No. 768,221. PATENTED AUG. 23, 1904.

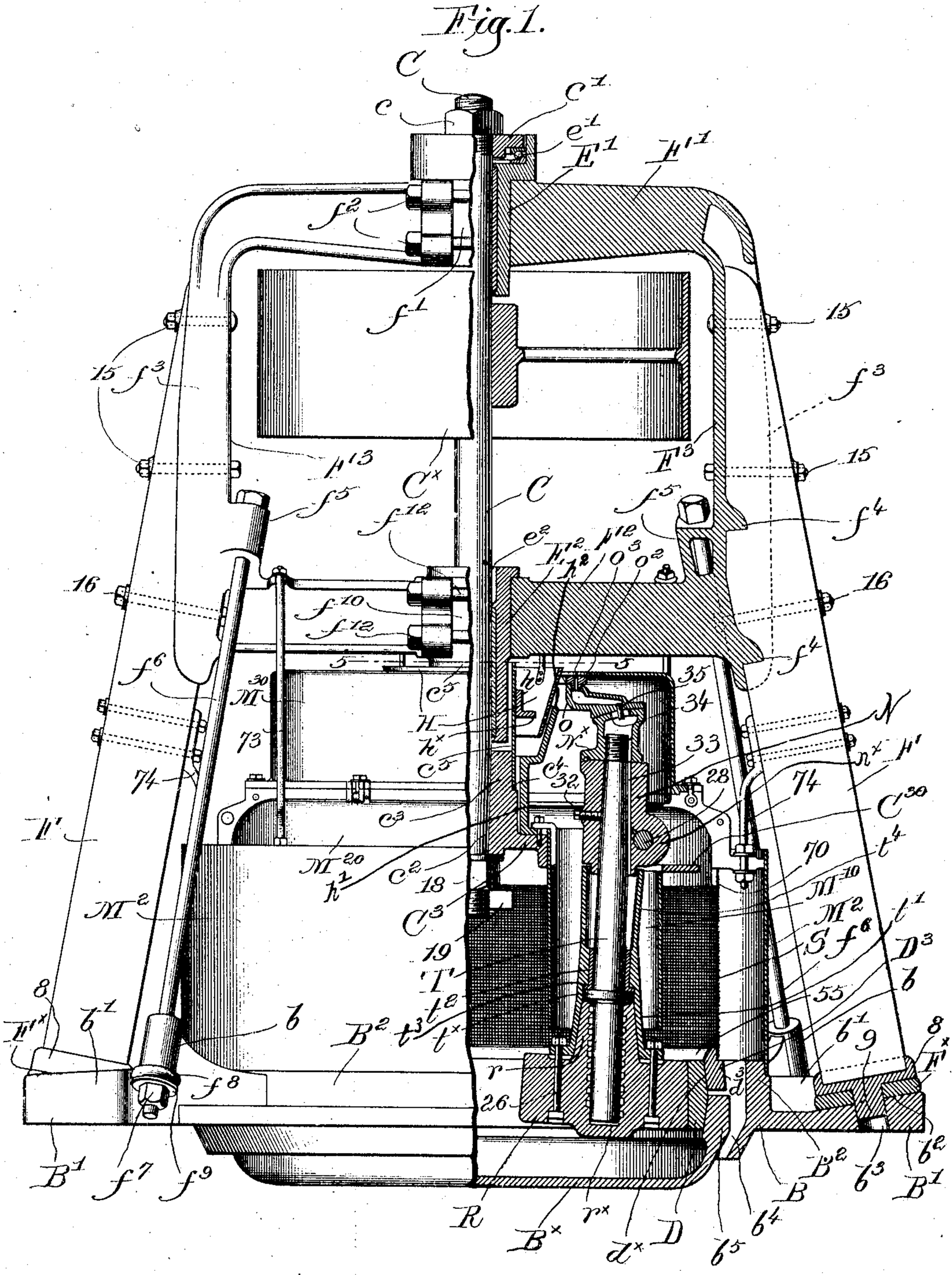
E. C. GRIFFIN.

CRUSHING OR PULVERIZING MILL.

APPLICATION FILED JULY 24, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.

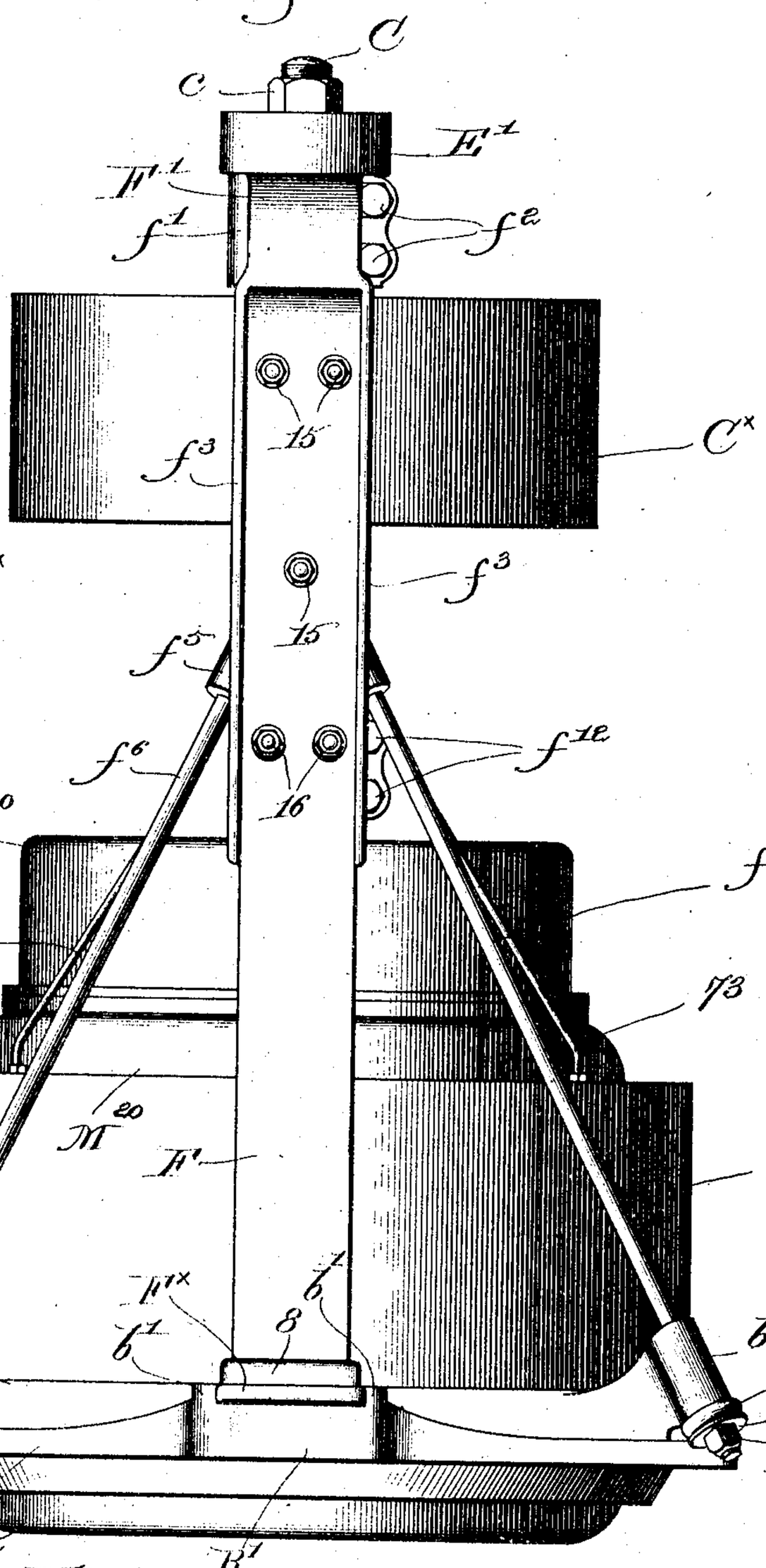


Fig. 7.

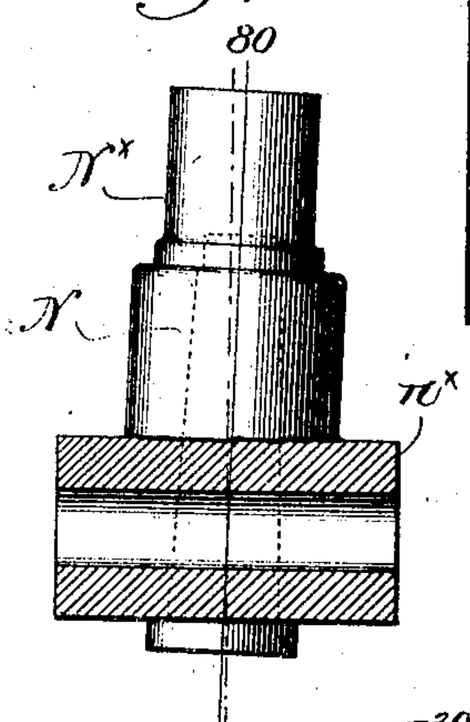


Fig. 4.

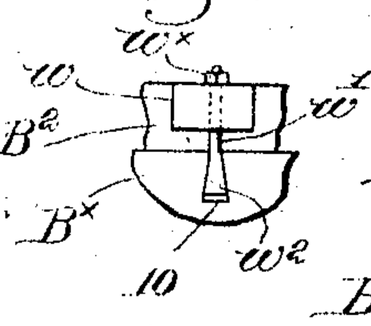
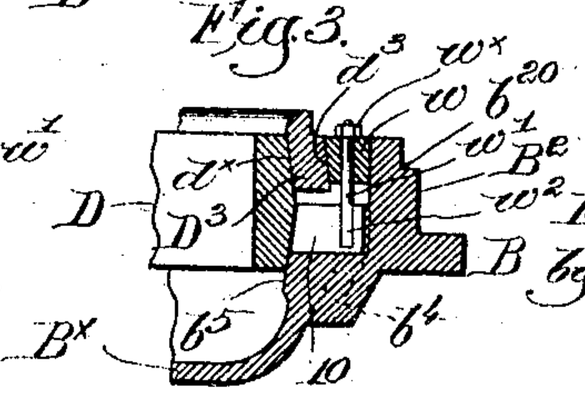


Fig. 3.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 5.

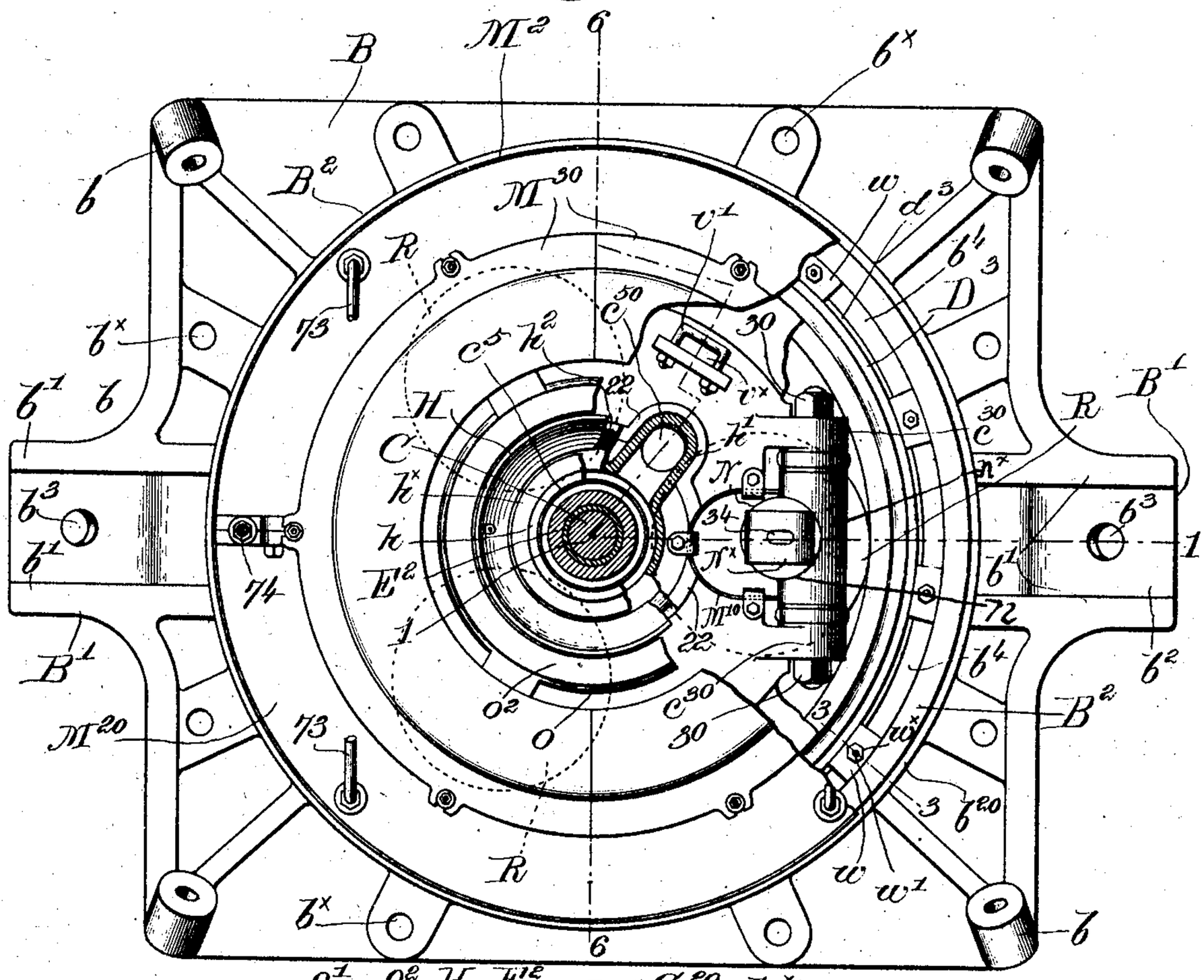
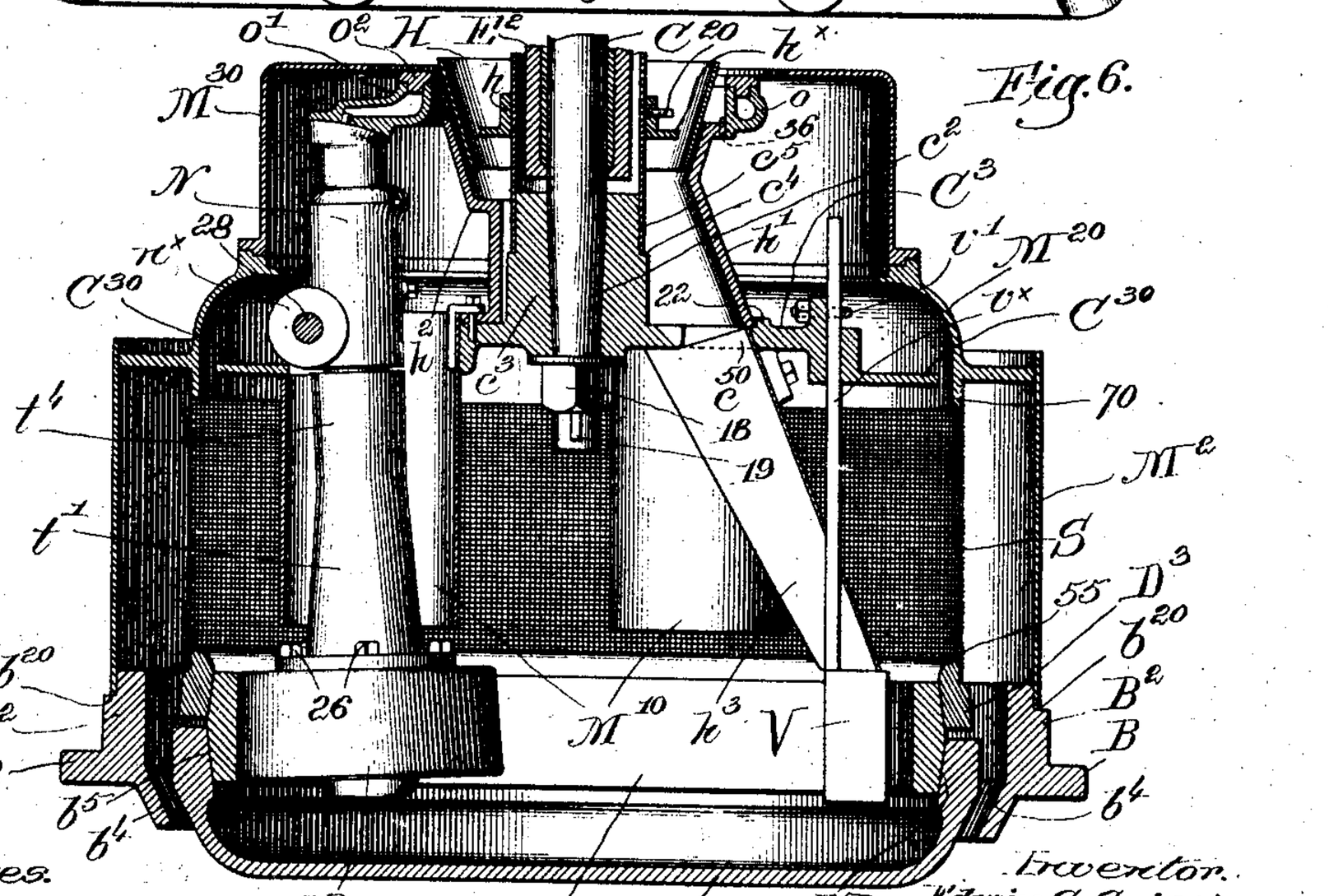


Fig. 6.



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No. 768,221. Patented August 23, 1904.

UNITED STATES PATENT OFFICE.

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CRUSHING OR PULVERIZING MILL.

SPECIFICATION forming part of Letters Patent No. 768,221, dated August 23, 1904.

Application filed July 24, 1903. Serial No. 166,805. (No model.)

To all whom it may concern:

Be it known that I, EDWIN C. GRIFFIN, a subject of the King of Great Britain, and a resident of Newton, county of Middlesex, State of Massachusetts, have invented an Improvement in Crushing or Pulverizing Mills, of which thefollowing description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to crushing or pulverizing mills of the type wherein the material to be crushed, ground, or pulverized is reduced to the desired fineness by the impact of one or more rolls traveling upon an annular die, the roll or rolls having axial rotation as well as bodily rotation about or with relation to the die.

My present invention is illustrated in connection with the so-called "centrifugal roller-mill," wherein the reduction of the material is effected by or through the centrifugal force developed by rotation of the roll or rolls within the annular ring or die.

One of the objects of my invention is the production of a strong, durable, and efficient frame or support on which the movable operating parts of the mill are sustained, the simplicity of construction of the frame reducing its cost, while its strength and efficiency are maintained.

Another object of my invention is the production of means for cushioning the working parts through or by means of the sustaining-frame, whereby the racking and shock inevitable in a mill of this general type may be reduced to a minimum.

Other objects of my invention relate to the mode of suspending the crushing roll or rolls from the revoluble driving-shaft, the proper lubrication of the roll-bearing, the shielding of the same from dust and grit as much as is possible, and certain structural details relating to different portions of the mill.

These various novel features will be fully described in the subjoined specification and particularly pointed out in the following claims.

Figure 1 is a half-front elevation and vertical section of a crushing or pulverizing mill embodying one form of my invention, the sectional half being taken on the line 1 1, Fig. 5. Fig. 2 is a right-hand side elevation of the mill shown in Fig. 1. Fig. 3 is a sectional detail on the line 3 3, Fig. 5, showing the manner of securing the annular die in place in the grinding-chamber. Fig. 4 is a detail in elevation showing more clearly the manner in which the wedges for holding the ring or annular die are anchored or locked in place. Fig. 5 is a top or plan view of the mechanism shown in Fig. 1, taken below the line 5 5, the frame being omitted and some of the other parts being broken out to show the mechanism beneath. Fig. 6 is a vertical sectional detail on the irregular line 6 1 6, Fig. 5, looking toward the left; and Fig. 7 is a detail to be described of the head which sustains the roll-spindle to show the slight lead given to the lower end of the spindle.

In order to effect better balancing and more even operation of the mill, it is preferable to use three crushing-rolls symmetrically disposed with relation to the central driving-shaft, and in Fig. 5 I have indicated three rolls; but it will be manifest that I may use more than three rolls or a less number without departing from the spirit and scope of my invention.

The bed B, which supports the frame and operative parts of the mill, is made as a strong heavy casting of great rigidity and of a suitable size, it being shown in Fig. 5 as rectangular in shape and provided at the corners with inclined tubular bosses b for a purpose to be described. On two opposite sides the bed-casting is provided with extensions B′, having upturned side walls b', the bottom portion of each extension between said walls being inclined, as at b^2, and a hole b^3, having inclined walls, is made in each incline, passing through the extension. The extensions form sockets in which are supported the feet of the standards composing a portion of the upright frame to be described erected upon the bed, and, as shown best in Fig. 1, a metallic shoe 8, recessed in its upper face to receive the foot of a standard, has a lug or projection 9 on its under face to enter the hole b^3, and thereby prevent lateral movement of the shoe, while

permitting slight up and down movement thereof. As shown in Fig. 5, the bed is provided with bolt-holes $b^{\times}$, through which tie-bolts are passed to secure the bed to a suitable timber or other support. An annular upturned wall or curb B^2 is formed on the upper face of the bed, forming the side wall of the grinding-chamber, the bottom of the latter being formed by a pan $B^{\times}$, herein shown as an integral part of the bed-casting and dropped below the same, so that the bed has a central recess surrounded by the wall B^2. The top of the wall is externally shouldered, as at b^{20}, to support the bottom of an imperforate cylindrical casing M^2, surrounding an upright circular screen S, erected around the top of the grinding-chamber and to be referred to hereinafter, the material when reduced by crushing or pulverizing to the proper size being thrown out through the screen. Such material falls down within the casing M^2 and is discharged through suitable laterally-elongated or segmental conduits b^4 in the bed and located outside of the pan, (see Figs. 1 and 6,) the conduits extending upward to the level of the pan-top. The annular top of the pan, which is below the top of the wall B^2, has its inner circumference slightly flared at b^5 to form a seat for the annular die or ring D, the lower portion of the periphery being downwardly tapered to correspond with the flare of the pan-top, as shown in Figs. 1, 3, and 6. The upper portion of the die-periphery is oppositely tapered or conical at $d^{\times}$, and a holding-ring D^3, having its inner face conforming to the surface $d^{\times}$ of the die, is set down thereupon, as shown very clearly in Figs. 1, 3, and 6, the outer face of the holding-ring being made conical at d^3 opposite the upper part of the circular inner face of the bed-wall B^2. A series of wedges w are inserted between the latter and the holding-ring and apertured to receive locking-bolts w', anchored at their lower ends in the bed and threaded at their upper ends to receive retaining-nuts $w^{\times}$, so that when the latter are set up the wedges are tightly drawn downward and secure the holding-ring and die in position with absolute rigidity. The wedges are located between the adjacent ends of successive discharge conduits or slots b^4, as shown in Fig. 5, and form a very convenient and highly efficient means for securing the die in position on its seat on the pan, while permitting ready removal of the die if necessary, the die and holding-ring being made sectional or in one piece, as desired, either or both. The pan-top is provided with a series of radial undercut grooves 10, Figs. 3 and 4, one for each wedge, and each bolt w' has its lower end shaped to form an anchoring-head w^2, said head corresponding to the cross-section of the undercut groove 10, as best shown in Fig. 4. The bolts are inserted into said grooves from their inner ends before the die is seated on the pan-top, and it will be manifest that said bolts will be securely held or anchored against any upward pull, and thus they in turn retain the wedges in position.

I have herein shown the frame as substantially A-shaped, erected in upright position on the bed, and comprising upwardly-inclined standards F, preferably heavy wooden timbers, located opposite each other and having their lower ends seated in the metallic shoes 8, and upper and intermediate metallic cross-girths F' F^2, rigidly secured to the standards. Referring to Fig. 1, the girths are shown as one casting connected by substantially parallel side portions F^3, having cheek-pieces f^3 to receive the upper ends of the standards, the latter being fitted thereto and secured by bolts 15. The girth F' serves as a cross-head to rigidly connect the standards and form a head for the frame, and it has a central tubular bearing-boss f', split longitudinally at one side and adapted to be closed by clamping-bolts f^2. A babbitted sleeve E' is clamped in the boss and is provided with a raceway for a series of balls e', Fig. 1, the coöperating raceway being carried by a collar e', screwed onto the threaded end of the vertical roll-driving shaft C, extended downward through the sleeve E', the shaft thus having a suspension ball-bearing and the sleeve providing a long lateral bearing therefor. The collar is held in place by a suitable check-nut e. As shown at the sectional side of Fig. 1, the cross-girth or intermediate F^2 is provided with shouldered projections f^4, which enter sockets or recesses in the standards F and assist in transmitting to the standards the weight of the parts supported by the frame, bolts 16 being passed through the standard into the girth. I have herein shown the frame as cushioned to decrease shock and jar upon the mill by interposing heavy blocks of rubber or other elastic material $F^{\times}$ between the shoes 8 and the inclined bottom b^2 of the bed extensions, the cushions yielding slightly to downward pressure. Manifestly the standards are compression members, and in order to maintain them in true upright position I have interposed lateral tension-braces between and connecting the standards and the bed. To this end the girth F^2 is provided adjacent each standard with two downwardly-divergent tubular bosses f^5, each being in alinement with one of the bosses b of the bed, and headed tension-rods f^6 are extended through the bosses f^5 and diverge in a downward direction to the corner-bosses b on the bed. A nut f^7 on the lower end of each brace f^6 retains it in place, and I have shown an elastic or cushion washer f^8, of rubber or other suitable material, surrounding each brace between the lower end of the boss b and the retaining-nut f^7, a flat metal washer f^9 being interposed between the nut and cushion-washer. By means of the

lateral braces the standards are firmly held in proper upright position, the cushion-washers f^8 yielding when a similar compression of the cushions $F^\times$ is effected.

The cross-girth F^2 has a central tubular and split boss f^{10}, tightened by clamping-bolts f^{12} and supporting an elongated bearing-sleeve E^2 for the shaft C, said sleeve being preferably babbitted and cored out at its upper end, Fig. 1, to form an oil-cup e^2. This lower bearing supports the shaft laterally and maintains it in proper vertical alinement, the shaft extending a considerable distance below the bearing, as shown in Fig. 1, for a purpose to be described. A pulley $C^\times$ is secured to the shaft between its upper and lower bearings, Figs. 1 and 2, and driven by a belt (not shown) from any suitable source of power. The lower end of the shaft is tapered at c^2 and threaded at its extremity, and the hub c^3 of a disk-like carrier C^3 is forced upon the tapered part and held in place by a nut 18, the latter after being set up being locked by a key 19, driven laterally into a hole in the shaft. At its upper end the hub c^3 is reduced in diameter to leave a shoulder c^4, which supports an upturned cylindrical guard c^5, loosely surrounding the lower end of the bearing-sleeve E^2 and preventing the material to be reduced from impinging upon the sleeve when introduced to the grinding-chamber through the inverted conical hopper H, supported on the cross-girth F^2 and concentric with the guard c^5. The latter is shown in Figs. 1 and 6 as passed through the hub h of a circular disk $h^\times$, held in vertically-adjusted position on the guard by a set-screw 20, Fig. 6, and by raising or lowering this disk the annular clearance or feed throat of the hopper will be widened or narrowed. By such adjustment I can prevent lumps of material above a given size from passing through the hopper-throat into the grinding-chamber.

A feed-duct h' is bolted to the top of the carrier C^3 and surrounds the hub c^3, the duct having a flared or bell mouth h^2, shown as concentric with and surrounding the lower end of the hopper H, an opening c^{50} in the carrier, Fig. 6, communicating with the duct h', so that the material from the hopper will be conveyed by the duct h' to this opening and thence into the grinding-chamber. An extension h^3 of the duct extends below the carrier from the opening c^{50} and terminates near and above the die, as shown in Fig. 6, it being manifest that the revolving motion of the carrier will act to throw the material outward and discharge it into the grinding-chamber in readiness to be acted upon by the crushing roll or rolls. The foot of the feed-duct h' rests upon the top of the carrier within a slightly-raised rib 22, which latter is mainly concentric with the carrier-hub, but outwardly extended to surround the opening c^{50}, as shown in Fig. 5.

The carrier C has suspended therefrom near its periphery one or more centrifugally-acting crushing or pulverizing rolls R, one of which is shown in vertical section in Fig. 1, the roll having a central socket $r^\times$, closed at its lower end and provided on its top with an elongated bearing-hub r, the socket and hub being preferably babbitted to receive the lower end of a roll-spindle T, the roll being rotatably mounted thereupon. The spindle near its lower end is provided with an annular enlargement or collar $t^\times$, adjacent to the under side of which the upper end of the hub r extends, and the roll is rotatably connected with and retained upon the spindle by a coupling t', flanged at its lower end to rest upon the top of the roll and secured thereto by bolts 26, the coupling being shown as conical to embrace with a snug fit the correspondingly-shaped exterior of the bearing-hub r. A metallic sleeve t^2 surrounds the spindle just above and rests upon the annular enlargement $t^\times$, the lower end of the sleeve having a lateral annular flange, as shown in Fig. 1, which is engaged by an internal shoulder t^3 in the coupling. In assembling the parts the sleeve t^2 is first slid down upon the spindle from its upper end. The coupling t' is then applied also from the upper end of the spindle, and the lower end of said spindle is inserted in the bearing hub and socket of the roll, after which the bolts 26 are set up to secure the coupling rigidly to the roll. At its upper end the coupling is slightly flared and elongated to form a tube-like guard t^4, the upper end of which is adjacent the lower end of the rocking or pivoted sleeve-like spindle-head N. One of the spindle-heads is shown in front elevation in Fig. 7 and in top or plan view in Fig. 5. The carrier is cut out to receive the spindle-head, which is provided with a hub $n^\times$, the opposite ends of which are laterally extended to fit between ears c^{30}, arranged in pairs and in parallelism on the carrier, one pair of ears for each spindle-head. A pivot or fulcrum-pin 28 is extended through the ears and through the hub $n^\times$ and rigidly held in place by suitable nuts 30, (see Fig. 5,) so that the roll-spindle T, which is rigidly secured to the spindle-head, can swing substantially radially to the carrier. Referring to Fig. 1, the slightly-tapered upper end of the spindle is inserted in a correspondingly-shaped hole in the spindle-head and is held in place by a hollow cap $N^\times$, screwed upon the threaded upper extremity of the spindle, a set-screw 32 serving to prevent any rotative movement of the spindle relative to the spindle head or cap. An oil-duct 33 is formed in the spindle-receiving bore of the head and communicates with the hollow cap to conduct oil from the latter down to the guard t^4 and thence to lubricate the bearing hub and socket of the roll, into which the lower end of the spindle is inserted. The top of each cap is curved, the curve being struck from the center of the pivot or

fulcrum pin 28, and has an elongated slot 34 therein (see Fig. 1) to receive a depending tubular nipple 35, secured to and projecting below a radial extension o' of the main oil-reservoir o. This reservoir is shown as an annular casting having the under surface of the radial extension o' curved to conform to the tops of the several caps $N^{\times}$. The caps form the main support for the oil-reservoir and any relative angular movement between the caps and the reservoir is prevented by the nipples 35. One or more lugs 36 (see Fig. 6) on the reservoir coöperate with the bell-mouth h^2 to connect the reservoir therewith and to turn in unison with it. The reservoir has an annular open top closed by a ring o^2, adapted to be dropped thereonto, and lubricating material can be introduced from the reservoir through a hole o^3 in the cover (see Fig. 1) without removing the latter.

It will be manifest that a very considerable quantity of lubricant can be contained within the reservoir and the hollow caps of the spindle-heads and also in the guards t^4 at the tops of the couplings.

As shown in Fig. 1, the oil-duct 33 is branched to communicate with the fulcrum-pin 28 to lubricate the latter within the hubs of the spindle-head.

The operation of the apparatus will be manifest from the foregoing description and the drawings, the rapid rotation of the driving-shaft C and carrier acting to throw the rolls outward by or through centrifugal force to coöperate with the die to crush or pulverize the material introduced into the grinding-chamber, the material when reduced to the proper size being thrown out through the screen S and discharged through the outlets b^4 in the bed, as hereinbefore referred to. There is of course a great deal of dirt, grit, and more or less finely divided material thrown about the grinding-chamber, and to protect the bearing of each roll I have devised a tubular shield M^{10}, surrounding the spindle and coupling between the carrier and the top of the roll, the upper end of the shield open above the carrier and its open lower end being located close to the top of the roll. With this arrangement I have found that a strong downdraft is introduced through the tubular shield, so that the entrance of dirt or grit to the roll-bearing is prevented. The tube-like shield is shown in Figs. 1, 5, and 6 as bolted to the carrier and depending therefrom nearly to the top of the roll, and in practice one of these shields will be employed with each roll and its suspending-spindle. The periphery of the carrier is dropped down and laterally extended, as at C^{30}, and the inner portion of each shield, behind the spindle, is elevated above the main portion of the carrier, while the outer part of the shield comes up close to the extension C^{30}, as clearly shown in Fig. 1.

The screen S is secured at its lower end to an upward extension or curb 55, forming a part of the holding-ring D^3, and the upper end of the screen is attached to a depending annular flange 70 on a sectional cap M^{20}, suspended by hangers 73 from the cross-girth F^2, and brackets 74 bolted to the inner sides of the two standards F. The cap is made in sections for convenience in assembling, and the two sections are bolted together, as shown in Fig. 5, and a cylindrical top M^{30} is bolted to the cap. The sectional cap and the cylindrical top M^{30} inclose the upper portions of the apparatus supported by the carrier C^3. The top M^{30} is also made sectional for convenience in assembling, and in Fig. 5 both the sectional cap and the top are broken out to show some of the working parts beneath.

By protecting or shielding the bearings for the crushing-rolls as herein provided the life of such bearings is greatly extended and the operation of the mill as a whole is enhanced.

The supporting-frame for the operating parts of the mill is not restricted to the precise construction and arrangement of grinding mechanism so long as the same is driven by a centrally-supported upright driving-shaft, and consequently my invention is not restricted to any particular form of grinding mechanism.

The carrier is provided with one or more plows V, which are arranged to scrape or stir up the material within the grinding-chamber, the plows being suspended from upright rods $v^{\times}$, extended through holes in the carrier and held in place thereon by staple-bolts v'.

It is desirable to give the lower end of the roll-spindle a slight lead or advance over its upper end in order to cause the roll to tend to rise as it travels upon the die, to thereby secure a somewhat better grinding action and also to prevent any possibility of the roll dragging or lagging behind, and to effect this the spindle is set into the spindle-head at a slight angle to the longitudinal axis of the head and not quite at right angles to the fulcrum-pin 28.

Referring to Fig. 7, it will be seen that the main body N of the spindle-head is slightly skewed with relation to the hubs $n^{\times}$, so that the longitudinal axis of the spindle (represented by the line 80 80 in said figure) is slightly inclined to the vertical, the axial line of the spindle therefore not being at right angles to the bore of the hubs.

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

1. In a crushing-mill, a metallic bed, a composite frame thereon comprising upright timber standards supported at their lower ends on the bed, a metallic cross-head interposed between the upper ends of the standards and provided with cheek-pieces to receive the latter, an intermediate cross-girth forming an integral part of the cross-head, bolts rigidly

connecting the standards and cross-head, and lateral tension-braces diverging from opposite sides of the standards and attached at their lower ends to the bed, the upper ends of said braces being attached to the cross-head.

2. In a crushing-mill, a bed, an upright A-shaped frame thereon comprising opposite inclined compression-standards, and rigidly-attached transverse connections, a pair of downwardly-divergent bosses integral with said connections adjacent each standard, and lateral, divergent pairs of tension-braces extended through said bosses from opposite sides of the standards to the bed and attached thereto at their lower ends, and means to regulate the tension on said braces.

3. In a crushing-mill, a bed, a frame thereon comprising upright, converging standards, an upper and an intermediate cross-girth rigidly connecting them, elastic cushions interposed between the feet of the standards and the bed, lateral, divergent tension-braces extended from opposite sides of the standards to the bed, and elastic connections between the latter and the braces.

4. In a crushing-mill, a bed having frame-sockets, an upright frame comprising upright, inclined standards and rigid cross connections between them, elastic cushions interposed between the feet of the standards and the sockets of the bed, lateral tension-braces oppositely diverging from said standards and extending to the bed, and cushion connections between the latter and said braces.

5. In a crushing-mill, a bed, a frame thereon including upright standards rigidly connected at their upper ends, shoes for the feet of the standards, having lugs to enter holes in the bed, a cushion interposed between the bed and each shoe, lateral tension-braces diverging from opposite sides of each standard and extended to the bed, and cushioned connections between the latter and the braces.

6. In a centrifugal roller-mill, a grinding-chamber containing an annular die, an overhead revoluble carrier, one or more crushing-rolls, a spindle operatively connected with each roll and fulcrumed on the carrier to swing in a plane radial thereto, and a tubular shield attached to the carrier and surrounding each roll-spindle, the lower end of a shield opening into the grinding-chamber and its upper end opening above the carrier.

7. In a centrifugal roller-mill, a grinding-chamber containing an annular die, a revoluble disk-like, overhead carrier, one or more crushing-rolls, a spindle for and on which each roll is rotatably mounted, a head secured to the upper end of each spindle and having lateral journals, bearings for the latter on the carrier, arranged to permit radial swinging of a roll-spindle, an upturned guard secured to each roll and surrounding its spindle up to the head thereof, and a tubular shield attached to and extending through the carrier and surrounding each guard, the upper end of the shield opening above the carrier and its lower end opening into the grinding-chamber.

8. In a centrifugal roller-mill, a grinding-chamber containing an annular die, an upright, central driving-shaft, a disk-like carrier secured thereto above the grinding-chamber and having a plurality of openings, an open-ended tubular shield depending through each opening, a plurality of crushing-rolls, a spindle for and upon which each roll is rotatably mounted, the roll having a long, attached bearing for its spindle, and a head rigidly connected with the upper end of each spindle and mounted on the carrier to swing in a plane radial thereto.

9. In a centrifugal roller-mill, a grinding-chamber containing an annular die, a plurality of crushing-rolls, a spindle for and upon which each roll is rotatably mounted, the roll having an elongated upturned bearing and guard surrounding the spindle, a sleeve-like head rigidly connected with the upper end of each spindle and fulcrumed on the carrier, an oil-duct in the head, a cap closing the duct, an oil-reservoir in continuous communication with the several heads, and a tubular, open-ended shield surrounding each spindle-bearing and guard and at its upper end opening above the carrier.

10. In a crushing-mill, a revoluble carrier, a spindle-head fulcrumed thereon to swing in a plane radial to the carrier, a depending spindle secured to the head and having an annular flange thereon near its lower end, a crushing-roll having a socket to rotatably receive the spindle below said flange, and a coupling to connect the spindle and roll and permit rotation of the latter, the flange retaining the coupling on the spindle.

11. In a crushing-mill, a revoluble carrier, a depending roll-spindle fulcrumed thereon to swing in a radial plane, a crushing-roll having a central socket and an elongated hub to rotatably receive the lower end of the spindle, an annular flange on the latter to take up end thrust of the roll-hub, and a tubular coupling rigidly secured to the roll and surrounding its hub and the shaft above it, said coupling having an internal shoulder above and to coöperate with the flange to retain the coupling and roll in position on the spindle.

12. In a crushing-mill, a revoluble carrier, a non-rotative, radially-swinging roll-spindle suspended therefrom, a crushing-roll having a central socket closed at its lower end, to loosely receive the lower end of the spindle, and a coupling surrounding the shaft adjacent the top of the roll and rotatably connecting the latter with the spindle.

13. In a crushing-mill, a revoluble carrier, a non-rotative, radially-swinging roll-spindle suspended therefrom, a crushing-roll having a central socket and an elongated, upturned bearing-hub, to loosely receive the lower end

of the spindle, and a tubular coupling surrounding the shaft and bearing-hub, the coupling being rotatably connected with the spindle and rigidly attached to the roll.

14. In a crushing-mill, a revoluble carrier, a non-rotative, radially-swinging roll-spindle suspended therefrom, a centrally-socketed crushing-roll having an upturned, elongated bearing-hub concentric with the socket, to receive with the latter the lower portion of the spindle and permit rotation of the roll thereupon, a coupling to connect the roll and spindle, and means to lubricate the spindle within the hub and socket.

15. In a crushing-mill, a revoluble carrier, a non-rotative, radially-swinging roll-spindle suspended therefrom, a centrally-socketed crushing-roll having an upturned, elongated bearing-hub concentric with the socket, to receive with the latter the lower portion of the spindle, and permit rotation of the roll thereupon, a coupling to connect the roll and spindle, means to lubricate the spindle within the hub and socket, and a tubular shield surrounding the coupling and having its open upper end above the carrier, its open lower end terminating above the top of the roll.

16. In a crushing-mill, a revoluble carrier, a radially-swinging spindle fulcrumed on and suspended from the carrier, a rotatable crushing-roll having an elongated bearing to receive the lower end of the spindle, a coupling rigidly secured to the roll and rotatably connected with the spindle, said coupling having a tubular, upturned guard surrounding the shaft, and means to introduce lubricant within the guard.

17. In a crushing-mill, a revoluble carrier, an upturned spindle-head fulcrumed thereon and having a chambered cap, a communicating oil-duct in the head, a depending spindle rigidly secured in the head and adapted to swing therewith radially to the carrier, a crushing-roll rotatably mounted on the lower end of the spindle, a guard surrounding the latter between the roll and the spindle-head, and an oil-reservoir in constant communication with the chambered cap of the latter.

18. In a crushing-mill, an inclosed grinding-chamber containing an annular die, a plurality of centrifugally-acting crushing-rolls cooperating therewith, a revoluble disk-like carrier in the top of the chamber, spindles suspended from the carrier and on which the rolls are mounted, and a tubular, open-ended shield surrounding each spindle and extending from above the roll to the carrier and opening above the same.

19. In a crushing-mill, a revoluble carrier, a plurality of spindle-heads fulcrumed thereon and each provided with a depending, radially-movable spindle, a hollow cap on each head, crushing-rolls each provided with a bearing to receive the lower end of a spindle, means connect the spindles and rolls while permitting rotation of the latter, an annular oil-reservoir in sliding contact with the several hollow caps and in constant communication therewith, and means to convey lubricant from each cap to the bearing of its corresponding crushing-roll.

20. In a crushing-mill, a revoluble carrier, a spindle-head mounted thereon to swing radially thereto, a depending spindle secured to the head and having an annular enlargement near its lower end, a crushing-roll having a bearing to receive the spindle below said enlargement, and a coupling rigidly secured to the roll and in rotative retaining engagement with the spindle above said enlargement.

21. In a crushing-mill, a vertical roll-driving shaft, a concentric inverted conical feed hopper or chute, and a disk within it, mounted on and concentric with said shaft and vertically adjustable thereon, the annular feed-opening between the edge of the disk and the hopper-wall being varied in width by vertical adjustment of the disk.

22. In a crushing-mill, a grinding-chamber, a vertical roll-driving shaft therein, an inverted conical feed-hopper, concentric with the shaft and opening into said chamber, and adjustable means rotatable with the shaft to vary the area of the annular throat of the hopper.

23. In a crushing-mill, a vertical roll-driving shaft, a concentric inverted conical feed hopper or chute, having an annular feed-throat surrounding said shaft, and means to vary the area of said throat.

24. In a crushing-mill, a grinding-chamber, a vertical roll-driving shaft therein, a feed-duct carried by the shaft and opening at its lower end into the grinding-chamber near its side wall, said duct having a bell-mouth encircling the shaft, a fixedly-mounted, inverted conical hopper surrounding the shaft and extended into the bell-mouth, to discharge material thereinto, and means to vary the area of the annular feed-throat of the hopper.

25. In a crushing-mill, a vertical roll-driving shaft, a concentric inverted conical feed hopper or chute, and a disk within the hopper and mounted on the shaft, to leave an annular feed-throat between the edge of the disk and the surrounding wall of the hopper, vertical movement of one relatively to the other varying the area of the feed-throat.

26. In a crushing-mill, an annular die, a revoluble carrier, a roll-spindle suspended therefrom, and a centrifugally-acting crushing-roll mounted on the lower end of the spindle, the spindle being mounted on the carrier with its lower end permanently set ahead in the direction of rotation of the carrier, whereby in operation the roll has a tendency to rise when pressing against the die.

27. In a crushing-mill, an annular die, an upright revoluble driving-shaft, a carrier se-

cured thereto, a roll-spindle suspended from and pivotally connected with the carrier to swing outwardly by centrifugal force, and a crushing-roll rotatably mounted on the lower end of the spindle, the longitudinal axis of the latter being slightly and permanently inclined in a non-radial plane to impart to the roll a rising tendency when pressing against and traveling over the die.

28. In a crushing-mill, a bed having an upturned annular wall, an annular die within it and having a conical periphery, a holding-ring internally conforming thereto and surrounding the die in engagement therewith, downwardly-acting wedges interposed between said ring and the bed-wall, and means to retain the wedges in position.

29. In a crushing-mill, a bed provided with a pan and having a surrounding annular wall, constituting a grinding-chamber, an annular die within said chamber, vertically supported on the pan and having a conical periphery, a holding-ring internally conforming to and in engagement with the conical surface of the die, and adjustable wedges interposed between the annular wall and the holding-ring, to retain the latter and the die in position.

30. In a crushing-mill, a bed having an annular, upturned wall, a pan concentric with and below it, an annular die vertically supported on the pan and having a conical periphery, a holding-ring internally conforming to and in engagement with the conical surface of the die, wedges interposed between the holding-ring and the bed-wall, and adjustable means to retain the wedges in position.

31. In a crushing-mill, a grinding-chamber having an annular side wall, an annular die therein having a conical periphery, a holding-ring surrounding and internally conforming to the conical surface of the die, and a series of removable, downholding-wedges interposed between the exterior of said ring and the side wall of the grinding-chamber, the holding-ring having an upturned screen-supporting flange.

32. In a crushing-mill, a grinding-chamber having an annular side wall, an annular die therein having a conical periphery, a holding-ring surrounding and internally conforming to the conical surface of the die, a series of wedges interposed between the exterior of said ring and the side wall of the chamber, upturned bolts detachably anchored in the chamber at the foot of its side wall and extended upward through the wedges, and retaining-nuts on the projecting ends of the bolts, to hold the wedges securely in position.

33. In a crushing-mill, a bed having an upturned annular wall, an annular die within it and having a conical periphery, a holding-ring internally conforming thereto, and having also a conical periphery, and surrounding the die in engagement therewith, downwardly-acting wedges interposed between said ring and the bed-wall, and means to retain the wedges in position.

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

E. C. GRIFFIN.

Witnesses:
JOHN C. EDWARDS,
EMILY C. HODGES.