g*, actuate the lower guiding-tapes *o* and *p*, the said tapes being carried upon suitable pulleys *z z*, upon the said shafts *f* and *g*, and extended to similar pulleys z^1 z^1, upon the shafts *h* and *s*, situated, respectively, at opposite ends of the machine. The upper or main guiding-tapes *q* extend around the folding-roller *e*, thence over guiding-pulleys z^2, z^3, z^4, and z^5 upon shafts u^1, u^2, u^3, and u^4, the two former stretching them in contact with

the face of the drum B. An auxiliary set of tapes, *r*, are stretched from the folding-roller *e'* over pulleys z^5 on shaft *v*. The function of these tapes is to direct the sheets to the folding devices, and, when folded, to deliver them from the machine or to auxiliary folders, as will be hereinafter explained.

The main gear-wheel E, to the shaft of which the driving-power may be applied, has fixed upon one side of its rim a cam-plate, *w*, upon which bears a lever, D, armed with a friction-roller, a^1, at its free end. The lever D is fast upon a shaft, a^2, from which extend suitable arms a^3, fast upon it, in the outer ends of which a roller, I, is journaled. This roller is thus vibrated or raised, at suitable intervals of time, into contact with the carrying-tapes, running over the pulleys z^3, for a purpose to be presently explained. In its lowest position the roller I rests upon the seat 8, which is a suitable plate or plates bolted or otherwise secured upon the main frame. The drum B is provided at one point of its periphery with gripers K, fast upon a shaft, O, extending through a longitudinal recess in the drum, and journaled in brackets L, which are secured to the ends of said drum. This shaft O carries fast upon one of its ends a lever, T, having arms M and N, extending in opposite directions. One of said arms, M, is pivoted to a rod, P, whose lower end slides freely in an eye, R, secured to one end of the drum B. This rod is surrounded by a spring, 2, which, seated upon the eye R, and bearing against a shoulder, n^1, upon the rod P, forces the same outward, to so rock the shaft O as to close the gripers down upon the edge of the recess in the periphery of the drum B. The other arm, N, carries a friction-roller, which bears upon a cam, S, which is fixed upon the main frame. While this arm is passing over the cam S, (it being understood that the drum revolves in the direction indicated by the arrows,) it is forced outward thereby, thus counteracting the spring-rod P. The gripers are gradually opened or extended from the periphery of the drum during the time occupied by their arm N in passing over the cam S from its point s^1 to that s^2, as is best shown in Figs. 4, 6, and 7. While the said arm is passing from the point s^2 to that s^3, the gripers are held open to their fullest extent, during which time the sheet is fed under them, and moved in concert with their circular travel; and while the said arm passes from the point s^3 to that s^4, the gripers are gradually closed down upon the sheet to clamp it upon the drum. As the said arm passes off from the cam until it again engages with it—that is, from the point s^4 to that o^1—the gripers will remain closed, and hold the sheet clamped upon the drum, as before explained. The gripers are thus closed upon the sheet while it is held by the tapes *q*, to which the roller I has delivered it, clamping or griping it upon the drum B just before the said tapes leave it, and thus carry it around with the drum until the folding-rollers *e* and *e'* are passed. When, in such revolution of the drum, the roller N reaches and rides upon the cam S, from the point s^1 to that s^2, it will be gradually forced outward to open the gripers and release the sheet, thus permitting its leading end to be drawn backward by the folding-blade, which will at this time have come into action upon it, in a manner hereinafter more fully explained.

The main office of the gripers is to carry the front end of the sheet past the folding-rollers, and keep it distended until it is drawn backward and folded into the bite of these rollers by the action of the folding-blade; but they may be omitted, and the tapes *q* be brought around the folding-roller *e*, when this result will be as well accomplished by means of an air-pipe, P', situated at a proper point on one side of the folding-roller *e*, (see Fig. 10,) from which a light blast of air, either intermittent or constant, is driven against the said sheet in a proper direction or angle, determined by the inclination of the eduction-orifices in said pipe. This blast of air will carry the end of the sheet upward and onward, away from the folding-rollers, which forward end may, in such case, be directed onto a set of tapes, r^1, mounted on small pulleys above the tapes *r*, and running in a direction contrary to that of the tapes *r*. Short curved bars *u* may extend between the pulleys r^2 and folding-roller *e'*, and bridge the space between them, to assist in guiding the end of the sheet; or the tapes r^1 may be omitted, and the curved bars *u* be extended a sufficient distance to receive and support the sheet.

At a point opposite to that occupied by the gripers, and in a suitable recess in the drum, or supported in a rotating frame or carrier, an interimittingly-revolving double-edged folding-blade, U, is journaled, its supporting-brackets V and V^2 being fastened to the ends of the drum, bridging the recess at these points. One end of the shaft X of the folding-blade is extended, and carries a double lever fast upon it, whose arms Z and Z' extend in opposite directions, and carry friction-rollers upon their ends, which alternately engage or bear upon a triangular cam, W, at suitable intervals during the rotation of the drum B, for a purpose and as will be presently explained. This folding-blade U is made up of radial arms i^1 i^1, to the ends of which are fixed plates or blades i^2 i^2. (See Fig. 4.) This construction may, however, be varied, and any other substituted, without departing from the spirit of this part of the invention.

Fixed upon the shaft of the drum B, and inside of the supporting-frame A, is a gear-wheel, I^1, which meshes into a companion gear-wheel, I^2. The latter carries fast upon its inner face the triangular cam W, which revolves with said gear-wheel I^2, and is thereby, once during each revolution of the said drum B, brought into a position to meet the forward arm Z or Z' of the folding-blade U, which is traveling, carried by the drum, in a

direction contrary to that in which the cam moves. The said arm Z or Z′ is forced to follow the curved face or leading side of the triangular cam W thus opposed to it, and is thereby deflected and thrown outward, carrying with it the folding-blade, which is thus rotated, and one of its blades projected beyond the periphery of the drum B, as shown in Fig. 6. Acting in conjunction with this flying-cam W is a stationary female cam, V^1, which is fixed upon the inside of the main frame, (see Figs. 3, 6, and 7,) and has a curved upper face, upon which the friction-roller on the end of the arm Z or Z′ of the folding-blade rides, and which the peculiar shape of the flying-cam forces it to follow.

The flying-cam is so shaped and its motion so timed that it provides a channel or way between it and the stationary cam, in which the friction-roller of the folding-blade is guided. This channel or way is of a width just equal to the diameter of the friction-rollers, which, in consequence, will move smoothly through it without play. The said upper side or face of this female cam is divided longitudinally, as shown in Fig. 8, so as to provide two ways having differing curves, (dotted lines, Fig. 6,) one forming the cam proper, upon which travels the friction-roller in the folding-blade arm, the other being cut away, so as to coincide with the sweep of, and provide for the passage of, the extreme point of the flying-cam. The flying-cam, in turn, is cut away a distance from its point to clear the swell or cam proper, just alluded to. This construction, which is clearly shown in Figs. 6, 7, and 8, is required in order that the extreme point of the flying-cam may bear upon the friction-roller of the folding-blade arm, and carry it down into the circular recess or seat provided in the center of the female cam V^1, and thus insure such a corresponding outward movement of the folding-blade—at this moment poised in a vertical position—as shall cause it to force the sheet it has doubled into the bite of the folding-rollers, in a manner as will be presently explained. By making the friction-rollers on the ends of the arms Z Z′ of sufficient length the point of the flying-cam may pass by the side of the female cam without either being cut away; but the cutting away of the parts, as described, is preferred, since a friction-roller on a long stud-pin will soon twist, and its perfect operation be thus destroyed.

The further movements of these devices will be set forth in the operation of the machine, which is as follows: The sheet is laid upon the feed-board Y, with its end adjusted against the gages J, so that its front edge or leading end overlies the roller I. This feeding may be by hand or through the medium of any automatic device. A continuous web from a perfecting printing-press may be cut into sheets, which are automatically fed to the folder by direct tapes connecting the two, as will be hereafter explained. For hand-feeding the sheets will be presented to the action of the feeding-roller I, which, at a suitable time during the revolution of the drum B, will be raised by the cam-plate *w* upon the gear-wheel E, and lift the forward end of the sheet clear of the gages and up against the pulleys z^3 on the shaft w^2, and, by the frictional contact of the two, will propel the sheet forward in the direction of the arrow, and ultimately between the guiding-tapes *q*, which run over the said pulleys z^3, and against the surface of the drum B. As the drum revolves and the gripers thereon have reached a point where the arm T of their actuating-shaft has cleared the swell of the cam S—viz., at s^3—the said gripers will begin their movement of closing down to seize the sheet between them and the drum, which closing movement is gradually accomplished while the griper-actuating arm is passing from the point s^3 to that s^4 on the cam S, in manner heretofore explained.

The raising of the roller I is so governed and timed by the relative position of the cam *w* to that of the cam S, operating the gripers, as to feed the sheet with its forward edge within the range of motion of the gripers, so that it will, when the gripers are forced down upon the drum by the spring-rod P, be seized and held between them and the face of the drum, as shown in Fig. 5. Thus held, the sheet is carried around with the drum and past the folding-rollers *e* and *e′*, until its leading end has nearly arrived at a point opposite to that s^2 of the cam S, as seen in Fig. 6. At this time the rear end of the sheet will be sustained upon the drum by the tapes *q*, and the leading end, which has been gradually released while the griper-actuating arm was passing from the point s^1 to that s^2 of the cam S, will now be entirely freed from the said gripers, and the folding-blade will begin its outward movements to fold the sheet. During the time occupied by the gripers in passing from the point where they seize the sheet to the point where they release it, the folding-blade U will have traveled an equal distance in its circular path, while in a position with its folding-blades approximately forming a chord to an arc of the drum B, as shown in Fig. 5, the sheet which is being carried around the drum overlying the said folder and its blades, as therein shown by dotted lines. As the sheet travels on, drawn or held by the gripers and tapes, the same relative positions of sheet, folding-blade, and gripers are maintained until the gripers are released, when the forward arm Z or Z′ of the folding-blade will impinge against one face of the flying-cam W, as in Fig. 6, which cam, by its rotation, caused by the gear-wheels I^1 and I^2, will be traveling in a contrary direction to meet the said arm of the folding-blade. The said arm Z or Z′ is deflected or pressed outward from the drum by reason of its friction-roller being forced to follow or travel in the channel or way formed between the curved leading face of the flying-cam W and the face of the stationary female

cam V, the effect of which is to rotate the folding-blade upon its axis and project it outward to impinge upon the sheet. The sheet is thus caught and held by the folding-blade from the moment its leading end is fully released from the gripers, and, as the rear end of the sheet travels forward, propelled by the conjoint action of the folding-blade, tapes *q*, and folding-rollers *e* and *e'*, the free leading end will reverse its line of travel and move rearward, propelled in like manner by the folding-blade and folding-rollers. As the drum continues to revolve in one direction, carrying with it the axis of the folding-blade and the flying-cam to move in a contrary direction, the joint effect is to force the folding-blade outwardly in an epicycloidal curve until it reaches the vertical position shown in Fig. 4, at which time said folding-blade will have reached its greatest movement or projection from the periphery of the drum, when the friction-roller in the end of its arm will have been carried by the point of the flying-cam W into and rest momentarily within the circular recess in the stationary cam V^1, as in Fig. 2, while the friction-roller on the end of its other arm, now uppermost, will be passing over the upper side of the flying-cam, which at this time is in a horizontal plane. The sheet is thus pressed downward or doubled in its center over the edge of the folding-blade, following the movements of the latter in all degrees of its projection outward beyond the periphery of the drum until it is forced into the bite of the folding-rollers *e* and *e'*, which, seizing it, propel it through them, press, fold, and lay its free ends together, thus folding the sheet once.

It should be understood that the travel of the sheet is so rapid that, as its ends are released by the gripers and from the tapes *q*, where they press it upon the drum B, it moves toward the folding-rollers *e* and *e'* with such speed as to prevent its dropping from the drum, though the leading end of the sheet should partially fall away from the drum, so as to be more easily drawn backward into the folding-rollers without tearing. While the said folded sheet is passing through the folding-rollers, the flying-cam and folding-blade, which latter has then ceased to have any effect upon its movements, are passing onward in their circular paths. When the flying-cam W has passed its center or greatest range of sweep beyond the line of the periphery of the drum, it will present its following side in such position as to guide the friction-roller in the forward arm of the folding-blade over the swell of the female cam on the side opposite to that which impelled it outward, and cause the blade to be thrown inward toward the periphery of the drum, as seen in Fig. 7, which illustrates its position at this moment of its operation. Continuing to follow the face of the stationary female cam V^1, the folding-blade arm will carry the folding-blade into its normal position, or state of rest, as in Fig. 5, by movements the reverse of those which impelled it outward. The folding-blade shaft will thus have made a semi-revolution, and the folding-blade, which it has brought into action, will now be closed into a position the reverse of that it occupied before it was thus rotated, which will bring the companion folding-blade into a forward position, ready to be projected outward, when the folding operation is repeated and its arm engages its actuating mechanism. The folding-blades are held in this closed position by a spring, s^5, Fig. 1, which carries a toe on its end, which engages suitable recesses in the hub on the end of the shaft of said folding-blades. This toe on the spring and the recesses in the hub are rounded or otherwise so shaped that the toe is easily forced out of the recesses to unlock the folding-blade. A swinging arm carrying a friction-roller in its end, which is held to duty by a spring, as in Fig. 9, may perform this office. While the drum is making a revolution, carrying with it the folding-blade and gripers, as seen in Fig. 5, the flying-cam will make a corresponding revolution in an opposite direction, and coming into operative contact with the arm of the folding-blade, as before described, at the proper time to cause the folding-blade to be projected to fold the sheet presented to its action into the bite of folding-rollers *e* and *e'*. The folded edge of the sheet, in passing between the folding-rollers *e* and *e'*, meets the upper edge of the switch C, which at this time has been shunted into a position close to or nearly against the periphery of one of the folding-rollers, say *e*, (see Fig. 4,) by means of the rocking shaft *d*, operated as hereinbefore described, and the said sheet is thus caused to follow the curved face of the switch head or plate, *l*, which thus directs the sheet between the tapes *r* on the folding-roller *e'*, and those *p* on the pulleys of shaft *g*, which tapes *r* and *p* deliver the sheet in a horizontal plane at one side of the machine.

During the time occupied by the folding-blade in folding the sheet, and consequently in opening out and closing into the drum, and hence in passing the cams W and V^1, which time is also occupied by the gripers in passing over the swell of the cam S from the point s^2 to that s^3, a second sheet will have been fed into the machine between the tapes *q* and the drum, as seen in Fig. 7, which sheet, at the proper time, will be seized by the tapes *q* and the gripers, and the operation of folding hereinbefore described will be effected with reference to the said second sheet. This second sheet, having been folded and delivered to the bite of the folding-rollers *e* and *e'*, in manner as explained, will be directed out of the machine between the tapes *o* and *q* by reason of the switch C having been meanwhile, and during the interval between two folded sheets, that now occupy only one-half their former space, shunted against the roller *e'*. When the switch is composed of a number of curved heads or shoes, *l*, they may run in slight

grooves in the folding-rollers, when they are single or continuous rollers, or enter between their separated rollers, when they are thus constructed, as shown in Fig. 3.

By this machine sheets of paper are fed in close proximity to each other, seized by the gripers, and folded and delivered with great rapidity, which folding is equal to the speed with which a web is printed upon both of its sides and severed into sheets by a web perfecting printing-press, in connection with which this folding apparatus is more particularly designed to be used. But it is obvious that the vibrating sheet-flier of an ordinary printing-press may deliver the sheets upon the table Y, from whence they will be fed into the machine and folded; but as the speed of this folding mechanism is so greatly in excess of that of a vibrating sheet-flier, two presses may be arranged with their sheet-fliers alternately vibrating to deliver sheets in succession upon the table Y, and thus with one folding mechanism the sheets perfected by two printing mechanisms may be folded.

With reference to the feeding in of the sheets it may be observed that the tapes *q*, running over the pulleys x^3, may be dispensed with, when said tapes will be disposed over the feed-roller *e* and pulleys x^5, in like manner to the tapes *r*. In this case, in place of the tape-pulleys x^3, a plain roller, or one having a roughened face, may be substituted, which will be driven by motion taken from any of the moving shafts, and the sheet impelled toward the drum B by being held in frictional contact with such roller by the upward pressure of roller I thereon. The sheet will then be deflected toward and directed to its proper position over the drum B by curved rods or a plate or plates extending from the under side of the roller x^3 to the required position over the surface of the drum B at the top of the machine.

When curved rods are used they may project into grooves in the periphery of the roller x^3, and where a plate or plates are used, fingers projecting from them may enter such grooves in the roller.

It may be desirable to apply positive rotary motion to the roller I, in which case the roller x^3 may be an idler, or both rollers I and x^3 may have independent and positive rotary motion.

The cam-plate *w* may be made adjustable upon the gear-wheel E in any well-known manner, to properly time its contact with the lever D, and thus cause the movements of the feeding-roller I to perfectly accord with the operation of the gripers.

If desirable, the tapes *o* and *p* may be omitted, and a second set, running around the folding-roller *e* and a pulley, *t*, as shown in Fig. 6, arranged to run parallel to the tapes *r*, and the switch omitted, when all of the sheets will be delivered by such arrangement at one side of the machine, once folded, where they may be a second time folded.

It may be expedient to lead each alternate sheet in a contrary direction, as explained, and providing auxiliary folding devices to impart one or more additional folds to the once-folded sheet. These folders may be the ordinary vibrating blades, working into the bite of a pair of rollers, or duplications of the rotating folder herein described.

The drum B in many cases need not be a cylinder, but simply a revolving frame carrying one or more rotating folding-blades, suitably supported in it.

The following modifications and extensions, embracing the principle of folding paper upon which this invention is founded, will be adopted and embodied in the mechanism, as may be found to be expedient—that is, according to the speed of folding or delivery of the sheets required, or the number of folds and their relative position to each other desired in each single sheet.

The folding blade may be arranged to fold sheets at both the top and bottom of the cylinder or drum B, as illustrated by Fig. 11. In this arrangement the feeding of the sheets may be accomplished wholly by tapes, as therein shown. A set of tapes, 1, are stretched from pulleys m^1 over the drum B, whose periphery they reach just underneath the upper folding-rollers *e e* and *e′ e′*, thence outward and around pulleys m^5, and returned under the drum B, coming again into contact with it just over the lower folding-rollers *e* and *e′*, to the pulleys m^1. The folding-blades will, of course, in this arrangement, be divided into sections, so as to pass outward by the tapes 1. A second set of tapes, 2, are stretched from pulleys m^2, under folding-roller *e′ e′*, over folding-roller *e e*, around pulleys m^3, back to the pulleys m^2. This set of tapes run parallel and in working contact with the tapes 1 to the point where they pass over the folding-roller *e′ e′*, and from where they run over the folding-roller *e e* to the pulleys m^3 they run parallel and in working contact with another set of tapes, 5, which are stretched from folding-roller *e e* over pulleys m^4. These tapes 1 and 2, where they run in contact, act as feeding-tapes, carrying the sheet over the drum, and said tapes 2, in conjunction with the tapes 5, where they run in contact, act as delivery-tapes for carrying out the once-folded sheet, as will be fully hereinafter set forth.

The tapes 1, 3, and 4, at the bottom of the machine, are similarly arranged, and have the same mode of operation, as will be readily understood from an inspection of the drawing. The folding-blade U is hung and actuated in like manner as heretofore explained, but has a double action—that is to say, is partially rotated upon its axis at both the top and bottom of the drum, so as to enter between both sets of folding rollers *e e′* and *e e* and *e′ e′*. These semi-rotations may be accomplished by duplicate flying-cams W and stationary female cams V^1, operating alternately upon arms Z Z′ of the folder-blade shaft, and driven as before

explained; or the mechanical devices illustrated in Figs. 12 and 13, to be hereinafter explained, may be used. The sheets will be introduced between the tapes m^1 and m^2 at the top of the machine, and between the tapes m^5 and m^6 at the bottom thereof, singly, by hand, or automatically, as has been heretofore explained. Those fed to the tapes m^1 and m^2 will be carried into the drum B, and past the upper folding-rollers, by the tapes 1 and 2, and their leading ends will, by their gravity, follow the periphery of the drum B, and momentarily rest upon the tapes 1, until the folding-blade doubles them upward into the bite of the upper folding-rollers, when they will be folded in a manner the counterpart of that formerly described. Thus folded, they will be delivered by the tapes m^3 m^4, and may then be again folded. The feeding and delivery of the sheets fed into the machine between the tapes 1 and 3, at the bottom of the machine, is precisely similar to those operations upon the sheets fed at the top of the machine, as will be readily understood; but the said sheets operated upon at the bottom of the machine will be more surely manipulated by the use of the air-blast pipe and the other sheet-directing devices described, and illustrated in Fig. 10, and, when required, these sheet-directing devices may also be employed at the top of the machine. The folding-blades, either single or double, may be mounted to rotate upon a shaft which carries at one end a pinion, N^1, whose teeth mesh into a ring, N^2, having internal teeth, which is fixed upon the frame-work A in such a position as to be coincident with the periphery of the drum B. The folding-blade, in such case, will continuously rotate upon its own axis while the drum is making its revolution. These rotations will cause the folding-blade to describe inverted quadrantal arcs, as shown in dotted lines, Fig. 12, which will project between the folding-rollers at both the top and bottom of the machine, as indicated in said Fig. 12. The teeth of the pinion N^1 will be, in this case, one to every four of the internally-toothed ring N^2, as is well understood, and the flying-cam W and stationary cam V^1, together with the folding-blade-operating-arms Z Z′, will be omitted, as is equally obvious. This mode of actuating the folding-blade may be applied to one, either single or double, operating in conjunction with one set of folding-rollers, which may be situated either at the top or bottom of the machine, when the pinion N^1, will, as it arrives at the folding-rollers, be projected between them, in manner as has been explained.

If more than two sheets are required to be operated upon at the same time, a single folding-blade will, by the mechanism shown in Figs. 12 and 13, be successively projected at each revolution of the pinion N^1, at points equal to quarter-divisions of the drum, into folding-rollers, which will have suitable feeding and delivery tapes, arranged to introduce and convey away the folded sheets.

From the foregoing description it will be apparent that one, two, or any number of sheets may be folded by a single rotating folding-blade, carried in a revolving carriage or drum, during each separate revolution of said drum or carriage. The same sheet may be once folded and returned a second time to the action of the folding-blade, and receive a second fold parallel with the first. A proper arrangement of devices to accomplish this is shown in Fig. 14. Here four sets of tapes are used to carry the sheet. One set, 10, run horizontally from pulleys n^2, over the top of the drum B, downward over pulleys n^1; thence backward in a horizontal plane to the bottom of the drum B; thence upward to the pulleys n^2, which tapes the folding-blades will be enabled to pass by the construction described with reference to their similar arrangement shown in Fig. 11. A second set, 7, run over the folding-roller *e e*, outward over pulleys n^9, descend and pass around pulleys n^8, and return vertically over pulleys n^{10}; thence to the folding-roller *e e*. A third set, 6, run in contact with the tapes 10, from the pulleys n^2 to the folding-roller *e′ e′*; thence over the folding-roller *e e*, from which they run in contact with tapes 7, until the pulleys n^9 are reached; from thence they continue downward, still in contact with tapes 7, until pulleys n^8 are reached; from thence they extend around the folding-roller *e*, running in contact with the tapes 10, from the pulleys n^7 to the folding-rollers *e*. A fourth set, 11, run over the folding-roller *e′*, and in contact with the tapes 6, and are returned over the pulleys n^6. A sheet fed, as before, between the tapes 6 and 10, is carried past the upper folding-rollers *e e* and *e′ e′*, and while its leading end is drooping beyond the periphery of the drum B, where it temporarily rests on the tapes 10, and its center has reached a point under the folding-rollers, the folding-blade will be projected, as before explained, and double it into the bite of the said folding-rollers. Thus doubled or folded, it will be carried between the tapes 6 and 7, around the pulleys n^9; thence down around the pulleys n^8, and returned to the periphery of the drum by the tapes 6 and 10, but at a point over the lower folding-rollers *e* and *e′*, its passage between the pulleys n^7 and n^8, where the tapes 7 leave it, being insured by guide plates or bars 12, which are hung on a rod or shaft, 13, fast to the main frame, which plates or bars have curved ends extending within the lines of the peripheries of the pulleys n^7 and n^8. Its leading end, now a double edge, will be carried past the folding-rollers *e* and *e′*, until the center of the doubled sheet has arrived over the said folding-rollers, when the folding-blade will be again projected, to double it between them to fold it a second time, in which condition it will be delivered out of the machine by being conducted between the tapes 6 and 11. Thus folded and delivered, it may again be folded as many times and with such folds as may be

desired by vibrating or other folders, as has been hereinbefore explained. Thus the same sheet is once folded, carried off, and returned to the drum, and a second time folded, the drum and folding-blade meanwhile having made complete revolutions; but during this time, occupied by the sheet passing away and returning to the drum, a second sheet will have been fed to the drum, the result being that as the second sheet is folded at the upper folding-rollers, the first, now a once-folded sheet, will be passing onward toward the lower folding-rollers, which it will pass, and reaching its proper position over them at the same time as the folding-blade has also reached its proper position over them, the said blade will be projected to fold the said first and folded sheet a second time. Thus sheets are twice folded while passing once through the machine.

While one sheet will be entering to the top folding-rollers *e e* and *e' e'*, another, once folded, will be passing on toward the lower folding-rollers, and a third will be receiving its second fold at the lower folding-rollers *e* and *e'*, simultaneously; and a fourth may be at the same time receiving its third fold at the point where it leaves the tapes 6 and 11.

Two single folding-blades, as shown in Fig. 15, may be hung at opposite points in the same drum or carrier B, and their pinions N^1 and N^3 be of any proportion equal to odd divisions of the internally-toothed ring N^2, as one-third, one-fifth, &c., which pinions, in their rotation, will cause each of the folding-blades to be projected beyond the periphery of the drum or carrier at three, five, or any other number of equally distant points of the drum. One of the single folding-blades, say N^1, will thus be made to describe the path indicated by dotted lines 14, and hence only be projected at one pair of folding-rollers—viz., the lower ones; and the other single folding-blade, N^3, describing the path indicated by dotted lines 15, will be projected only at the other folding-rollers—viz., the upper ones. In all which cases the folding-blades will be simultaneously projected at the upper and lower folding-rollers, but the folding-blade projected at one set of folding-rollers will be extended inwardly toward the center of the drum as it is passing the point where the opposite folding-rollers are located. The same effect may be produced by one rotating double folding-blade, as is shown in Fig. 16. In this case its pinion will be proportioned to the internally-toothed ring, as is described with reference to those shown in Fig. 15, and will then be so rotated as to project one of its blades at the lower folding-rollers *e* and *e'*, and its opposite blade at the upper folding-rollers *e e* and *e' e'*, its operation being the same as those described with reference to the single folding-blades, except that its opposite blades are alternately projected beyond the periphery of the drum.

Thus one blade of the folder N^1, having been presented to the lower folding-rollers, travels onward with the carrier, and is so rotated on its own axis that it describes the path of travel shown in dotted lines, Fig. 16, thus being pointed toward the center of the drum while underneath the upper folding-rollers, while the opposite edge of the double folding-blade is at the same time projected between the upper folding-rollers. In this manner the opposite blades of the double folder are alternately projected at the points of the periphery, marked 17 to 22, inclusive. The blade projected between the lower folding-rollers at 22 will again be projected at the point 18 of the periphery, and again at 20, returning in this manner to the lower folding-rollers at 22. In the meantime the opposite blade of the folder will be projected at the points 17, at 19 between the upper folding-rollers, again at 21, and returned to its point of starting.

In the arrangements which combine the internally-toothed ring N^2 as one element, it is to be observed, as is particularly shown in Fig. 18, that the said ring necessarily occupies such a position as to cut off the shafts of all of the folding-rollers, which, in consequence, have to be hung in brackets 23 24, fastened to the main frame A outside of said ring, and curved inward to the proper point of alignment with said shafts. In order to afford firm and secure bearings for said shafts in the main frame, the construction shown in Figs. 17 and 18 is provided. In this case the operation of the folder and folding-rollers is the same as formerly described in Figs. 12 to 16, inclusive; but the mechanism for imparting a continuous rotary motion to the folding-blade is as follows: The pinion N^1 of the folding-blade is connected, through an idler, N^4, with a gear-wheel, N^5, fast upon the main frame, whose toothed periphery is concentric with the folder carrier or drum B; and in this manner the folding-blade is rotated in the direction indicated by an arrow in the drawing, which arrangement of devices permits the folding-roller shafts to have direct bearings in the main frame. This gear-wheel N^5 and pinions N^1 and N^4 may be so relatively proportioned as to project the folding-blade at different points an equal distance apart, in like manner as has been set forth with reference to the toothed ring N^2 and the pinion N^1, as will be readily perceived. Two or more pinions, N^1, may, in like manner, actuate two folding-blades; and it is to be observed and understood that any or all of the folding-blades herein described may be operated by cams, as is that described and shown in Figs. 1 to 8, inclusive, or by pinions and internally-toothed rings, properly proportioned to each other, as are those described, and shown in Figs. 12 to 16, inclusive.

I am aware that a folding mechanism in which the folder-blade is carried by a revolving or rotating drum or cylinder, and co-oper-

ating with a suitable folding drum or cylinder, is not new.

What I claim, therefore, is—

1. The method of folding paper by means of a revolving drum, upon which a sheet is supported, a folding-blade rotated within and projected from said drum, and devices which receive said sheet, substantially as shown and described.

2. The method of folding paper by means of a revolving drum, upon which a sheet is supported, a folding-blade rotated within and projected from said drum, and a pair of rollers which receive the sheet, substantially as shown and described.

3. The method of folding paper by means of a revolving carrier, supporting a folding-blade rotated in and projected from it, and conducting devices, which carry the sheet within the range of action of the folding-blade and one set of folding-rollers, and, when once folded, convey it away from the one set and return it to a second set of folding-rollers, again within the range of action of the folding-blade, where it is again folded, substantially as shown and described.

4. The combination of sheet gages or stops, intermittingly-acting pressing-roller, and endless tapes and pulleys z^3, substantially as shown and described.

5. The combination of the vibrating sheet-controlling roller I, pulleys or roller z^3, guiding-tapes q, and drum B, substantially as shown and described.

6. The combination of stationary gages J, vibrating sheet-controlling roller I, and feed-table Y, substantially as shown and described.

7. A revolving folder-carrying frame, a rotating single or double folding-blade, and devices into which the sheet is folded or doubled, combined and coacting substantially as shown and described.

8. A revolving folder-carrying frame, a rotating folding-blade, and stationary folding-rollers, combined as shown and described.

9. In combination with a rotating carrying frame or drum, mechanism for alternately seizing and releasing the sheet, and a folding-blade having a part rotation to project it outward from the periphery of the drum or carrying-frame for folding the same, substantially as shown and described.

10. A folding-blade hung in or near the periphery of a revolving carrier or drum, and intermittingly rotated a part revolution to project it outward, to double or crease a sheet of paper, in combination with devices which receive said doubled sheet, substantially as shown and described.

11. A folding-blade hung in a revolving drum or carrier, and traveling in a circular path therewith, and capable of independent rotation therein, substantially as shown and described.

12. A folding-blade having intermittent part rotations in its revolving carrying frame or drum, in combination with a locking mechanism to retain it in its normal position during the intervals of time between its rotary movements, substantially as shown and described.

13. The combination of rotating folder-shaft, notched hub, and spring-detent, substantially as shown and described.

14. The method of causing the folding-blade to move in a circular path, and be projected outwardly from the periphery of the supporting-drum, by means of a flying-cam, substantially as shown and described.

15. The combination of flying-cam W, stationary cam V^1, and folding-blade, substantially as shown and described.

16. The combination of folding-blade, its rotating carriage or drum B, flying-cam, and stationary cam V^1, substantially as shown and described.

17. The combination of revolving sheet-supporting and folder-carrying drum, the independent rotating folding-blade, flying-cam, and stationary cam, substantially as shown and described.

18. The combination of revolving folder-carrying drum, independently-rotating folding-blade, flying-cam, stationary cam, and folding-rollers, substantially as shown and described.

19. The combination of revolving folder-carrying drum, independently-rotating folding-blade, folding-rollers, and sheet-carrying tapes, substantially as shown and described.

20. The combination of revolving folder-carrying frame, independently-rotating folding-blade, flying-cam W, stationary cam V^1, rollers e e', and sheet-delivering tapes, substantially as shown and described.

21. The female or stationary cam V^1, constructed with a divided face, whereby is provided a guiding-way for directing the movements of the folding-blade, and a recess for the passage of the point of the flying-cam, substantially as shown and described.

22. The combination of gear-wheels I I^1, flying-cam W, folding-blade U, drum B, stationary cam V^1, and folding-rollers e and e', substantially as shown and described.

23. In combination with the sheet-supporting drum and folding devices, the air-pipe P', substantially as shown and described.

24. In combination with the sheet-supporting drum and folding devices, the sheet-directing guards u, with or without the tapes r^1, substantially as shown and described.

25. A revolving carrier or drum, supporting a rotating folding-blade, and means for projecting said blade beyond the periphery of the carrier or drum at two or more points, substantially as described and shown.

26. The combination of a revolving carrier or drum, a folding-blade rotating therein, means for projecting it beyond the periphery at two or more points of the circular or path of its carrier or drum, and two or more sets of

folding-rollers, substantially as shown and described.

27. The combination of folder carrier or drum, rotating folder, folder-actuating mechanism, upper and lower folding-rollers, and carrying-tapes leading from one pair of folding-rollers to the other pair, substantially as shown and described.

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

STEPHEN D. TUCKER.

Witnesses:
W. W. HANNA,
JOS. B. FITZPATRICK.