No. 814,961. PATENTED MAR. 13, 1906.

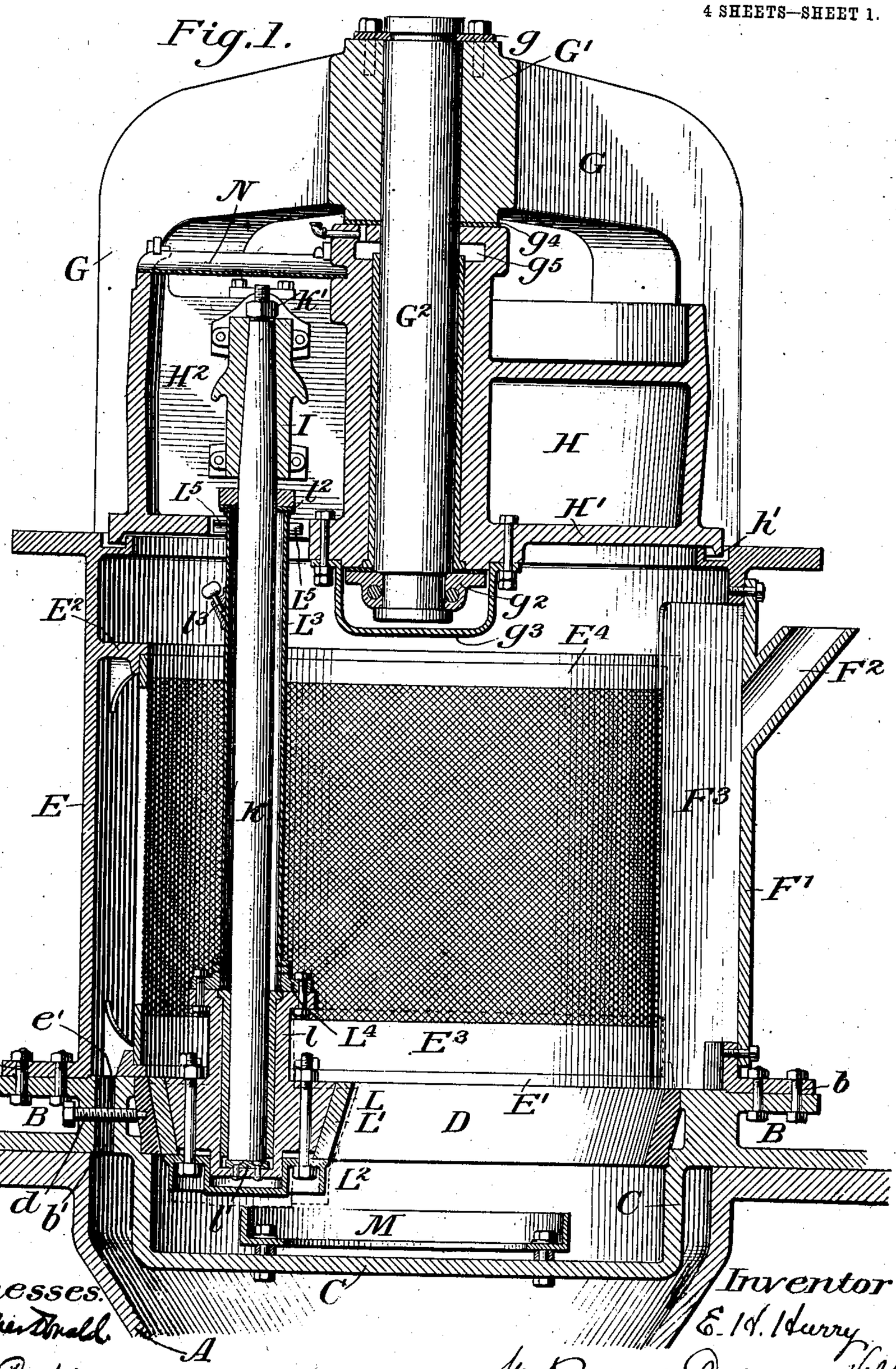
E. H. HURRY.

PULVERIZING MILL.

APPLICATION FILED DEC. 13, 1898.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

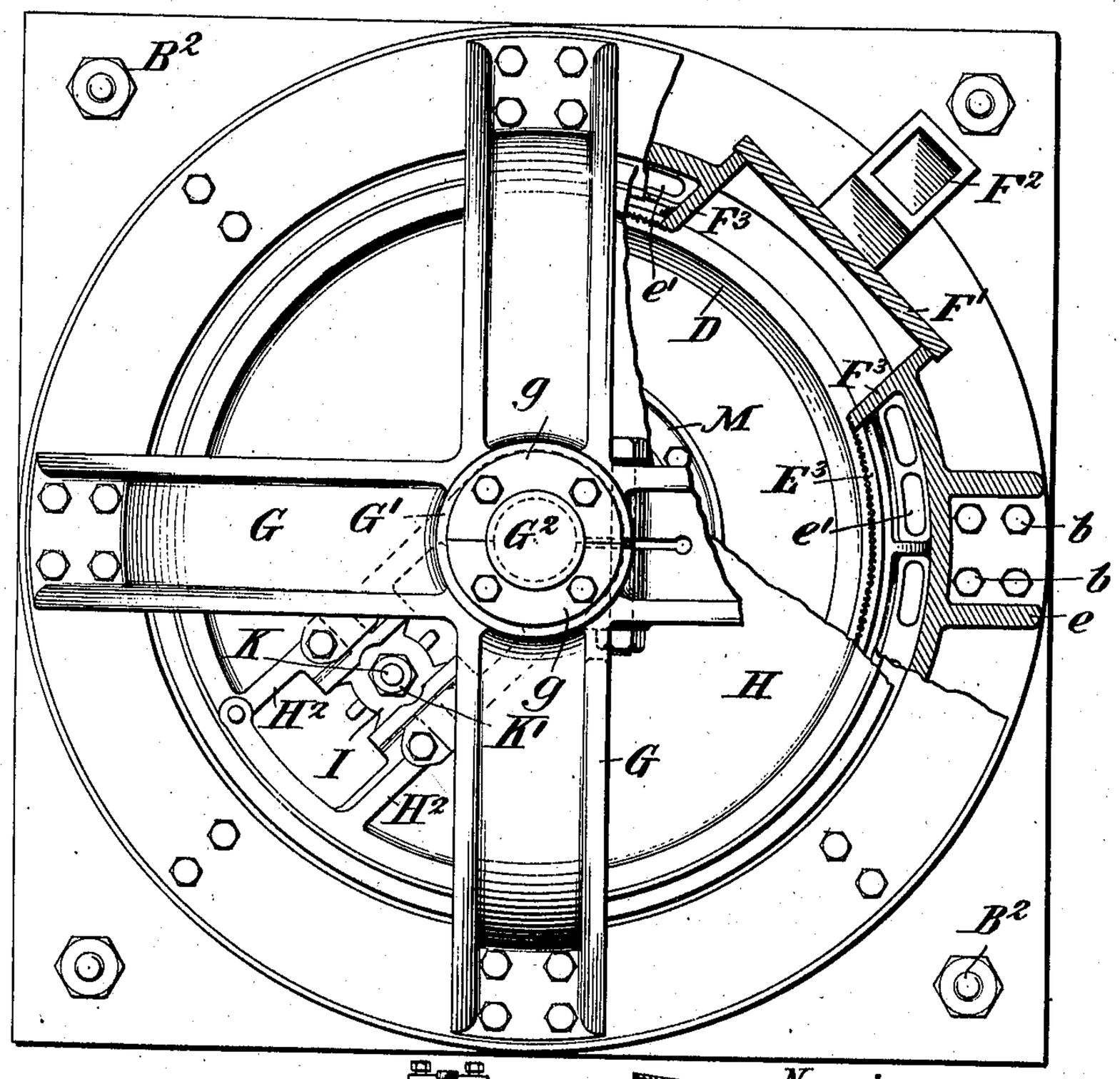



Fig. 5.

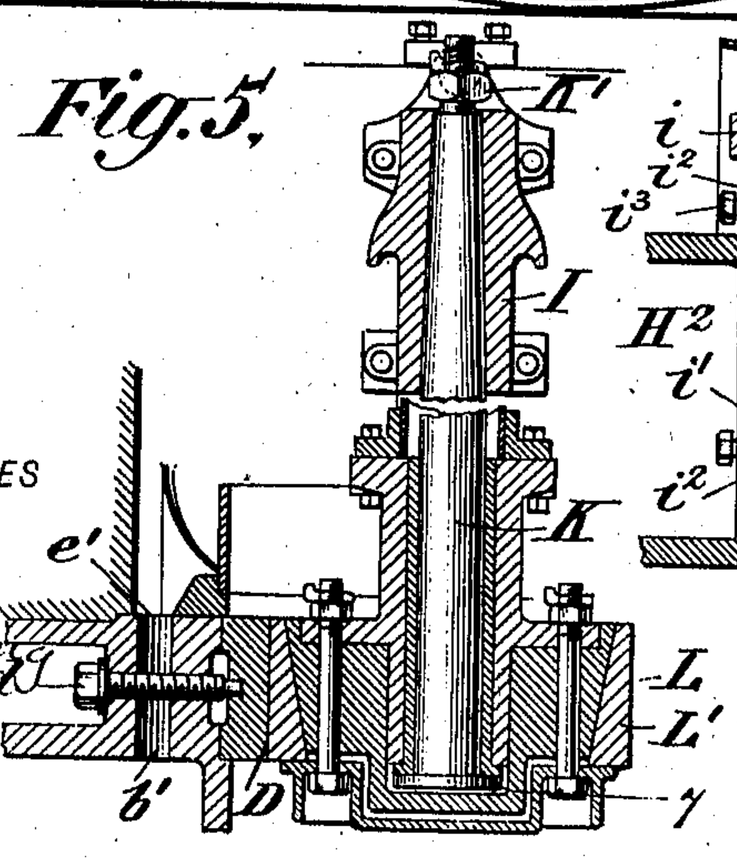
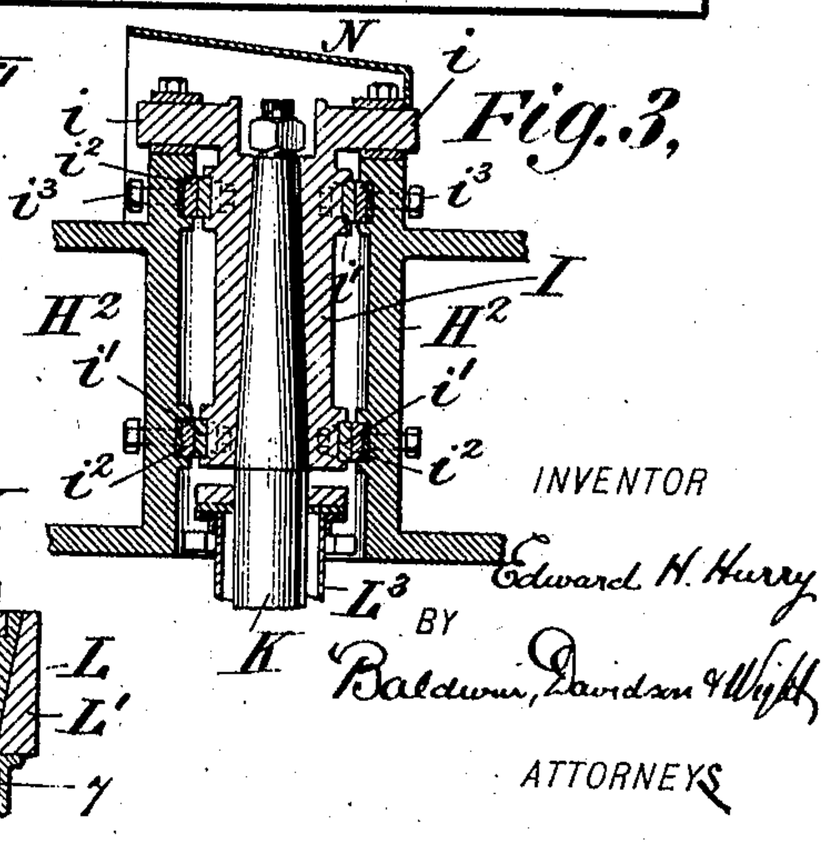



Fig. 3.

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4 SHEETS—SHEET 3.

*Fig. 4,*

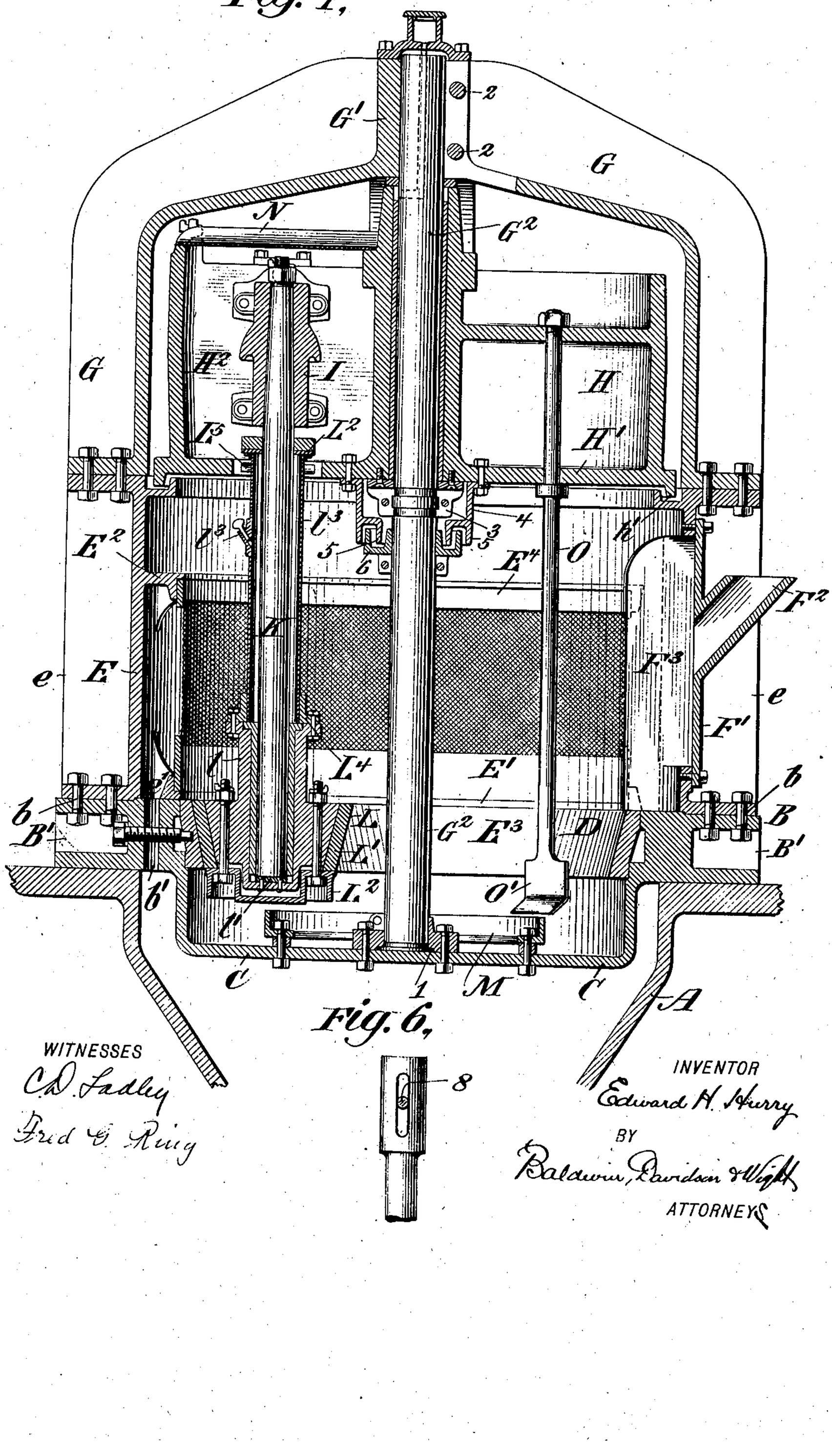


*Fig. 6,*




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4 SHEETS—SHEET 4.

*Fig. 7,*

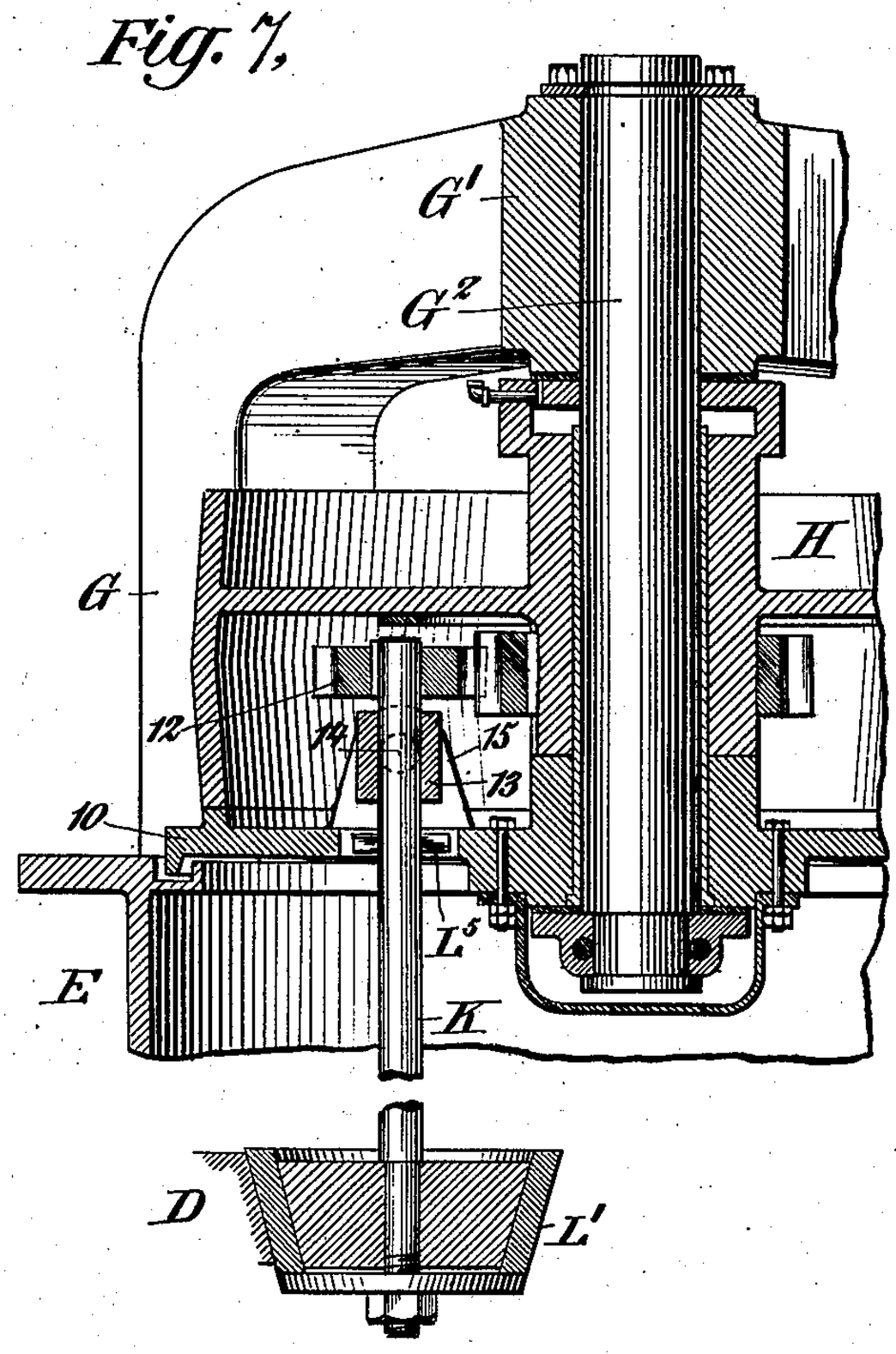
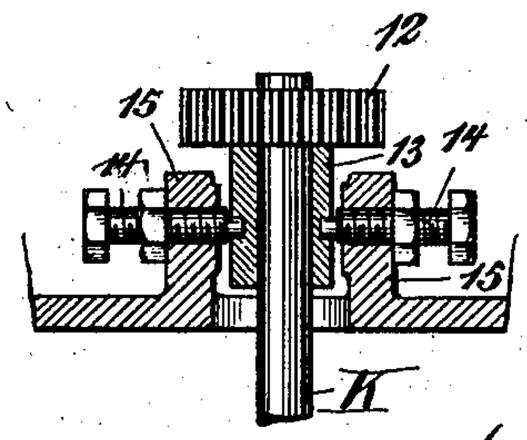



*Fig. 8,*

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# UNITED STATES PATENT OFFICE.

EDWARD H. HURRY, OF BETHLEHEM, PENNSYLVANIA.

## PULVERIZING-MILL.

No. 814,961. Specification of Letters Patent. Patented March 13, 1906.

Application filed December 13, 1898. Serial No. 699,132.

*To all whom it may concern:*

Be it known that I, EDWARD H. HURRY, a subject of the Queen of Great Britain, residing at Bethlehem, county of Northampton, State of Pennsylvania, have invented certain new and useful Improvements in Grinding or Pulverizing Mills, of which the following is a specification.

The invention relates to that class of mills in which one or more rolls capable of radial movement relative to the center of the machine revolve upon their axes and about the axis of and in contact with the inner surface of a grinding-ring. Its object is to increase the efficiency of such mills, improve and simplify their construction, reduce wear, make the working parts more accessible for repair or replacement, to provide for proper lubrication, and to prevent the access of dust or grit to the bearings. In mills of this general class the axes of the revolving rolls are sometimes at an angle to a vertical line. In some cases the power applied to the machine revolves the roll and shaft about the axis of the grinding-ring, and the roll is caused to revolve upon its own axis by frictional contact with the ring, while in other cases the applied power revolves the roll about its axis and the orbital travel of the roll, or that about the axis of the ring, is produced by frictional contact between the ring and roll. In some mills the rolls revolve upon their shafts, while in others their shafts revolve, and generally the rolls are so hung, supported, or carried that when in operation they are impelled against the ring by centrifugal force. My improvements, as will be obvious from the following description, are applicable to the various styles of this general class of grinding-mills.

The accompanying drawings show an embodiment of my invention which experience has demonstrated to be practical and efficient. Obviously, however, those skilled in the art may readily vary the construction without departing from the principles of my invention.

The following detailed description is specifically addressed to the construction illustrated and words of reference or description of parts therein are not to be taken as limiting the scope of the invention or confining the form in which it may be embodied.

In the drawings, Figure 1 is a vertical central section; Fig. 2, a plan view, partly broken away at one side; Fig. 3, a detail vertical section at right angles to the section of Fig. 1, showing the upper end of the roll-shaft and the pivoted head in which it is mounted; Fig. 4, a vertical section through a machine of modified construction; Fig. 5, a detail vertical section on the same plane as Fig. 1 through a roll and the parts carrying or supporting it, showing a modified construction; Fig. 6, a detail view of a modified way of mounting or suspending the roll-shaft; Fig. 7, a sectional view illustrating a construction in which the grinding-roll is positively revolved about its axis by the power applied to the machine; and Fig. 8 is a detail sectional view at right angles to the section of Fig. 7, showing the upper end of the roll-shaft and the parts connected therewith.

The chute or receptacle A at the bottom of the machine for the reception of the reduced material is mounted upon any suitable base. Over the receptacle and secured thereto in any suitable way is a heavy ring B, that supports or has made in one piece with it a pan C, which forms the chamber to hold the material to be reduced. The ring is formed with two external horizontal flanges extending from its upper and lower edges and which may be connected by strengthening webs or braces, which webs appear in Fig. 4 square in plan and may be secured to the base by bolts $B^2$. Around the inner circumference of the ring is arranged a grinding-ring D, seated upon an offset or shoulder in the ring B and held by one or more bolts *d* or otherwise. The interior face of the grinding-ring is an upwardly-flaring one—that is to say, the diameter of its opening at its lower edge is less than the diameter at the upper edge.

Upon and concentric with the ring B and secured thereto by bolts *b* is seated a cylindrical casing E, that may be of cast-iron and have outwardly-extending flanges at top and bottom connected by vertical webs *e*. An inwardly-projecting flange E′ is formed at the bottom of the casing, rests upon the ring B, and has therein apertures *e′*, that coincide with apertures *b′* in the ring opening into the chute or receptacle A. Near the upper end of the casing is another inwardly-projecting flange $E^2$. The two flanges E′ $E^2$ have on their inner faces shoulders that form seats for bands $E^3$ $E^4$, suitably secured therein and to which are attached the screen or wire-cloth of suitable mesh. At one side the casing is formed with an enlarged opening closed by a removable cover F′ and provided with a

hopper or feed-inlet $F^2$. The sides of this opening in the casing are formed with vertical inwardly-extending plates $F^3$, against or at which the ends of the bands $E^3$ $E^4$ and the netting terminate. Material to be operated upon delivered to the hopper $F^2$ will therefore pass inside the netting and into the pan C. Above the casing is an arched or bell-shaped spider-frame G, the ends of whose arms are flanged and bolted to the upper flange of the casing. The space within the spider-arms forms a chamber in which a belt-pulley H works. The spider is formed with a hub G′, in which a vertical pendent shaft $G^2$, Fig. 1, is mounted, being supported by a split ring or plate *g*, engaging an annular groove in the upper end of the shaft. The hub may be radially slotted, as shown in Fig. 2, and pinching-bolts employed to contract the hub to cause it to firmly clamp the shaft. The pulley runs on this shaft and is supported by a collar $g^2$, fitted to the lower end of the shaft. On the bottom of the pulley is bolted a closed cap $g^3$, covering the end of the shaft, and a packing-washer $g^4$ is interposed between the upper end of the pulley-hub and the hub of the spider. An annular oil-chamber $g^5$ is formed within the pulley-hub near its upper end and has one or more passages extending to the upper face of the hub. The washer $g^4$ and the entire bearing of the pulley may therefore be kept supplied with oil, while there is no opportunity for dust or grit to enter the bearing. The bottom H′ of the pulley may be solid except as hereinafter mentioned and at its lower edge has a downwardly-projecting flange *h*′, that runs in an annular gutter or trough formed in a flange at the upper edge of the casing E. The trough may be filled with oil or suitable liquid, and it and the flange *h*′ should be of suitable depth. In this way the escape of dust or grit between the edges of the casing and pulley is prevented.

The pulley H has two parallel webs $H^2$ $H^2$, extending from its hub to its rim, forming a chamber communicating with the interior of the casing through an opening in the under face or side of the pulley. A pendent block or head I has trunnions *i*, Fig. 3, turning in pillow-blocks or bearings in or on the upper edges of the webs $H^2$ and also on each side at one or more points below the trunnions (two being shown) sockets for the reception of cheek pieces or strips *i*′ of suitable metal, that work against corresponding cheek pieces or strips $i^2$, secured in sockets in the sides of the webs $H^2$ to reduce friction and torsional strain on the trunnions *i*. Set-screws $i^3$ are provided to adjust the strips $i^2$. The head or block I is bored out to receive the end of a shaft K, which is supported therein by a nut K′ on its end. The shaft extends down into the grinding-chamber and carries at its end the grinding-roll L, mounted to move longitudinally on the shaft. This roll has a bushed hub *l*, formed integrally with the body of the roll and closed at its lower end, where it is provided with a bearing washer or disk *l*′ to take the friction of the thrust against the end of the shaft, and also a separately-formed grinding rim L′, held in place on the body of the roll by a shoe or casting $L^2$, applied at the bottom of the roll-body and secured by bolts, as snown. A sleeve $L^3$, attached to a collar $L^4$, bolted to the open end of the roll-hub, surrounds the shaft and extends up into the chamber within the pulley in which the shaft is mounted, where its end is closed by a disk $l^2$, through which the shaft passes, suitable packing being employed, if necessary, to guard against the admission of dust or grit to the roll-bearing. This sleeve may be provided with an oil-cup $l^3$, so that the bearing may be flushed with oil. When the mill is not in operation, the roll will slip down on the shaft, but should not descend so far as to pass out of engagement or contact with the grinding-ring. I prefer, therefore, to place centrally on the bottom of the pan C an annular track or support of some kind M, against which the shoe or casting on the bottom of the roll bears. In the construction illustrated the roller-shaft is vertical when the machine is in operation and the periphery of the roll is tapered to correspond with and conform to the angle of flare of the grinding-ring. As is apparent, the suspended shaft is hung so that it and the roll can swing radially with reference to the axial line of the machine toward and from the grinding-ring. When power is applied and the pulley H rotated, the roll is of course rotated bodily around the axis of the grinding-ring and the centrifugal force developed tends to carry the roll away from such axis and against the grinding-ring. The friction of the roll against the ring due to this orbital movement induces the roll to revolve about its axis, and the forces exerted and reaction between the flaring face of the grinding-ring and tapered roll cause the roll to rise on its shaft into the position shown in Fig. 1. As stated, the material to be acted upon, introduced at $F^2$, descends into the pan, while the reduced material resulting from the grinding operation passes through the screen F into the chamber or space between the screen and casing and passes thence through the apertures *e*′ *b*′ into the receptacle A. The shoe on the bottom of the roll acts as a stirrer; but any other usual or ordinary device for stirring the contents of the pan may be employed. For instance, in Fig. 4 I have shown a shaft O depending from the pulley and carrying at its lower end a stirrer O′ of a character well known in this class of machines. As has been pointed out, the bearing of the roll upon its shaft and the bearings of the driving-pulley are completely protected

against the admission of dust or grit, and the only passage through which dust might pass (the feed-hopper $F^2$ being of course normally covered) is the opening in the bottom of the pulley communicating with the chamber therein, in which the pivoted head or block I, supporting the roll-shaft, is mounted. To guard against the entrance of dust into this chamber, a vane or inclined hood N is placed over it, Figs. 1 and 3, and closed against the walls of the chamber on all sides except that facing the direction of rotation. When the pulley is rotated, a draft of air is induced which passes down through the chamber in the pulley and into the interior of the casing and thence out into the receptacle A. To assist this action, I place upon the sleeve $L^3$ and within the opening in the under face of the pulley one or more inclined blades or vanes $L^5$. As the operation of the mill ceases the roll will descend by gravity until the shoe or casting on its bottom rests upon the annular track on the bottom of the pan, the shaft-head I being then swung inwardly, the shaft correspondingly deflected toward the axis of the machine, and the roll still in contact with the grinding-ring and resting against it by force of gravity. Then the weight of the roll and the parts rigidly connected therewith is carried by the bed-plate through the pan C. When the pulley is revolved, the roll rises, as already stated, into proper and efficient cooperative position with the grinding-ring, and the strain of its tendency to further rise is then exerted against the end of its shaft. This upward strain on the shaft substantially, approximately, or beneficially neutralizes the greater weight on the side of the pulley supporting the shaft, and thus reduces the total weight then carried by the pulley, and where but one roll is employed correspondingly eliminates the unequal lateral strain on the pulley-bearing that would otherwise exist because of the unsymmetrical disposition of the weight about its axis. The forces exerted to lift the roll may be varied by changing the flare of the grinding-ring and the corresponding taper of the roll, the general rule being that the greater the angle of flare of the ring the greater the tendency for the roll to rise. When the mill is in operation and the roll rises under the influence of the centrifugal force developed and the reaction between the grinding ring and roll and, incidentally, because of the pressure against the periphery of the roll of the material being ground, the roll will carry the weight of its shaft and in the construction Fig. 1 the weight of the driver. The weight of all of the revolving parts will be sustained by the step-bearing $l'$ in the roll, thus reducing friction and incidentally applying the weight so carried to reinorce the pressure of the roll against the track. The same is true in part of the construction shown in Figs. 7 and 8, where the roll carries the weight of the roll-shaft which may pass into contact with the horizontal web of the pulley. In the operation of the mill when the forces which tend to sustain the roll in its upper position are decreased—as, for instance, by the roll striking a hard lump of material and rebounding therefrom—there will be a tendency for the roll to descend; but in the further operation of the mill it would rise again to its normal coöperative relation to the grinding-ring. It is believed that the mill so operates and that there are advantages incident to such operation resulting in more perfect grinding or pulverizing of the material. In the construction of Fig. 1 the resistance of the shaft and driver to the upward thrust of the roll constitutes a means for limiting the upward movement of the roll, whereas the downward movement of the roll is arrested by the pan or by an appropriate stop, as M.

In mills of this type, but having a cylindrical roll and die, the centrifugal force of the roll-sleeve acting horizontally outward and at a point considerably above the die tends to tilt the roll and sleeve in such a manner that if unresisted the top of the sleeve would move outwardly, the roll itself rocking at the point of contact of its periphery with the die when the outward sleeve-thrust exceeds the holding-down thrust of the roll, both acting on given arms. This tendency is resisted by the roll-shaft, which is prevented from tilting in the direction described by reason of its trunnion attachment to the driving-head. The restraining influence of the roll-shaft is, however, exercised through the roll-journal, and in practice this is found to produce very rapid wear of that journal. My organization, however, permits this source of wear to be entirely removed. The tendency of the top of the sleeve to move outward is balanced without the force necessary to do so being transmitted through the roll-journal. When the mill is in operation, the reaction of the outwardly-flaring die on the downwardly-tapering roll acts on the latter normally to the line of contact of these two parts—that is to say, in a direction inclined upwardly from the horizontal. The vertical component of this reaction overcomes the combined weight of the roll and its sleeve; but as this weight acts downwardly along the axis of the roll, whereas the above vertical component acts upwardly at the periphery of the roll, where it is in contact with the die, a turning moment is impressed upon the roll and sleeve, which turning moment is in a direction opposite to the turning moment produced by the centrifugal force of the roll-sleeve acting above the top plane of the die-ring. By properly proportioning the several parts and the speed of operation of the machine the objectionable thrust of the roll-sleeve against its shaft may be entirely eliminated and the

resultant of the centrifugal force of the sleeve and the weight of sleeve and roll combined delivered directly to the roll-track, together with the direct outward thrust due to the centrifugal force of the taper portion of the roll-body. A further advantage of the construction is that a crushing pressure is produced between the roll and the die materially in excess of the centrifugal force of the roll. When the machine is in operation, the roll tends to move outwardly and upwardly along the flaring face of the die. This tendency is resisted by the trunnion-pin, which cannot move upward, the result being that the roll and its shaft act as a wedge pushed between the trunnion-pin and the die, with the effect stated.

In Fig. 4 the construction is the same as that already described, except the shaft $G^2$ extends through the grinding-chamber and has a bearing or seat 1 on the bottom of the pan C. The upper end of the shaft is clamped in the slotted hub of the spider-frame by pinching-bolts 2, and the pulley is supported by a split collar 3, applied to the shaft. In this construction the bearing of the pulley is protected from dust and grit by an oil or fluid seal. A flanged ring 4, surrounding the collar and shaft, is bolted to the under side of the pulley and has formed at its lower edge two downwardly-extending parallel annular flanges 3 5. A ring 6, formed with an annular trough or gutter, is secured to the shaft, and in the trough, which may be filled with oil, the inner flange 5 runs.

Some features of my invention may of course be used without the others. Thus in Fig. 5 I have illustrated an ordinary construction of roll and grinding-track wherein the grinding-faces of these parts are vertical. Here the roll is supported by an enlargement 7 on the end of the shaft. Otherwise the construction of the mill is or may be such as I have above described.

In Fig. 6 the roll-shaft is slotted at its upper end. A bolt 8, suitably mounted or secured in the pulley or driver, may pass through the slot. In such a construction the roll may be mounted on the shaft, as in Fig. 5, or otherwise, so as to have no longitudinal motion thereon, and the roll in rising lifts the shaft with it. The pin or bolt 8 may be so related to the slot that when the roll and shaft are in their lower position the end of the slot will not come against the bolt, and the weight of the shaft or roll may be carried by the track or support in the pan, as already described. Similarly when the roll is in its highest position when the machine is running at full speed the opposite end of the slot may not come against the bolt. Such bolt, therefore, need not bear the weight of the shaft and roll nor receive its upward thrust, but may serve merely as a guide.

But one roll has been illustrated. The use of a plurality of rolls is, however, common, and I may of course use more than one roll without other change in construction or otherwise affecting the operation of the mill.

Fig. 7 shows a construction wherein the roll is driven positively about its axis. My invention is also applicable to machines of this general type irrespective of the special details shown. In the form illustrated the driving-pulley H, revolving upon the shaft $G^2$, is closed at the bottom by a separately-formed disk 10, free to revolve upon the shaft independently of the pulley. A gear 11, keyed to the hub of the pulley within its rim, meshes with a pinion 12, keyed to the upper end of the roll-shaft which has its bearing, and may slide endwise in a sleeve 13, capable of rocking upon the horizontal bearings 14 14, carried in lugs 15, rising from the disk 10, closing the lower face of the pulley. Otherwise the construction may be the same as shown in Fig. 1. In Fig. 7 the vane or hood N is dispensed with; but the vanes $L^5$ are retained and are placed upon the shaft within the opening in the disk 10, through which it passes. When the machine is in operation, these vanes tend to draw air through the joint between the pulley and the disk and induce a current of air downwardly through the opening in the disk. In the drawings the roll and its shaft are indicated as in active position. The pulley as it rotates revolves the shaft, and the roll thereon being in contact with the grinding-ring an orbital motion about the ring is induced, which is assisted more or less by the frictional contact between the hub and rim of the pulley and the hub and flange of the disk 10. When the machine is idle, the roll may descend and rest upon a track or support in the pan C, as already described. The width and depth of the teeth of the gear 11 and pinion 12 are such as to permit this vertical and incidental angular movement of the shaft.

In the mill illustrated as embodying this invention the roll-shaft is mounted directly in the driver between its hub and periphery, to which the driving power is directly applied, and thus no power is transmitted through keyed connections, which are very liable to work loose when subjected to the vibration caused by the grinding operation. Experience has shown this to be an efficient and advantageous way of applying the driving power to the roll-shaft, as in these machines the revolving parts are of considerable weight and speed of rotation is high.

I claim as my invention—

1. A centrifugal grinding-mill, comprising the combination of a horizontally-arranged grinding-ring having an upwardly and outwardly flaring grinding-face, a downwardly-extending roll-shaft, a driver above the ring with which the roll-shaft is connected, and a roll with a downwardly-tapering periphery,

connected with the roll-shaft and traveling around the ring.

2. In a centrifugal grinding-mill, the combination of a pan for the reception of the material to be pulverized, a horizontally-arranged grinding-ring having an upwardly and outwardly flaring grinding-face, a downwardly-extending radially-movable roll-shaft, a driver above the ring with which the roll-shaft is connected, and a roll with a downwardly-tapering periphery, connected with the roll-shaft and traveling around the ring clear of the bottom of the pan.

3. In a centrifugal grinding-mill, the combination with an upwardly-flaring grinding-ring, of a downwardly-projecting, radially-movable roll-shaft, a driver above the ring with which the roll-shaft is connected, a roll having a downwardly-tapering periphery and mounted revolubly on the roll-shaft, and an upwardly-extending sleeve attached to the roll.

4. In a centrifugal grinding-mill, a horizontally-arranged grinding-ring having an upwardly and outwardly flaring face, and a rotating grinding-roll with a downwardly-tapering periphery traveling around the ring, whereby the reaction between the ring and roll and the centrifugal force developed, when the mill is in operation, impart to the roll a tendency to rise relatively to the ring, in combination with a driver located above the ring, a downwardly-extending shaft connected with the driver and free to swing radially and traveling bodily around the axis of the ring, and a connection between the roll and shaft which permits the roll to drop, when the mill is not in operation, out of normal operative relation to the ring and which limits the upward movement of the roll.

5. In a centrifugal grinding-mill, the combination of a horizontally-arranged grinding-ring having an upwardly and outwardly flaring face, a rotating grinding-roll with a downwardly-tapering periphery traveling around the ring and free to move, within limits, longitudinally of its axis and which descends, when the mill is at rest, out of normal operative relation to the ring, and, when the mill is in operation, is caused to rise by the reaction between the ring and roll and the centrifugal force developed, and a stop for limiting the downward movement of the roll.

6. In a centrifugal grinding-mill, a horizontally-arranged grinding-ring having an upwardly and outwardly flaring face, a rotating driver located above the ring, a downwardly-extending substantially vertical but radially-swinging roll-shaft operatively connected with the driver, and a roll having a downwardly-tapering periphery coöperating with the ring, whereby the reaction between the ring and roll and the centrifugal force developed when the mill is in operation impart to the roll a tendency to rise.

7. In a centrifugal grinding-mill, a horizontally-arranged grinding-ring having an upwardly and outwardly flaring face, a rotating driver located above the ring, a downwardly-extending substantially vertical but radially-swinging roll-shaft operatively connected with the driver, and a roll associated with the shaft, having a downwardly-tapering periphery and capable of free movement, within limits, longitudinally of its axis, whereby when the mill is not in operation the roll descends out of complete coöperative relation to the ring and when the mill is in operation rises into complete coöperative relation therewith by reason of the reaction between the ring and roll and the centrifugal force developed.

8. In a centrifugal grinding-mill having a stationary grinding-ring and a central vertical shaft, the combination of a rotative driver adapted to have the driving power applied directly to its periphery, having a central bore for the reception of the shaft, and a chamber located between its periphery and hub, a roll-shaft pivoted at its upper end in said chamber, and a grinding-roll on the lower end of the shaft.

9. In a grinding-mill, the combination of a driving-head adapted to have power applied to its periphery, and formed with a chamber having parallel opposite walls, a roll-shaft head movably supported in said chamber, and wearing strips or plates interposed between the head and the walls of the chamber.

In testimony whereof I have hereunto subscribed my name.

EDWARD H. HURRY.

Witnesses:
EDWARD C. DAVIDSON,
C. D. LADLEY.