(No Model.) 3 Sheets—Sheet 1.

# C. M. DAY.

## ROTARY PULVERIZING MILL.

No. 587,501. Patented Aug. 3, 1897.

Fig. 1.

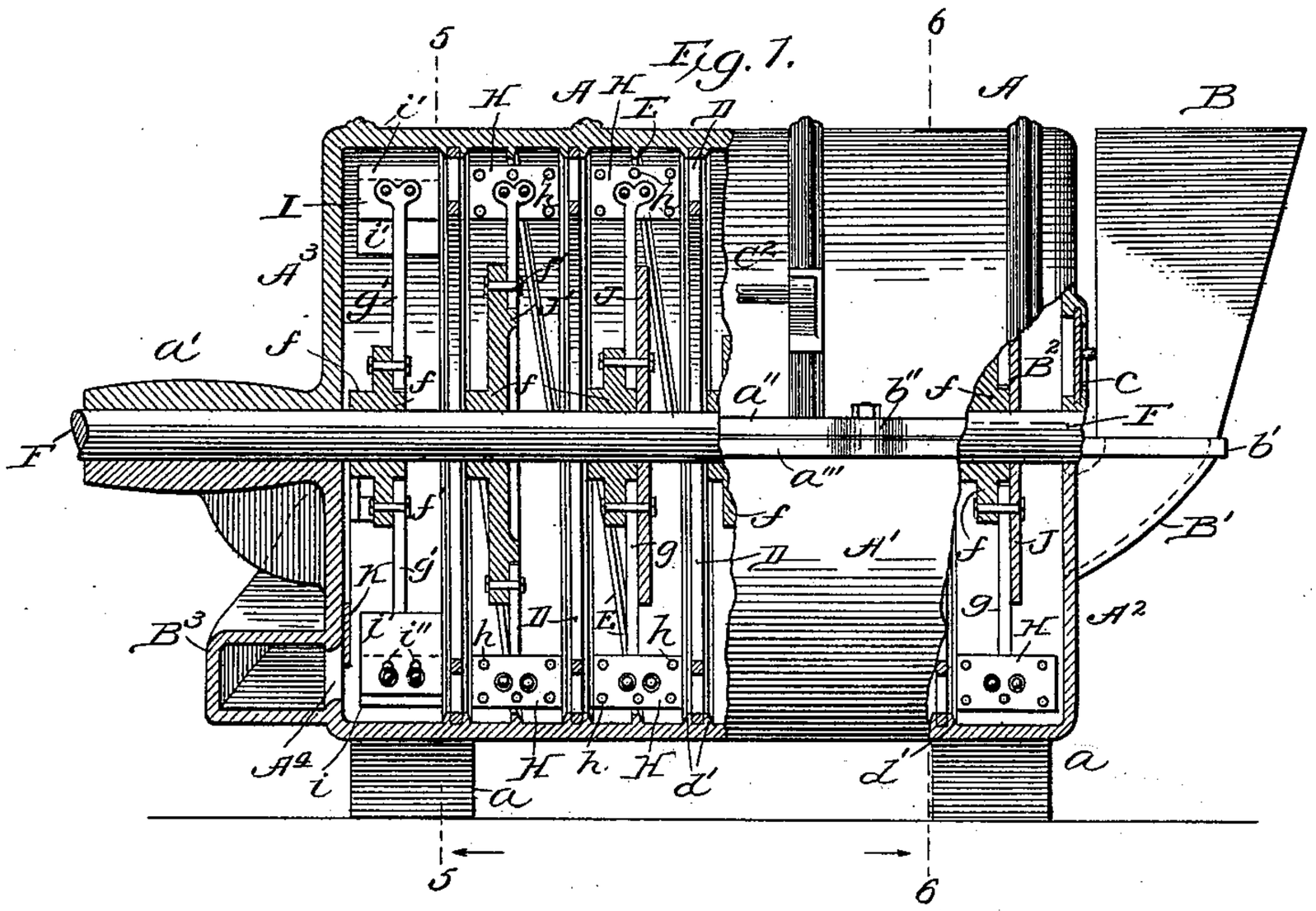
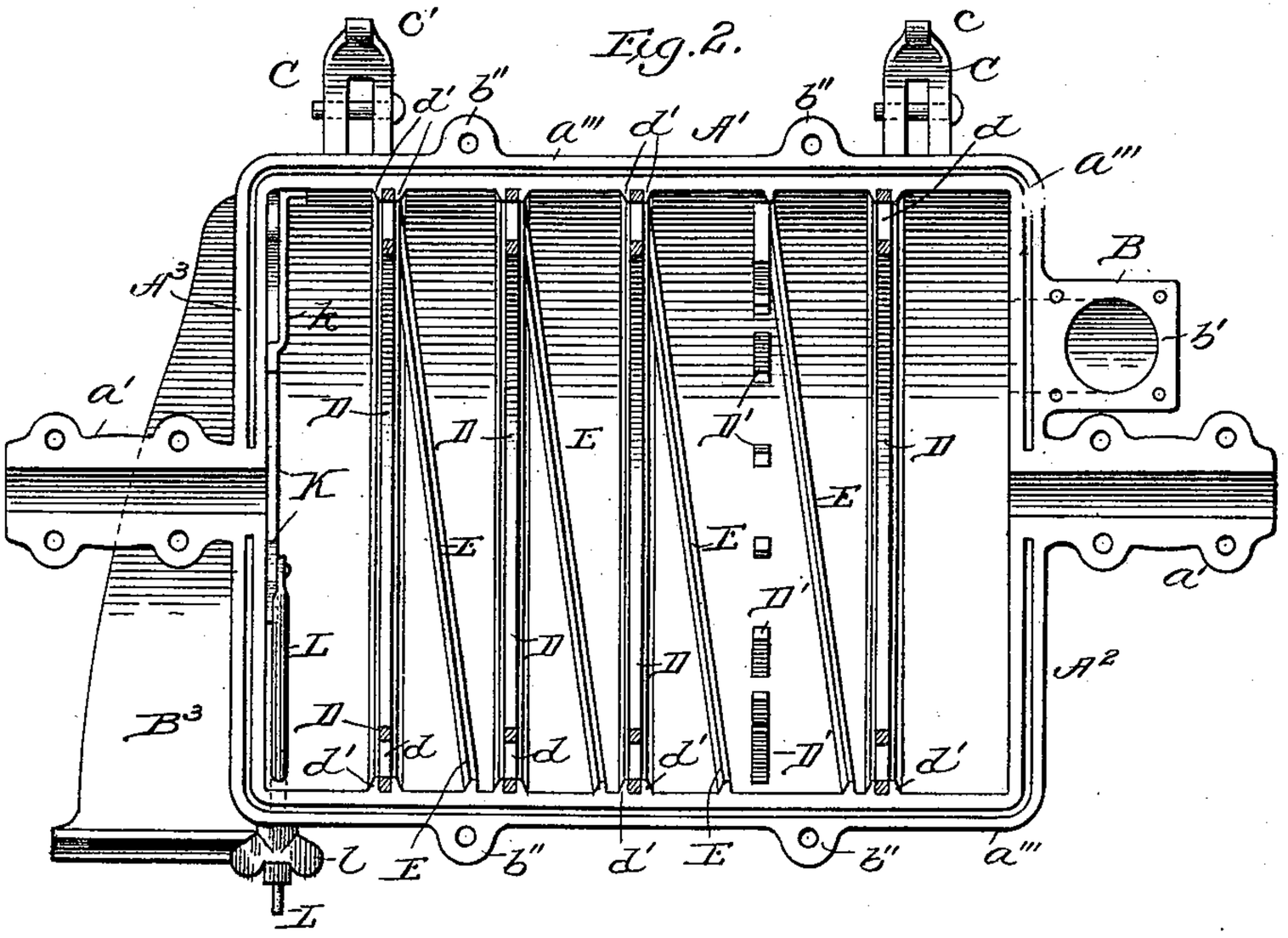



Fig. 2.




WITNESSES:

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(No Model.) 3 Sheets—Sheet 2.

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## ROTARY PULVERIZING MILL.

No. 587,501. Patented Aug. 3, 1897.

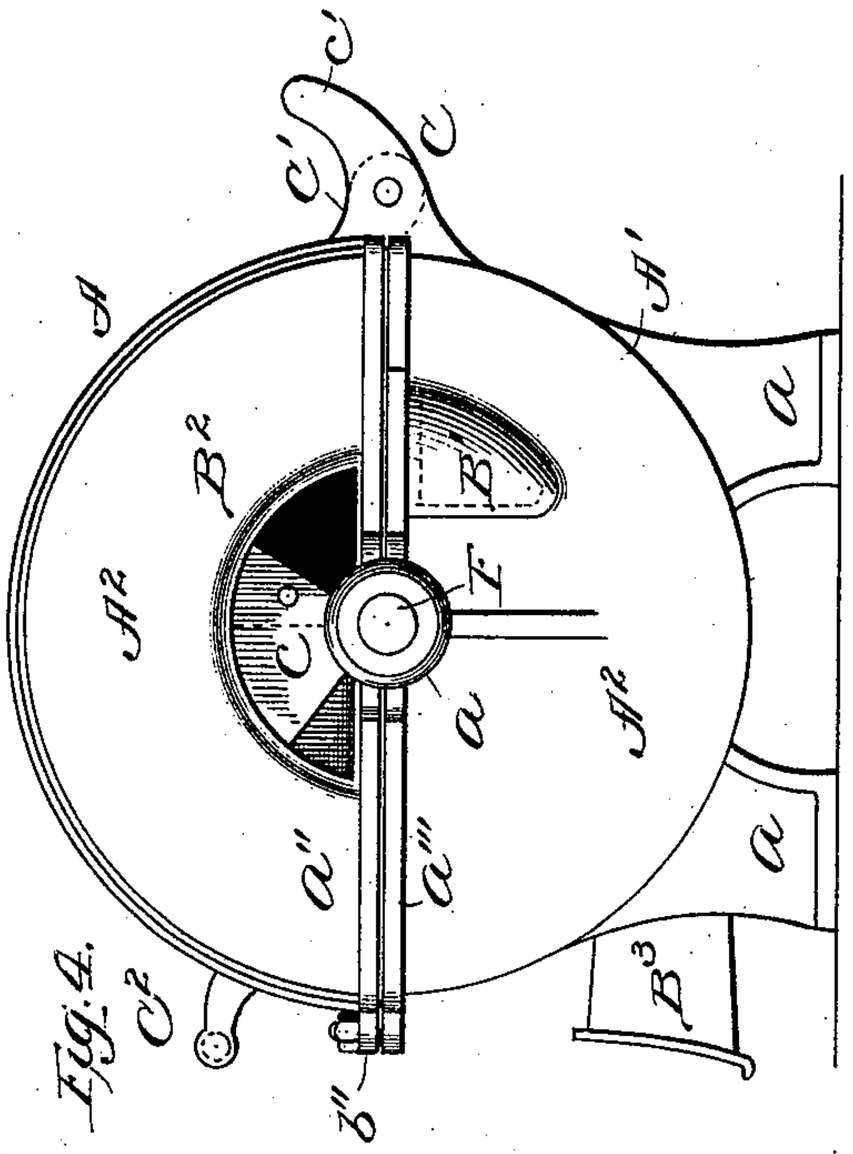


Fig. 4.

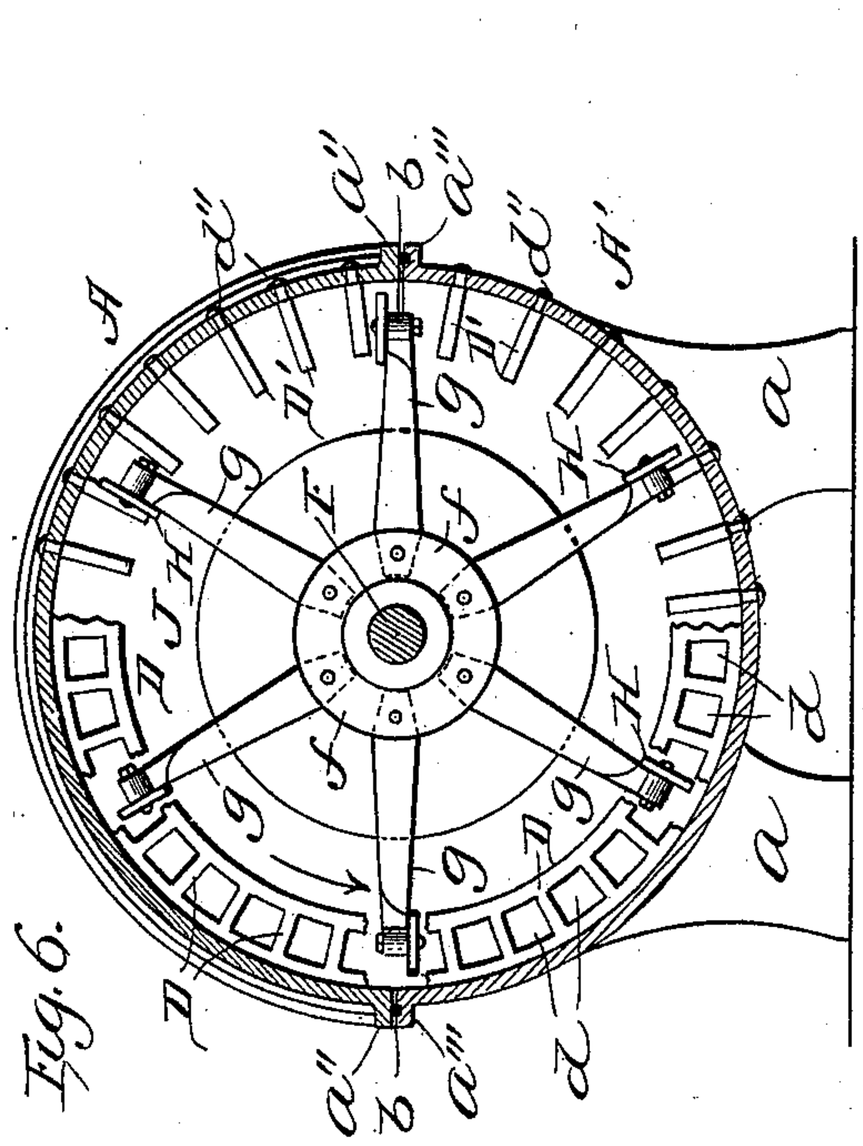


Fig. 6.

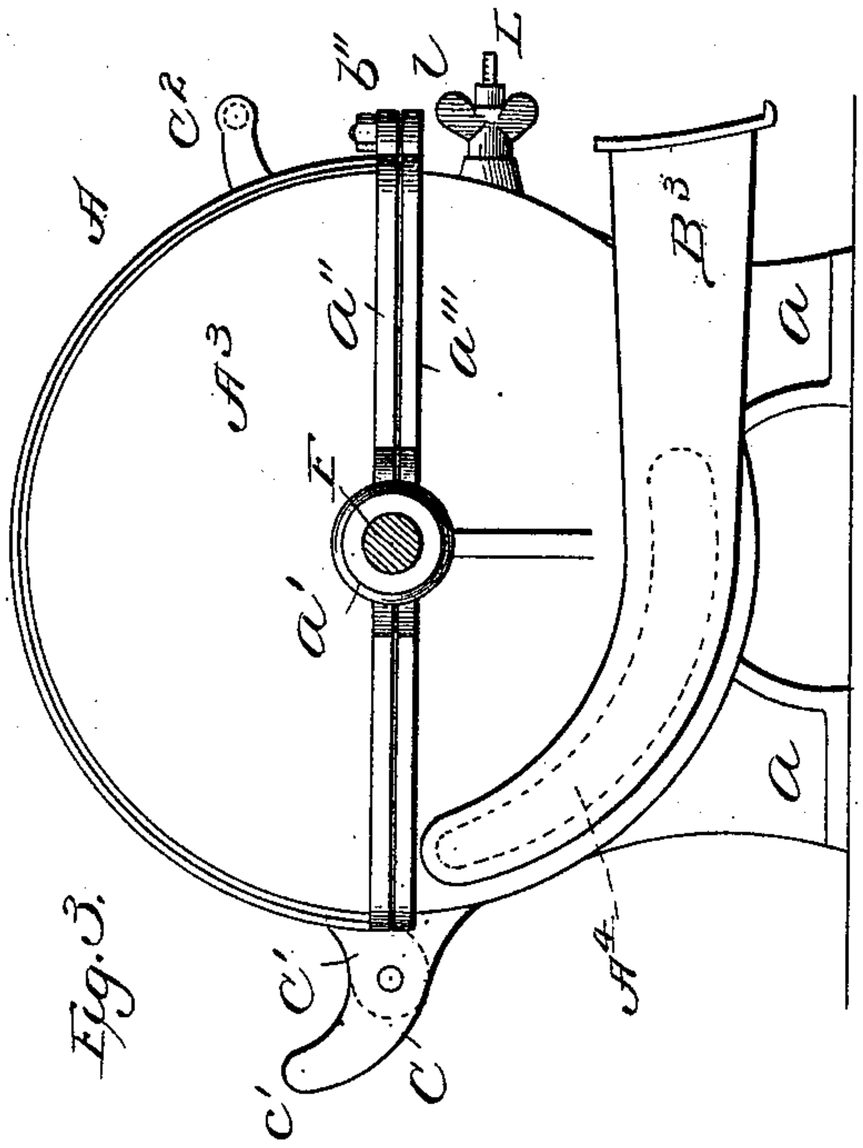


Fig. 3.

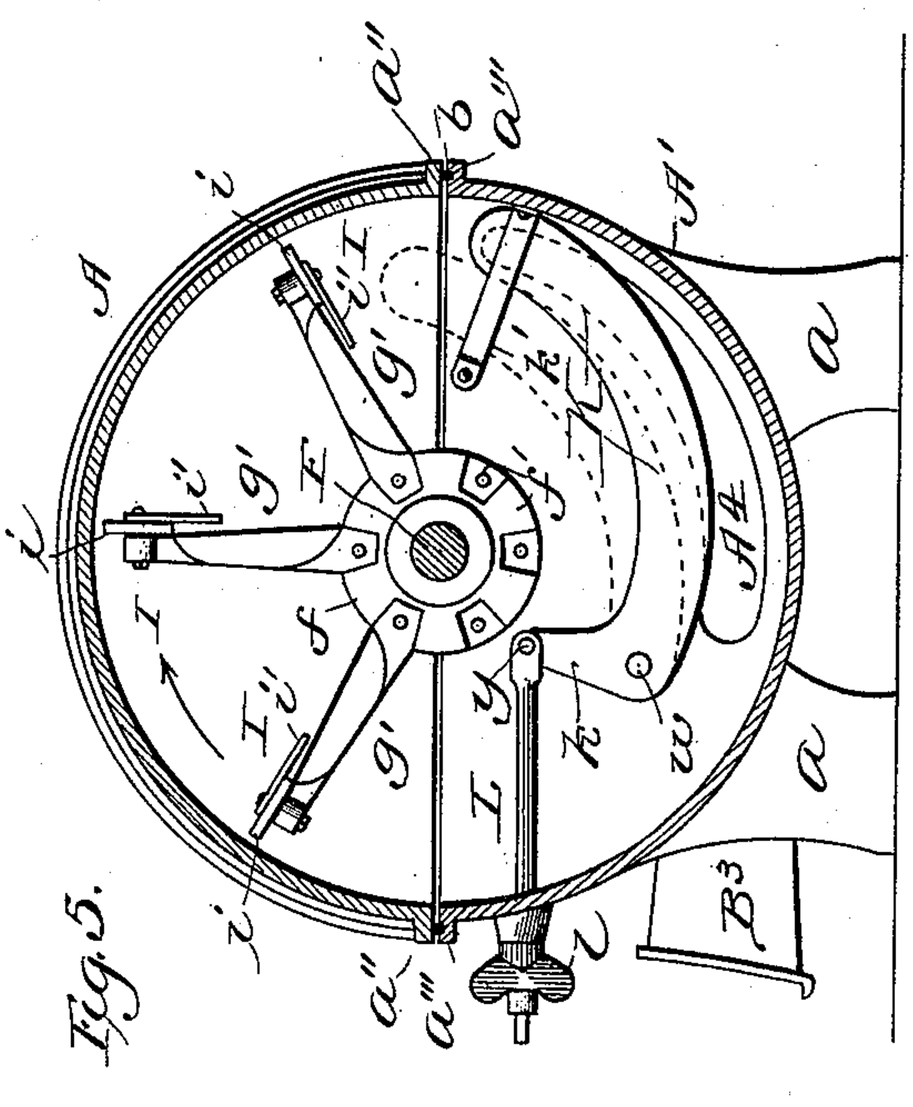


Fig. 5.

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(No Model.) 3 Sheets—Sheet 3.

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## ROTARY PULVERIZING MILL.

No. 587,501. Patented Aug. 3, 1897.

Fig. 7.

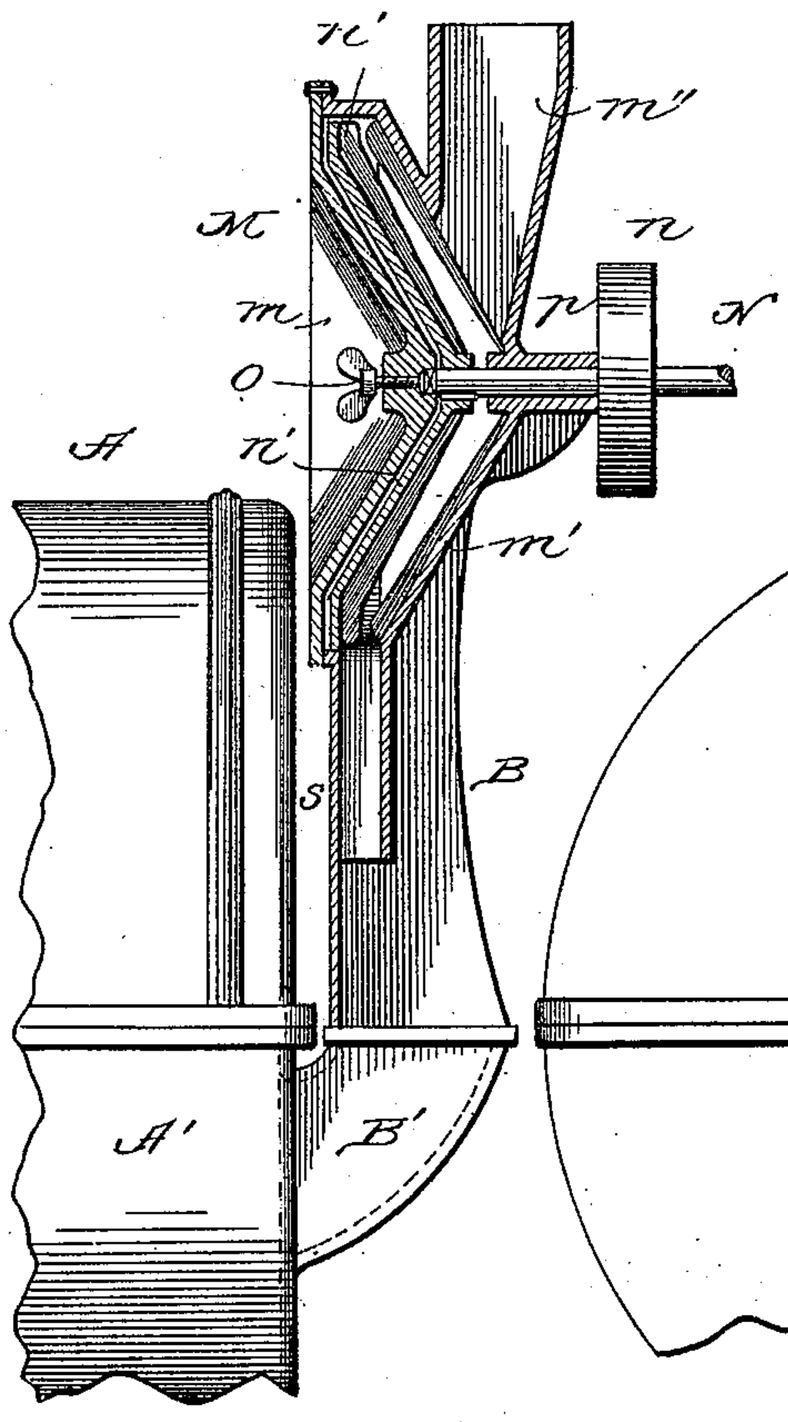



Fig. 8.

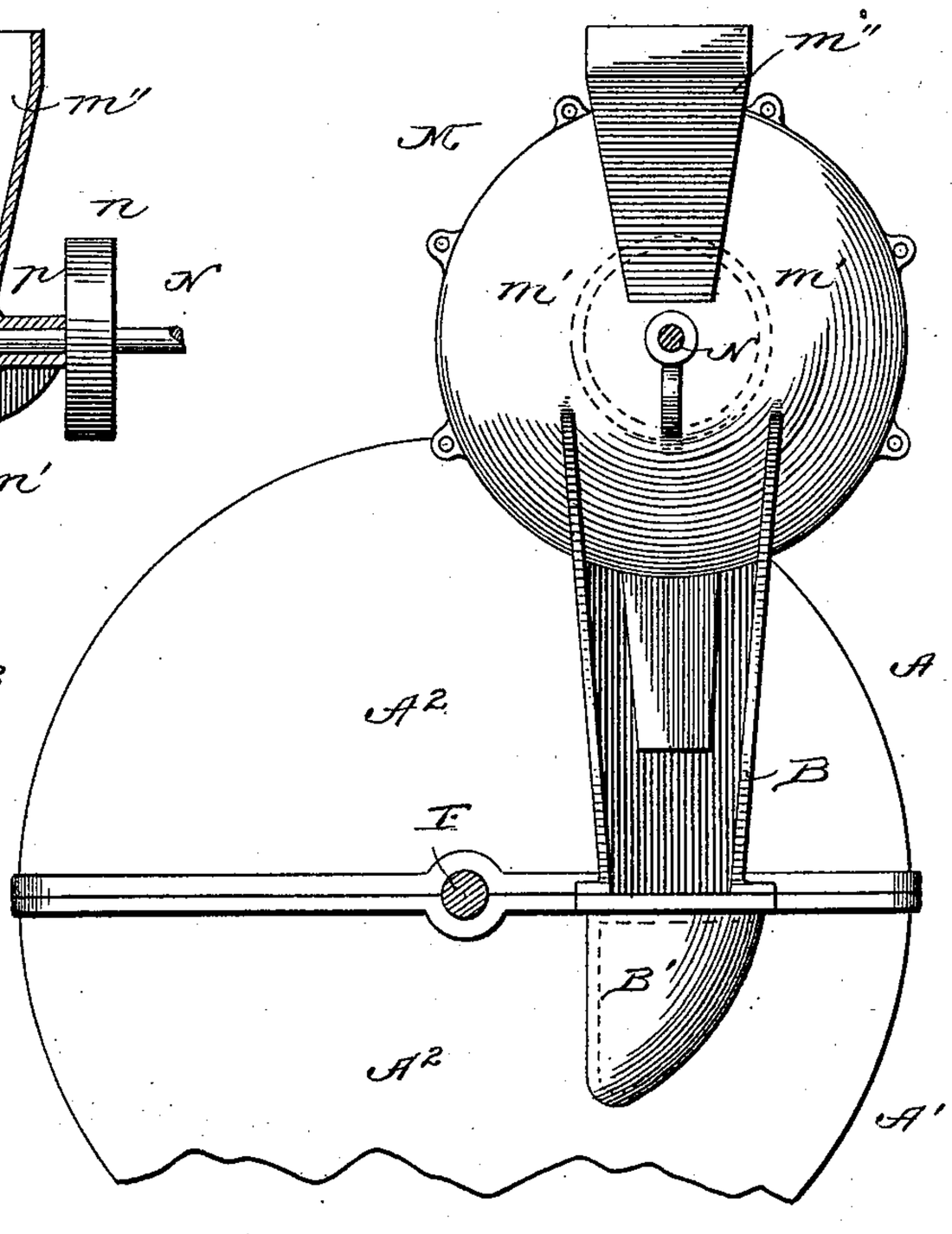
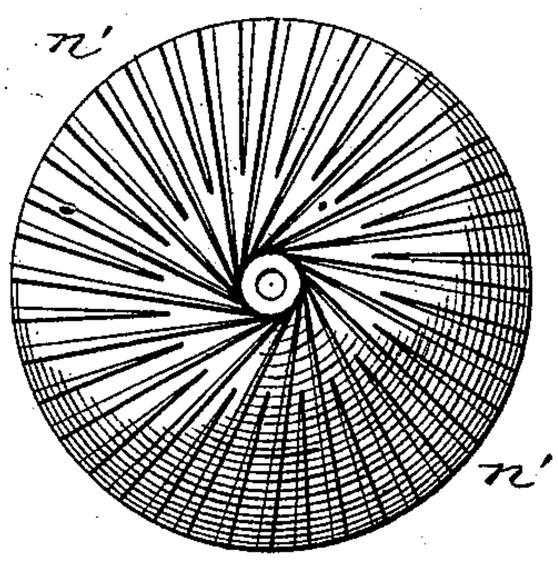



Fig. 9.




WITNESSES:

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# UNITED STATES PATENT OFFICE.

CHARLES M. DAY, OF BROOKLYN, NEW YORK.

## ROTARY PULVERIZING-MILL.

SPECIFICATION forming part of Letters Patent No. 587,501, dated August 3, 1897.

Application filed December 4, 1895. Serial No. 571,043. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES M. DAY, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Rotary Pulverizing-Mills; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a rotary mill for pulverizing refractory material—such as coal, different kinds of ores, minerals, &c.—and producing an impalpable powder.

The object of my invention is to provide for more thoroughly and uniformly pulverizing all kinds of refractory material than heretofore attainable, and more particularly to reduce coal to an impalpable powder and mix and suspend such powder in a current of air and force the mixture through and out of the mill to a combustion-chamber in a furnace.

One of the special objects of my invention is to form and hold (by centrifugal action aided by spiral ribs) against the peripheral surface of the pulverizing-cylinder a layer of granular coal and to cause other granular coal to roll and rub over such layer till by attrition or abrasion of the particles they are reduced to impalpable powder.

Another special object is to provide for retarding the longitudinal movement of heavy particles of coal and pushing them backward toward the inlet end of the cylinder until they have been reduced to a very fine or impalpable powder.

Another object is to provide additional means for pulverizing the material through the impact thereof against suitable obstructions, also through the shearing action of the outer edges of the revolving blades on the edges of spiral ribs in the pulverizing-cylinder.

Another special object is to separate and free the fine dust from the heavier particles and cause it to be taken up and rapidly carried to the delivery end of the mill by the longitudinal currents of air.

Another object is to provide for directing and confining the longitudinal air-currents in the zone of pulverized dust for quickly taking up and carrying forward such dust, thereby freeing the heavier particles, so that they will be more rapidly abraded and reduced to fine powder.

Another object is to provide for breaking large irregular lumps of material to a smaller and nearly uniform size and delivering it in regulated flow to the pulverizing-mill.

Another object is to provide for regulating and checking the flow of the current of air and dust at the outlet of the mill.

The matter constituting my invention will be defined in the claims.

I will now describe the details of construction of my improved pulverizing-mill by reference to the accompanying drawings, in which—

Figure 1 represents a side elevation of the mill, partly in vertical section. Fig. 2 represents a horizontal section showing the lower half of the cylindrical shell with the longitudinal shaft and its attached devices removed. Fig. 3 represents the left-hand or outlet end of the mill. Fig. 4 represents the right-hand or inlet end of the mill. Fig. 5 represents a vertical transverse section through the mill at the fan-compartment on the line 5 5, Fig. 1, looking toward the left or outlet end. Fig. 6 represents a vertical transverse section on the line 6 6, Fig. 1, looking to the right or inlet end of the mill. Fig. 7 represents a vertical section of a breaking and feeding device connecting with the feed-hopper of the mill. Fig. 8 represents an end elevation of the feed device and mill. Fig. 9 represents the face view of the movable cone-disk of the feeding device.

My pulverizing-mill is made of cylindrical form and is preferably composed of two semi-cylindrical sections A and A′, which are secured together by flanges $a''$ $a'''$. The lower half of the cylinder is provided with supporting-legs $a$ and with journal-bearings $a'$, which may be cast therewith or otherwise connected, as desired. The flange $a'''$ of the lower section is preferably made with a groove, as shown in Fig. 2, into which is inserted a packing $b$, of rubber or other suitable material, for making a tight joint with the upper section of the cylinder. The flanges are provided with ears $b''$, having bolt-holes, through which are inserted bolts for clamping the parts together. The cylindrical shell is closed

by end walls or heads $A^2$ at the inlet end and $A^3$ at the outlet end. The feed-hopper, composed of the detachable part B and the fixed part B′, connects with the inlet-head of the cylinder, and such parts are connected by the flanges $b'$ and suitable bolts. The part B′ may be cast with the lower section of the cylinder, as shown.

My breaking and feeding device is preferably mounted upon a hopper B, as shown in Figs. 7 and 8, and will be hereinafter more particularly described.

The head $A^2$ is provided with an air-inlet opening $B^2$, into which is fitted a damper or register $c$ for controlling the supply of air to the cylinder. The upper and lower sections of the cylinder are provided with hinge lugs or ears C C′, and the lower lugs C are extended to form supporting-horns $c'$ for supporting the upper section of the cylinder when turned backward. The handle $C^2$ is secured to the front of the upper section, as shown in Figs. 1 and 3, for use in opening and closing the section. The outlet end $A^3$ of the cylinder is provided near the bottom with an elongated curved discharge-opening $A^4$, leading into the discharge-spout $B^3$, which may be cast upon or otherwise secured to the head $A^3$. The upper and lower sections of the cylinder are provided with any desired number of inwardly-projecting rings of openwork obstructions, as D and D′, two modified forms being shown in Figs. 2 and 6 of the drawings. The rings D are made with outer and inner continuous rims and connecting-bars, forming the intermediate perforations or openings $d$, as shown in Figs. 2 and 6. The rings D are set into grooves which may be formed by the circular ribs $d'$. The circular grooves may be countersunk in the metal of the shell.

The rings of obstructions D′ are preferably formed of inwardly-projecting pins, which are suitably spaced apart and are secured to the shell by riveted heads $d''$ or in other suitable manner. The bars of the rings D or pins of the rings D′ form obstructions for receiving the impact of granular coal which may be thrown against them by the revolving blades for abrading and diffusing the particles. I may use either the rings D or the rings of pins D′, or both of them, in my pulverizing-mill. The rings D D′ are suitably spaced apart for the passage between them of the revolving blades H, as shown in Fig. 1.

The upper and lower sections of the cylinder are constructed with spiral or helically-curved ribs E, which intersect the spaces between the rings, as shown in Fig. 2. Separate series of ribs may be formed in the upper and lower sections, if desired. Each rib may make a half-turn or be continuous around the interior of the cylinder. These ribs may be either cast integral with the shell or may be riveted thereto, as desired. The pitch of the ribs is toward the feed end of the mill—that is, their working faces are inclined backward toward the inlet end of the mill. These spiral ribs serve, in conjunction with the revolving beater-blades, the purpose of retarding the heavy particles of material and pushing them back toward the inlet end of the mill until they are reduced to a very fine or impalpable powder, also the purpose of shearing the material to reduce it to dust, and other useful purposes, as will be described in the operation of the mill.

The central longitudinal shaft F is supported in the journal-boxes $a'$ and carries the revolving blades H, disks J, and fan-blades I. A series of hubs $f$ are secured to shaft F, and to said hubs are secured the radial arms $g$ by bolts $f'$, the arms being preferably set in recesses in the hubs, as shown in Fig. 5. To the outer ends of the radial arms $g$ are secured the beater-blades H by screws or rivets. The blades are set at the proper distance from shaft F to clear the spiral ribs E and leave a space for holding an annular layer of coal or other material against the peripheral surface of the shell. The blades H are provided with perforations $h$ for the passage of fine particles of material.

The beater-blades are secured to the radial arms with their working faces at an angle toward the working faces of the inclined spiral ribs and with their outer edges adapted to shear against the edges of said inclined ribs, so that when the shaft is revolved the working faces of the beater-blades will be caused to sweep against or toward the working faces of the ribs which are inclined backward toward the inlet end of the mill, both for shearing particles of coal and for crowding the larger particles backward along said working faces of the ribs for retarding them until reduced to an impalpable powder.

To the hubs $f$ are bolted the deflecting-disks J, which extend outward to the dust-zone. Instead of using detachable disks J, a fixed disk J′ may be cast integral with the hub, as shown in Fig. 1. I may use any desired number of disks J or J′ for deflecting the longitudinal air-currents into the dust-zone between the outer edges of said disks and the outer edges of the blades H. The air-currents are thus prevented from taking a direct course from the inlet at the end of the cylinder to the outlet at the other end thereof. By deflecting such currents as above described the air is caused to more readily take up and carry forward the fine or impalpable dust as soon as produced, and coarse particles are thus better freed from dust and subjected to the pulverizing action of the mill.

The fan-blades I are connected by radial arms $g'$ to the hub $f$, the arms being set at their inner ends into recesses in the hub and secured by bolts $f'$, as shown in Fig. 5. The blades I are composed of a fixed part $i$ and a radially-movable part $i'$, having slots $i''$, the part $i'$ being secured to the part $i$ by adjustable screws, as shown. This construction is to provide for increasing the velocity and

quantity of air without increasing the speed of the mill.

A curved elongated damper K, provided at its inner end with an arm *k*, is pivotally connected at its inner end by a pin *w* to the interior of the head $A^3$ for controlling the size of the discharge-opening $A^4$, as shown in Fig. 5. A guard-strip *k'* is secured to the head of the cylinder and forms a guideway for damper K. To the upper end of arm *k* there is pivotally connected by pin *y* an operating-rod L, which passes out through the shell and is provided at its outer end with a thumb-nut *l* for adjusting the damper, as required. By means of this damper the volume or quantity of the current of air and dust discharged from the mill is controlled. In practice the discharge-spout $B^3$ may connect directly with a burner-nozzle opening into a furnace, or it may connect with a pipe leading to any suitable receptacle or be left open, as shown.

The breaking and feeding device M, Figs. 7 and 8, is preferably mounted upon the feed-hopper B, and it is constructed with a casing composed of the fixed plates or conical disks *m* and *m'*. The conical disk *m'* is formed interiorly with radial breaking-ribs. Adjacent to the disk *m'*, within the casing, is set the revoluble disk *n'*, also having radial ribs, as shown in Fig. 9. The disk *n'* is secured to the shaft N, which is longitudinally adjusted in its bearing *p*, and said disk may be set closer to or farther from the fixed disk *m'* by means of the adjustable screw *o*, working in the screw-threaded opening in the hub of the casing. The adjusting-screw *o* is provided at its inner end with an oval or conical head which bears upon the curved end of shaft N. A belt-wheel *n* is secured to shaft N. The casing M is provided with a feed-hopper *m''* and with a discharge-spout *s*.

My pulverizing-mill may be operated as follows: Coal, either in the form of culm or lumps, is preferably fed through my breaking and feeding device and hopper B B' into the mill, and, coming in contact with the first series of revolving beater-blades H, is thrown by centrifugal action toward the peripheral surface of the cylinder, where in a short time a lining or thin layer of coal is formed. The helically-curved or spiral ribs E on the inside of the cylinder aid materially in holding this peripheral layer of coal in place, and thus prevent the layer of coal thus provided from sliding on the surface of the casing, to which there is a tendency by reason of the circular motion of the blades. The peripheral layer of coal being formed, the additional coal which is fed to the cylinder is pulverized by the action of the revolving blades pushing, rolling, and tumbling the additional material in contact with the surface of said layer of coal, particles against particles, until by abrasion of the granular mass it is pulverized and reduced to an impalpable dust.

The spiral or helically-curved ribs E act to retard the heavier particles of coal from passing too rapidly through the mill. Since the working faces of the ribs are inclined toward the inlet end of the mill, the heavier particles, when thrown outward by the blades, will be gradually crowded backward along the ribs toward the feed end to be repeatedly subjected to the pulverizing action. The heavy particles will always be thrown out farthest and kept in contact with the peripheral layer of coal by the centrifugal action of the blades, so that they may more readily be subjected to the abrading action on the fixed layer of coal. The ribs E also act as shearing edges upon which the outer edges of the revolving blades act to shear the particles or granules, and thus reduce them to fine dust.

As the blades H rapidly revolve they throw the material against the inwardly-projecting rings of open-work obstructions D or D', and thus by impact aid the pulverizing operation. The material is thus pulverized by each successive set of revolving blades from the inlet to the outlet end of the mill. The holes *h* permit the finer particles of material to pass through the blades, and such escaping material is struck by the following blade. By means of the rings of obstructions and the holes in the blades the finer dust is separated or thrown out from the coarser particles, and thus diffused, so as to be readily taken up by the air-currents, while the heavier particles are left free to be more rapidly abraded and reduced to fine powder.

Air is admitted by the register *c* at the inlet end and is deflected by the central disks J J' into the dust-zone, so that the passing currents will quickly take up and carry forward the fine or impalpable powder. The air-currents are drawn through the dust-zone by means of the fan and pulverizing-blades, and the current of mixed air and dust is finally expelled through the discharge-spout $B^3$. The flow of the current of mixed air and dust may be checked and regulated by means of the damper K. The material may thus be held longer in the mill till pulverized, as required. The rate of feed of the material to the mill will be regulated by the adjustable feeding device M at the inlet end.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a pulverizing-mill, the cylindrical shell, having spiral or helically-curved ribs projecting inward therefrom, with their working faces inclined toward the inlet end of the mill, in combination with a rotary shaft, radial arms secured thereto and blades connected to said arms, with their outer edges adjacent to said ribs, and their working faces at an angle toward the working faces of the ribs which are inclined backward toward the inlet end of the mill, whereby the blades will exert a shearing action, and work against the ribs to convey the heavier and larger parti-

cles backward and repeatedly subject them to the pulverizing and shearing action, substantially as described.

2. In a pulverizing-mill the cylindrical shell having inwardly-projecting, helically-curved ribs and rings of open-work obstructions in combination with a shaft and rotary beater-blades in said shell, substantially as described.

3. In a pulverizing-mill, the cylindrical shell having inwardly-projecting rings of open-work obstructions, in combination with a shaft and perforated rotary beater-blades connecting with said shaft, substantially as described.

4. The pulverizing-cylinder having at one end, adjacent to the periphery, a curved elongated discharge-opening and delivery-spout, in combination with a curved elongated sliding damper, as K, having an arm *k*, and pivoted at *w*, to the end wall, a rod connecting with said arm, and passing out through the shell, means for adjusting the rod, inward or outward for moving the damper, and a rotary shaft and connected blades, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES M. DAY.

Witnesses:
H. M. STERLING,
E. B. CLARK.