(No Model.)

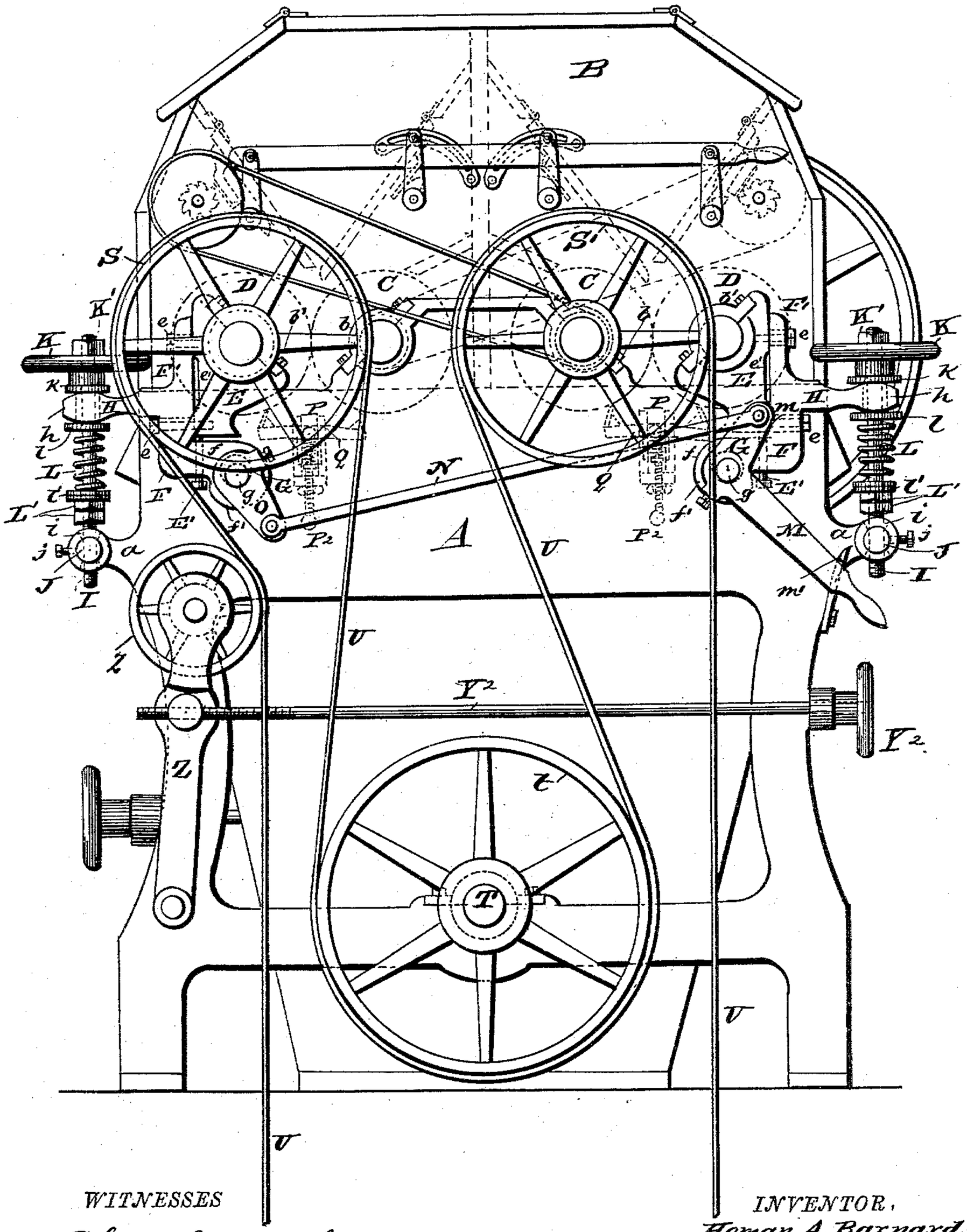
4 Sheets—Sheet 1.

H. A. BARNARD.

ROLLER MILL.

No. 401,243. Patented Apr. 9, 1889.

Fig. 1.



WITNESSES

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Attorney

(No Model.) 4 Sheets—Sheet 2.

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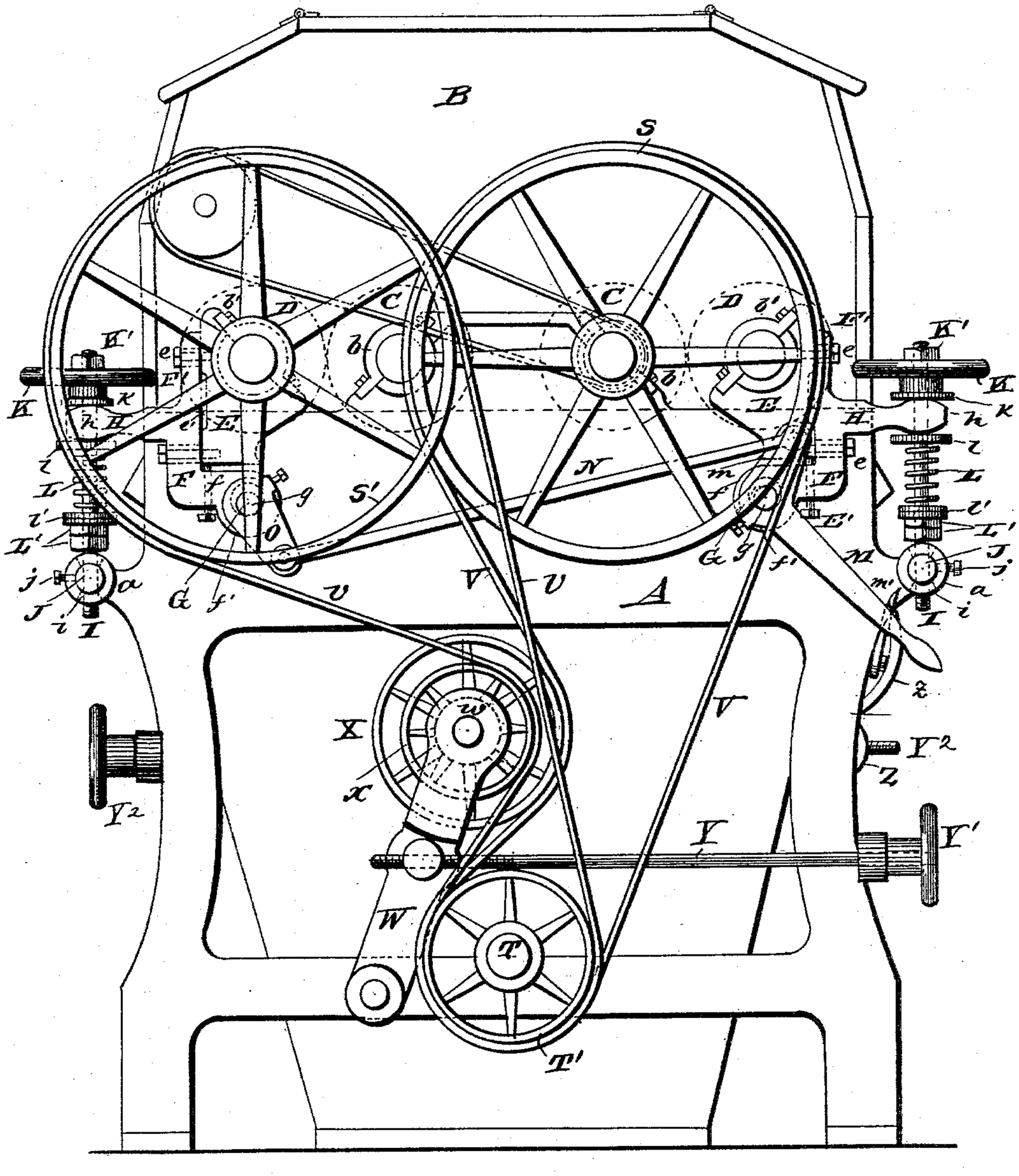
Fig. 2.



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(No Model.) 4 Sheets—Sheet 3.

H. A. BARNARD.

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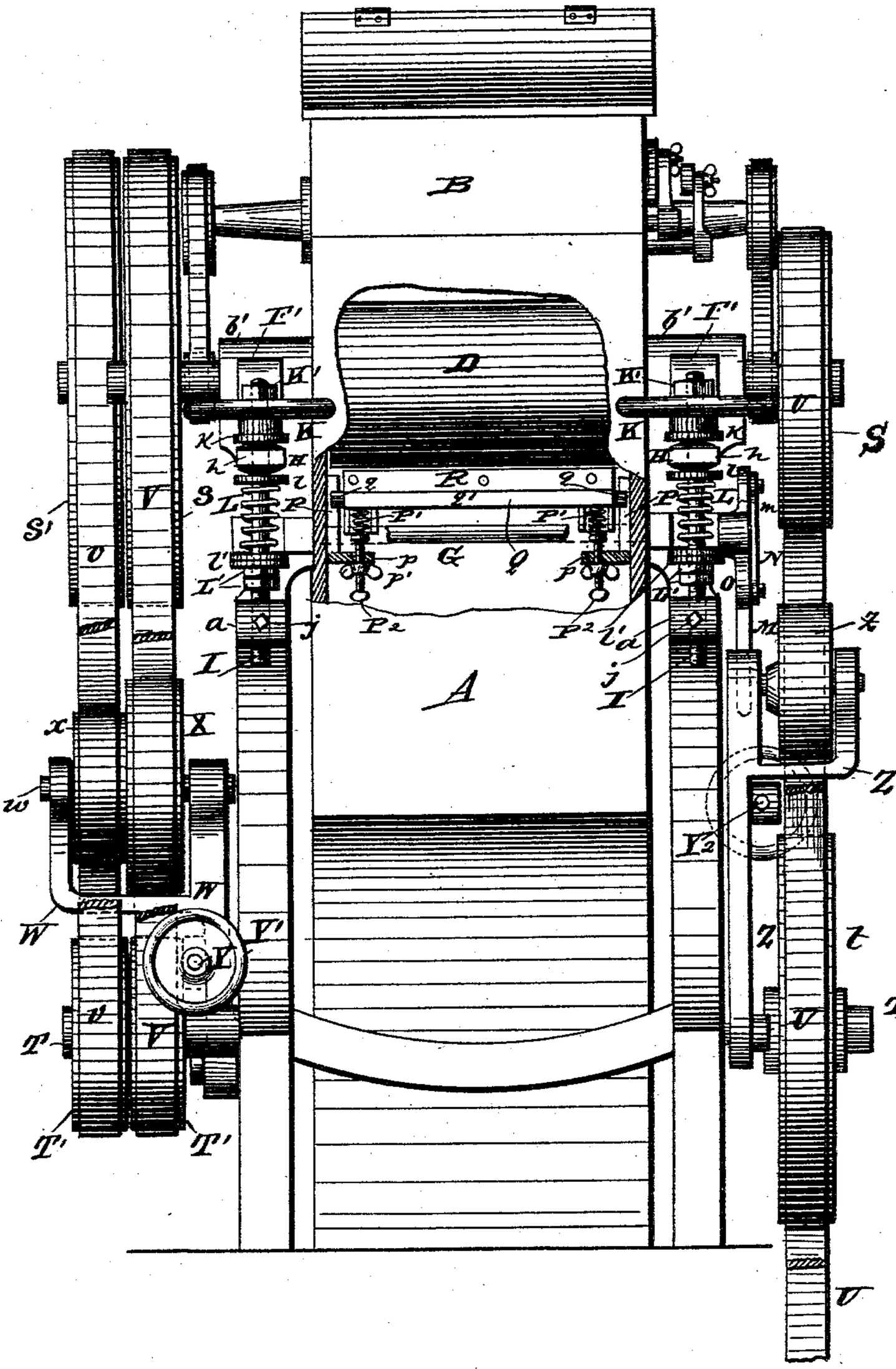
Fig. 3.



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(No Model.)

4 Sheets—Sheet 4.

H. A. BARNARD.

ROLLER MILL.

No. 401,243. Patented Apr. 9, 1889.

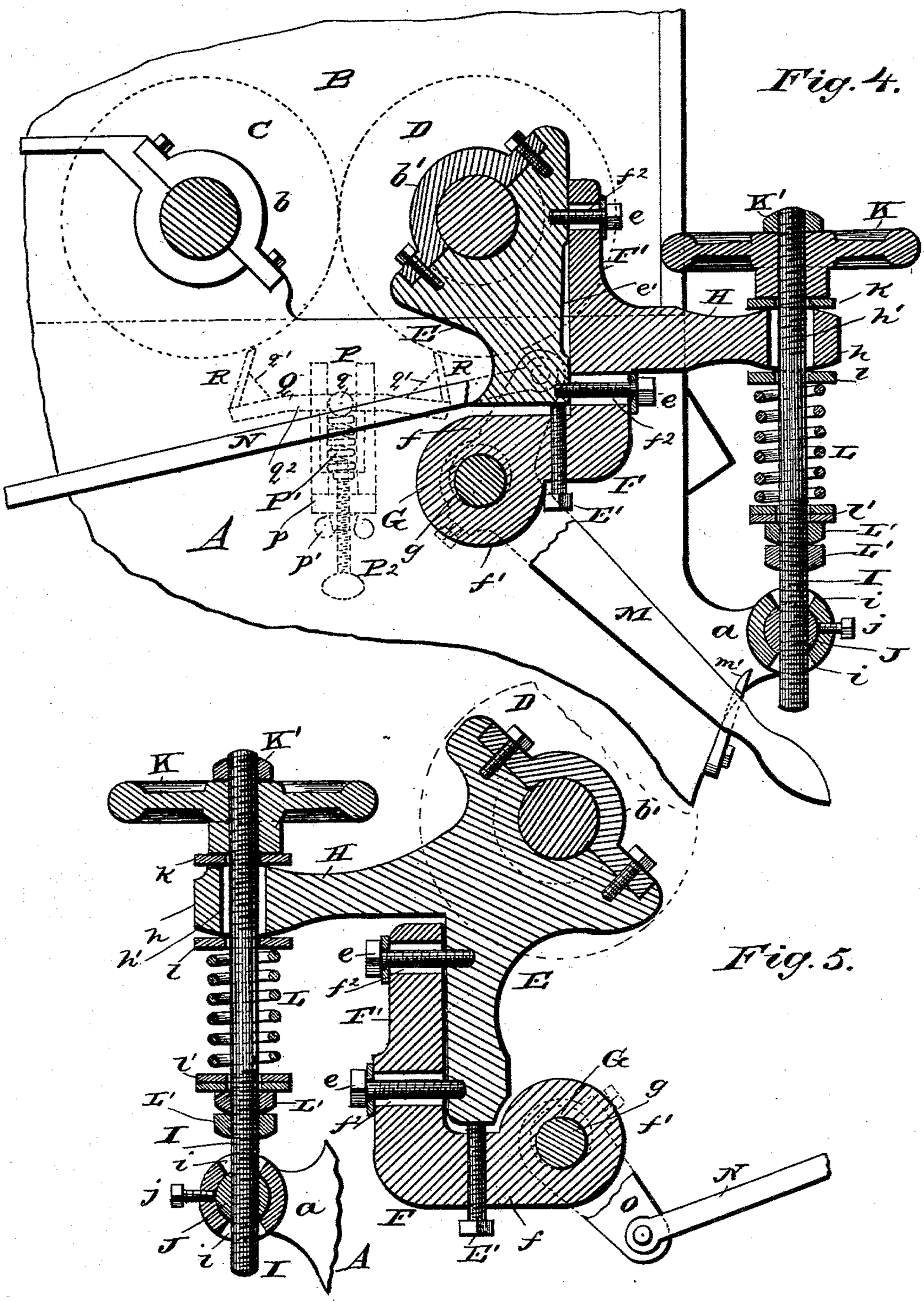

Fig. 4.

Fig. 5.

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UNITED STATES PATENT OFFICE.

HEMAN A. BARNARD, OF MOLINE, ILLINOIS, ASSIGNOR TO THE BARNARD & LEAS MANUFACTURING COMPANY, OF SAME PLACE.

ROLLER-MILL.

SPECIFICATION forming part of Letters Patent No. 401,243, dated April 9, 1889.

Application filed May 26, 1887. Serial No. 239,465. (No model.)

To all whom it may concern:

Be it known that I, HEMAN A. BARNARD, of Moline, in the county of Rock Island and State of Illinois, have invented certain new and useful Improvements in Roller-Mills; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form part of this specification.

Figure 1 is a side elevation of my improved roller-mill. Fig. 2 is a similar view shown from the opposite side. Fig. 3 is an end elevation partly in section. Fig. 4 is an enlarged sectional view showing the roller-adjusting mechanism. Fig. 5 is a similar view showing a modification of the same.

This invention relates to improvements in roller grinding-mills of the class in which horizontal pairs of parallel cylinders or rolls are employed to reduce the material by crushing it between them as they revolve, and it has especial reference to flour or grain mills of this class having pairs of rolls rotating at different speeds and in which one roll of each pair is journaled in fixed bearings on the main frame of the mill and its opposite or coacting roll is journaled in movable arms, so that the latter roll can be adjusted toward or from the rigid roll to regulate the amount or quality of reduction of the grain.

The invention has for its objects to provide proper supporting-arms for the journals of the yielding roll; to pivot or support these arms in such manner that they can be simultaneously moved to separate the yielding roll from the rigid roll, to stop the grinding of the material, or moved to restore the roll to its operative position; to form the journal-blocks of the movable roll in such manner and secure them to the arms so that each journal of the yielding roll can be adjusted vertically independently of the other journal or of the movement of the arms; to provide means whereby the arms can be independently adjusted to shift the roll horizontally and to retain the roll in such position normally while in operation and yet permit the roll to yield or separate from the rigid roll should any foreign hard substance fall between them, so that injury to the faces of the rolls is prevented and whereby the yielding roll is at once returned to its normal position after the passage of such foreign substance, and to provide suitable devices for continuously cleaning the surface of the rolls in the pair during the operation of the mill.

Further objects of the invention are to provide an improved drive for the four-roller mill in which the slow rolls of the pairs are driven by separate belts from the counter-shaft on the same side of the mill, while the fast rolls are driven by the main belt, and to provide tightening devices for the main belt or fast-roll drive and suitable devices for simultaneously and equally tightening the separate belts of the slow rolls.

These objects I attain by the present invention, which consists in the novel construction and arrangement of various parts of the mill and in the arrangement of the drive-belts, as will be fully understood from the following description when taken in connection with the accompanying drawings, and particularly specified in the appended claims.

Before proceeding with the description of the mill I will state that I have shown a four-roller mill in the drawings, which is the ordinary manner of arranging such mills, being, in fact, a double mill arranged in one machine. The rolls of each pair and their relative arrangement and construction of mechanisms being similar, a description of the mechanisms of one pair of rolls will impart a clear understanding of both. In the drawings I have also shown an arrangement whereby the rolls in each pair can be simultaneously separated or caused to approach to start or stop the grinding operation, and which is fully hereinafter described.

Referring to the drawings by letter, A designates the frame or casing of a four-roller mill of any proper form and construction, its side pieces, however, being provided at opposite ends and in parallel lines with the oppositely-outstanding arms *a a*, as will be hereinafter more specifically referred to, the arms *a a* of each side piece standing parallel with the arms *a a* of the opposite side piece at their respective ends of the mill.

B designates the hopper or feed mechanism casing, secured to casing A above the grinding-rolls. This hopper is made double, so as to deliver grain to each pair of rolls, as shown, and each feeding device consists, essentially, of a double hinged pair of valves, each of which can be closed toward the other by means of suitable cams mounted on proper rods or shafts to be operated from the outside of the casing, and the outer valve of each pair is adapted to be vibrated by means of a cam-wheel or vibrator secured on a shaft within the casing and rotated by means of belts and pulleys on the cam-wheel shafts and on the extended journals of the rolls. These feed devices are provided with suitable mechanisms for regulating the size of feed-opening to each pair of rollers and for cutting off the feed at both ends of the mill simultaneously. As this feed mechanism, however, forms the subject-matter of a separate application filed by me March 25, 1887, Serial No. 232,401, further description of it is unnecessary.

C C designate the rigid rolls of the pairs, which are mounted parallel with each other in suitable journal-bearings formed in the upper portion of casing A, and retained in such journal-bearings by half-boxes or caps *b*, as shown. Outside of and below the journal-bearings of the rigid rolls the casing A is reduced in height, as usual, to allow of horizontal adjustment of the yielding roll, as hereinafter described.

I will now proceed to describe the means for supporting and adjusting the yielding rolls.

D D designate the yielding rolls, corresponding in size and form to rolls C and journaled in pillow-blocks E E, which are mounted upon and adjustably bolted to movable or swinging arms F F, as will be hereinafter more particularly described. The arms F have their horizontal shanks *f* standing inwardly toward each other on the same side of the casing A. The ends of these shanks *f* are provided with the downwardly-standing enlargements *f'*, which are centrally perforated for the passage of cams *g*, formed on the ends of rods or shafts G, which extend entirely across the width of the mill and are properly journaled in the sides of casing A thereof.

F' designates the upright portion of arms F, which portion rises from shanks *f*, outside of their enlargements *f''*, to about the height of the top of the boxes *b* of the rigid rolls. The inner faces of shanks *f* and portions F' are dressed at right angles to each other and properly finished to form a seat for the journal-blocks E E. These blocks are held in position on arms F and can be adjusted vertically thereon by means of the screw-bolts E', which extend vertically through corresponding screw-threaded openings in shanks *f*, outside enlargements *f''*, and impinge against the bottom of blocks E, and by screw-bolts *e e*, which play through vertical slots f^2, formed in the parts F' of arms F, near the upper and lower ends thereof, and engage in screw-threaded openings in the block E, so that when the yielding rolls and the blocks receive their initial vertical adjustment by bolts E', the bolts *e* riding up or down through slots f^2, the latter screw-bolts can be tightened and securely and rigidly lock the pillow-block E in position on arm F. Each arm F and its pillow-block is provided with similar adjusting and retaining devices. The blocks E E are made sufficiently high to give them a firm support against the faces of part F' of the arms F and are preferably recessed on their inner surfaces, as shown at *e'*. The journal-boxes proper for the shafts of the rolls D are formed in the upper ends of blocks E and secured by caps *b'*, similar to the journal-bearings of rolls C.

H designates an outstanding piece or part of each arm F, standing horizontally from the portion F' and preferably between the slots f^2 therein. These parts H are preferably formed integral with arm F, but may be made separate and secured thereto in any proper manner.

The part H of each arm F extends outward a sufficient distance to bring its end *h* directly over the end of the arm *a* of casing A on its end and side of the machine. The end or head *h* of part H is provided with a central vertical opening, *h'*, through which passes freely the upper threaded end of a rod, I. The lower threaded end of each rod I passes through a vertical slot, *i*, formed in the end of arm *a*, and through a cylindrical nut, J, which has its ends journaled in proper openings in the arm *a* on the sides of slot *i*, so that while the rod I can be screwed up or down through the nut J it can also with this nut have a light lateral rotary or swinging movement on arm *a* by reason of the widened upper and lower ends of slot *i*, as shown in Fig. 4. The upper end of rod I above head *h* is provided with the hand-wheel nut K, having a suitable washer, *k*, interposed between it and head *h*, the upper surface of head *h* being suitably rounded to present as little frictional bearing-surface to the washer *k* as is found desirable.

K' designates a jam-nut on rod I above hand-wheel K.

L designates a suitable spring placed on rod I below head *h* and bearing against said head through an interposed washer, *l*, the lower surface of head *h* being rounded to reduce friction with the washer, as shown.

L' L' are setting and jam nuts on the lower portion of rod I above arm *a* and engaging the lower portion of spring L through interposed washer *l'*, as shown. The spring L presses the head *h* of part H of arm F upward against the nut K, the pressure being regulated by the nuts L', so that the arms F are upheld by rods I through the springs L thereon, as is evident.

j designates a bolt engaging through a suit-

able threaded opening in the head of arm *a* with the nut J, so that the latter can be rigidly locked therein, if desired.

The arms F and their appurtenances and connections with rod I form the setting and adjusting devices for the yielding roll and are operated as follows: The arms F F, carrying rolls D D, as described, are mounted on the shaft G or on similar bearings by their shanks, so that they can swing or rotate on said shaft, there being two arms F for each roll, mounted on opposite sides of the main frame and independent of each other, so that either end of the yielding roll can be independently adjusted to compensate for wear of the surfaces of the rolls C D. The pivots of arms F are preferably vertically below the centers of the yielding rolls when the latter are in grinding position, or may be set outward, so as to naturally incline the yielding rolls toward the rigid rolls, as is found preferable, but should not be located to the inside of the shaft of the rolls D, because it is found in practice that when so located compression is always had upon the governing-springs of the arms, as the weight of the roll causes it to move outward by gravity, and therefore the springs have at all times to support more or less of the weight of the yielding roll. Consequently the springs are weakened and need frequent regulating. The rolls D being mounted on arms F, as described, if it is found that they are out of vertical alignment with the rigid rolls the bolts *e* are loosened, the bolts E′ raised or lowered until the proper alignment is reached, then bolts *e e* are tightened, and the rolls are ready for action. The yielding rolls are horizontally adjusted by means of the rods I and their connections. For instance, if it is desired to draw one end of a roll D outward to parallel the rolls, the rod I of the arm F supporting that end of the roll is turned down through nut J and engages the upper end of piece H of the arm F, depressing the latter and causing the arm to turn outward on its pivot and thereby separate the rolls. If it is desired to set one end of roll D closer toward its roll B, the rod I is turned upward, carrying with it the nuts K and allowing the spring L to lift the piece H and turn arm F inward. The springs L at all times keep the arms H pressed upward against the washers and nuts K, and this spring regulates the tension of the rolls as usual; but should any hard foreign substance fall between the rolls when in operation the roll D can by the swinging arms F move outward, this action causing the compression of spring L through arms H, as is evident.

It will be observed that while the rolls can be horizontally adjusted by the rods I, as described, the adjustment of spring L is in no wise affected, the springs being supported and adjusted solely on the rods, as described, this feature permitting the rapid setting of the mill to reduce the grain to various grades and obviating the resetting of the springs at each change of position or "set" of the rolls.

The shanks *f* of arms F might be, if desired, pivoted to rigid lugs or points on casing A, and would then permit the required adjustments of the yielding rolls; but in order to make the separation of the rolls when it is desired to stop the grinding without stopping the motion of the rolls, I mount them on the horizontal shafts G, as shown. These shafts have their ends reduced in diameter, forming thereby cams *g* with the main body of the shaft, the shaft being journaled in the casing A, as described, so that when it is rotated the axis of cams *g* will move concentrically to the axis of the shaft proper. Upon these cams *g*, at opposite sides of the machine, are mounted the arms F of each roll D. The cams *g* of the shaft are extended beyond the bearings of arms F on one or both sides of the mill, and on one cam *g*, outside arm F, is rigidly secured by a set-screw or in other proper manner a lever, M, which extends downward and outward to a point below arm *a*, and is adapted to be engaged by a retaining-catch, *m′*, of suitable construction, secured to the main frame A.

m designates an arm rising from the upper end of lever M at or about right angles thereto, the levers M and *m* forming a bell-crank journaled or secured at its angle to the cams *g*.

O designates a lever-arm similar to arm *m*, secured to the end *g* of the opposite shaft G to that bearing lever M and on the same side of the machine. The lever O inclines inward and downward at right angles to the inclination of arm *m* when the parts are in normal position.

N designates a pitman-rod pivotally connected to the levers *m* and O, so that they move synchronously when operated.

There may be a similar arrangement of levers and connections on the opposite side of the mill, if desired.

The normal position of the arm bearing cams *g* of the shafts G in relation to the body thereof is to lie at the lowest point of the shaft with their axis in vertical lines with the axis of the shaft, as shown in Fig. 4. Now, upon lifting the outer end of lever M, the shaft G, to which it is attached by cam *g*, is rotated, and through the connections of arms *m* and O and pitman-rod N the opposite shaft is similarly and simultaneously rotated. The cams *g*, being eccentric to the main body of the shaft G, will ride upward and outward, thereby lifting the inner portions of arms F. The pieces H of the arms F, being kept from lifting by the nuts K on rod I, will cause the arms to turn downwardly and outwardly, thereby separating the rolls D from rolls C, this separation continuing as long as the lever M is raised. The rods I can swing slightly on their nuts J, and thus prevent any friction of pieces H against the rods, rendering the

separating of the rolls both rapid and easy through the described means. When the lever M is depressed and again engaged by its catch m', the rolls are returned to their grinding position. It will be observed that, owing to the yielding or swinging of rods I, as described, when the rolls are separated by turning shafts G the springs L are not compressed or put under strain, so that they are ready for instantaneous action immediately upon the return of the rolls to the grinding position.

It will be observed that, by reason of the cylindrical nuts J, when the arms F are moved outward the rod I is allowed a corresponding degree of swinging or rotary movement, so that there is no binding or friction caused by the separating of the rolls, except at the pivots of arms F and rods I, and the amount of necessary movement of said parts in this operation is so slight that friction is imperceptible.

In Fig. 5 I have shown a modification of arms F. In this the upright F′ is shortened and the piece H is formed on or secured to the block E, the adjusting mechanism being the same. On the inner faces of the sides of the casing A, at points centrally between but below each pair of rolls, are formed the outstanding vertical pairs of flanges P, united at bottom by a bracket-piece, p. The flanges P on opposite sides of the mill form guides for and receive the lugs q on the ends of scraper-frames Q. These frames are rectangular and consist of side pieces, q', and end pieces, q^2, on which are formed the lugs q, which lie in the longitudinal axial line of the frames and pivot them centrally in their bearing, as shown. The parts of the frames are cast integral, so that the frames are rigid, and when in position the depression of one bar q' will elevate the other, as is evident. Upon bars q' are secured by proper screws the scrapers or brushes R. The journals q of the frames are supported in their bearings upon springs P′, which are adjusted by set-screws or bolts P^2, playing through proper openings in brackets p and having upon them below these brackets jam-finger-nuts p' for locking the bolts P^2 when properly adjusted. By means of these springs the scrapers are held with sufficient pressure against the rolls to ordinarily clean their surfaces; but should the roll-surface become broken and catch the scraper R the spring would permit the frame to descend and disengage the scraper from the damaged roll without injury; but their principal object is to compensate for wear of the scrapers, so that they will always effectually cleanse the rolls without requiring frequent adjustment, as would be the case were no springs used. If desired, brushes might be substituted for the scrapers, their operation being the same, but not so effective.

I will now describe the drive of the rolls and the regulating or tightening devices therefor. The shafts of roll D in one pair and of roll C in the opposite pair of rolls are extended on one side of the machine outside their respective bearings, and have secured upon them the similar pulleys S S′. The shafts of the remaining rolls, C D, are similarly extended on the opposite side of the mill and bear the similar pulleys s s'. The rolls bearing pulleys S S′ are the fast rolls and those bearing pulleys s s' are the slow rolls.

T′ designates a counter-shaft journaled centrally in proper bearings on the main frame below the rolls and bearing at one end, on the same side of the mill as pulleys S S′, a pulley, t, of suitable diameter, hereinafter referred to. On the other end of the counter-shaft are fixed two pulleys, T′, which may be of equal or unequal diameter, as desired; or one extra-wide pulley may be substituted. The pulleys S S′ are on the front side of the mill and are run by the endless main driving-belt U, which passes up through the floor upon which the mill rests from a pulley on a driving-shaft of the mill (not shown in the drawings) to and over pulley S, thence down to pulley t on the counter-shaft, thence up over pulley S′, and then down through the floor to the driving-pulley. The main belt U, it will be seen, is thus made to drive both fast rolls and also the counter-shaft.

On the rear side of the mill I employ two endless belts, V v, for driving the pulleys s s' of the slow rolls. The belt V drives pulley s and its roll from inner pulley T′ on the counter-shaft, and belt v drives pulley s' from the outer pulley T′, the shaft of the roll on which the pulley s' is splined being extended sufficiently to bring the pulley s' and outer pulley T′ into proper alignment. It is obvious that by having the pulley t on the counter-shaft larger than pulleys T′, I can obtain the different speeds of the rolls, and can, by varying the sizes of the pulleys t T′, regulate the amount of differential speed of the rolls. The counter-shaft T, being situated centrally of the mill, as shown, will be nearer the inner slow roll than the outer slow roll, as is evident. Now, the belts V v, which drive the slow rolls, are of unequal lengths, but are simultaneously tightened or tensioned by means of a single device, which is as follows: W designates an arm pivoted at its lower end to a suitable support on one side of frame A below the driving-pulleys on the rolls thereof. The upper end of this rod is bifurcated, as shown, and in the sides of this bifurcated portion are formed proper bearings for a shaft, w, as shown, and on this shaft are mounted two pulleys, X x, of unequal diameters, one of which may be keyed on the shaft, if desired, or both left free to turn thereon. The arm W stands in such position that its pulleys X and x rest against the belts V and v. The belt V runs to the nearest roll, and by pivoting arm W to the main frame on the same side as the belt v before its pulley X can be brought to bear upon belt V pulley x has engaged and taken up the slack in belt v, as shown. The relative sizes of the

pulleys X x are such that when arm W is sufficiently moved inward to cause pulley x to take up the slack of belt v the pulley X will impinge against belt V, and any further movement of arm W will similarly affect both belts and tension them equally and simultaneously, so that the regulation of both belts is effected by one device. It is obvious that in order to tighten the belt V its loose or slack side must pass by the line of the tight side of the belt v. Consequently it is imperative that the pulley for belt v must be smaller than that for belt V, or it would prevent the tensioning of belt V. It is also desired sometimes to employ pulleys of unequal size on the slow rolls or for their driving-pulleys on the counter-shaft. In this case the belts are not only of unequal length, but also travel at different speeds, and a single pulley would be inoperative, so that it is necessary that the pulleys be of unequal diameters and also independent of each other. By having the pulleys of unequal diameters a more even and uniform tension of the belts can be attained.

The means for regulating and adjusting the position of arm W is as follows:

Y designates a rod extending from arm W to and through a bracket on the main frame, having a hand-wheel nut, Y′, on its threaded end outside the bracket, by which the position of the arm can be regulated. The inner threaded end of rod Y connects with arm W by means of a nut, w, journaled in the sides of a slot formed in the arm, similarly to the nut J and its connections to rod I in the roll-adjusting mechanisms.

Z designates an arm similar to arm W in all respects except that it bears but one pulley, z, and is situated on the opposite side and end of the mill from arm W, being controlled by a rod, Y^2, and its connections, as described. The pulley z of arm Z impinges against belt U and regulates the tension of the same, as is evident.

Having described my invention, I claim—

1. In a roller-mill, the combination of the rigid roll and the yielding roll, with the swinging arms supporting the yielding roll, the springs controlling said arms mounted on swinging supports, the transverse shaft G, journaled in the main frame below and parallel with the yielding roll and having cams formed on its ends upon which the swinging arms are supported, and the lever to oscillate the shaft and thereby shift both arms simultaneously to throw the yielding roll away from the rigid roll without disturbing the alignment of the rolls or the tension of the controlling-springs, and mechanism for holding the yielding roll up to the rigid roll when in operative position, substantially as specified.

2. In a four-roller mill, the combination of the rigid rolls with the yielding rolls, the swinging arms supporting the latter, the adjustable springs controlling said arms mounted on swinging supports, the two shafts G G, journaled in the main frame below the yielding roll, having cams g on their ends, upon which said arms are mounted, the series of connected levers for simultaneously oscillating shafts G G, to adjust the yielding rolls to or from the rigid rolls without disturbing the tension of the springs, and mechanism for holding the yielding rolls up to the rigid rolls when in operation, substantially as specified.

3. In a four-roller mill, the combination of a counter-shaft journaled in the main frame and receiving motion from the main driving-belt at one side of the machine, pulleys on the other end of said shaft at the opposite side of the machine, pulleys on the shafts of two of the rolls, and belts of unequal length diverging from the pulleys on said counter-shaft to said other pulleys, with a tightening device mounted on the main frame, having two pulleys of unequal diameters adapted to be brought, respectively and simultaneously, against the slack sides of said driving-belts, all substantially as and for the purpose specified.

4. In a roller-mill, the combination of the crushing-rolls and the main frame provided with vertical guides and horizontal brackets p on the inner faces of its sides with a rectangular frame, Q, carrying suitable roll-cleaning devices and having lugs q on its ends moving in the guides on the main frame, the springs loosely supporting the frame, and the bolts P^2, carrying the springs, whereby the frame can be adjusted, all constructed and arranged to operate substantially in the manner and for the purpose described.

5. In a roller-mill, the combination of the rigid rolls, the yielding rolls, the upright movable arms F, bearing the yielding rolls, the springs engaging said arms mounted on swinging supports, the transverse shafts G G, journaled in the main frame below the yielding rolls, having cams g on their ends, forming the pivotal supports of said arms, and the connected levers for oscillating said shafts simultaneously to shift arms F and throw the yielding rolls into or out of grinding position without disturbing the adjustment of the controlling-springs, with the screw-rods and their adjusting-nuts engaging arms F and projections of the main frame for regulating the grinding adjustment of the rolls, substantially as specified.

6. In a roller-mill, the combination of the rigid and yielding rolls and the independent movable arms F with the vertically-adjustable pillow-blocks mounted on arms F, forming the journal-bearings of the yielding rolls, the springs L, for regulating the adjustment of the arms F, mounted on swinging supports, the transverse shafts G G, having on their ends cams g, forming the pivotal supports of arms F, and the connected levers to oscillate said shaft to simultaneously shift the arms F to throw the yielding rolls into or out of grind-

ing position without disturbing the tension of the springs, all constructed and arranged substantially in the manner and for the purpose described.

7. The combination of the swinging arms F, carrying the yielding rolls, the adjustable swinging screw-rods I, and adjustable nuts and springs L thereon controlling arms F for regulating the grinding operation of the rolls, with the transverse shafts G, having cams *g* on their ends, upon which arms F are mounted, and the levers for oscillating said shafts to shift arms F without disturbing the tension of springs L, all constructed and arranged substantially as and for the purpose described.

8. The combination of the adjustable angular arms F and the rod I and its nuts and springs for regulating and adjusting the arms, substantially as described, with the angular pillow-blocks E, mounted on said arms, the adjusting-bolts E′ and retaining-bolts *e* for said pillow-blocks, and the rolls mounted on the pillow-blocks, all constructed and arranged to operate substantially in the manner as and for the purpose described.

9. The combination of the roll-supporting pivoted swinging arms F F, having outstanding slotted pieces H H, with the journal-nuts mounted on the main frame, the threaded rods I I, adjustably engaged at their lower ends in said nuts and playing freely through openings in pieces H H, the adjusting-nuts and jam-nuts on rods I above pieces H, and the springs L and nuts L′ on said rods between nuts J and pieces H, whereby the arms F can be adjusted without disturbing the springs, all constructed and arranged to operate substantially in the manner and for the purpose described.

10. In a four-roller mill, the combination of the rigid roll, the pivoted swinging arms F, having each an outstanding piece, H, the pillow-blocks E and the yielding roll mounted in said blocks, and the shaft G, journaled in the main frame below the yielding roll and having cams *g g* on its ends, forming the pivotal supports of arms F, with the rods I, springs L, and nuts L′ thereon, and the journal-nuts J, K, and K′, engaging piece H, whereby the arms F can be adjusted without disturbing the springs, substantially as and for the purpose specified.

11. In a roller-mill, the combination of the fast rolls having equal-sized pulleys on their shafts at one side of the mill and the slow rolls having equal-sized pulleys on their shafts at the opposite side of the mill with the counter-shaft having pulleys on its opposite ends driven by the main belt, that also drives the fast rolls, and driving the slow rolls by different belts of unequal length, and a belt-tightener composed of a bifurcated bracket pivoted on the main frame and carrying two pulleys on one shaft adapted to simultaneously tension these belts, and suitable tension devices for the main belt, substantially as and for the purpose specified.

12. The combination, in a four-roller mill having fast and slow rolls and a counter-shaft, T, having single pulley *t* at one end and double pulleys T′ T′ at the other, of the main belt U, driving the fast rolls and counter-shaft at one side of the mill, and the belts V *v*, driving the slow rolls from pulleys T′ T′ at the opposite side of the mill, with the belt-tightening devices for belts V *v*, consisting of an arm, W, pivoted to the main frame and operated by an adjustable horizontal screw-rod, Y, and bearing in its upper bifurcated end the large pulley X and small pulley *x*, mounted upon the same shaft, engaging, respectively, the belts V *v*, and the similar arm Z, bearing one pulley and its operating devices for tightening belt U, all substantially as and for the purpose described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

HEMAN A. BARNARD.

Witnesses:
J. S. LEAS,
CHAS. S. KERNS.