906,829.

T. L. & T. J. STURTEVANT.

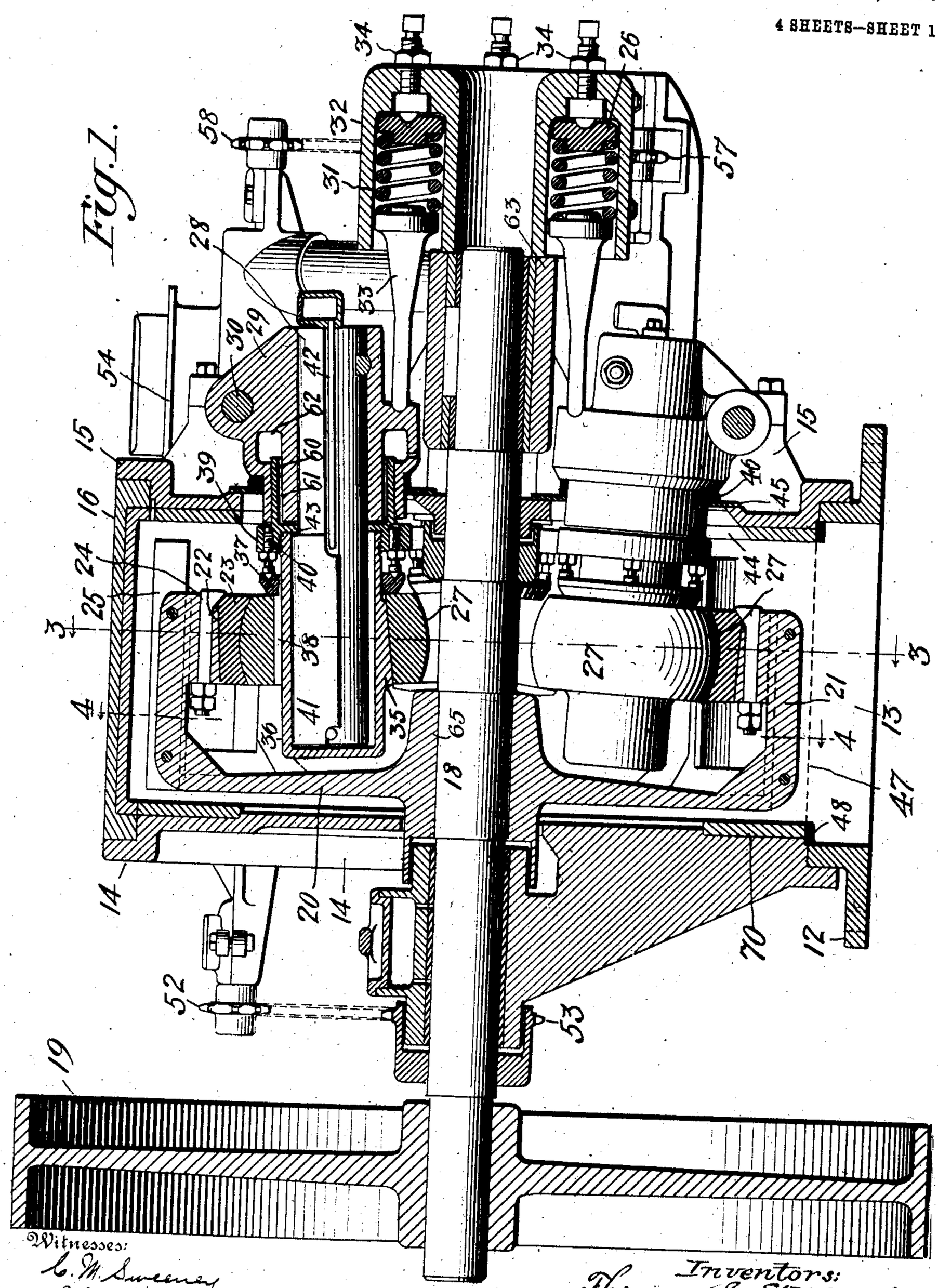
CRUSHING MILL.

APPLICATION FILED MAR. 28, 1907.

Patented Dec. 15, 1908.

4 SHEETS—SHEET 1.

Fig. 1.

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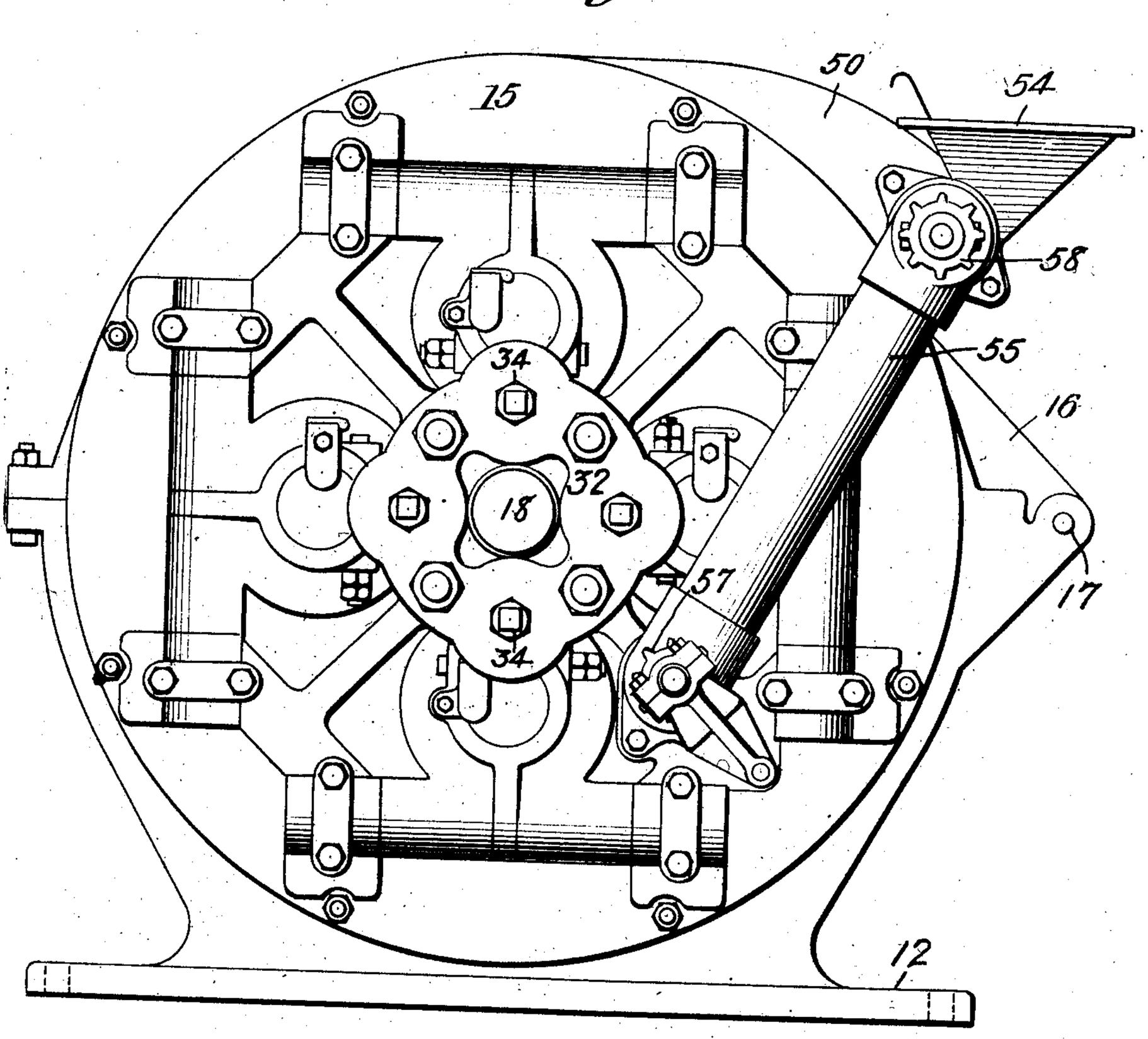
4 SHEETS—SHEET 2.

*Fig. 2.*

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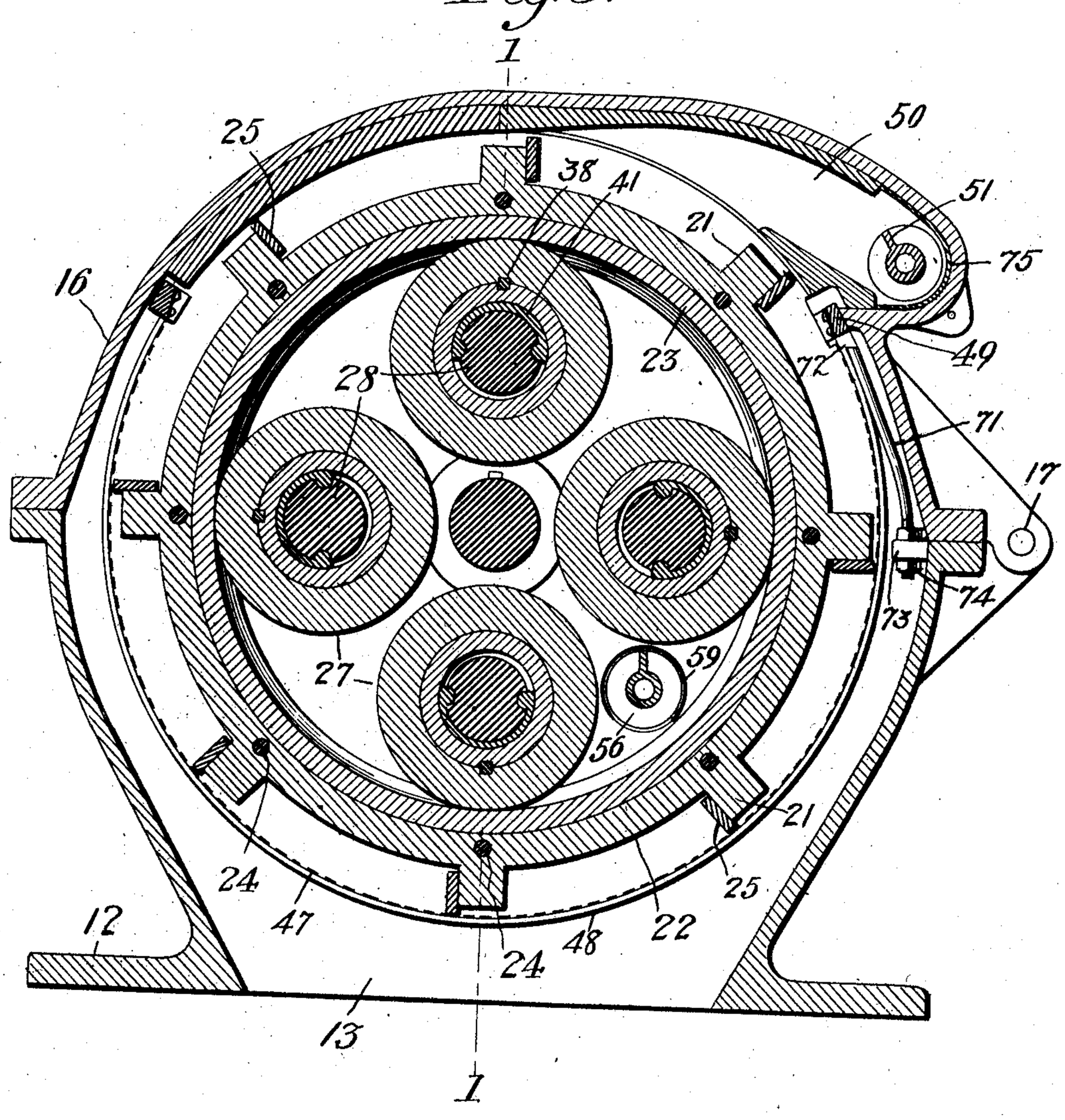
4 SHEETS—SHEET 3.

*Fig. 3.*

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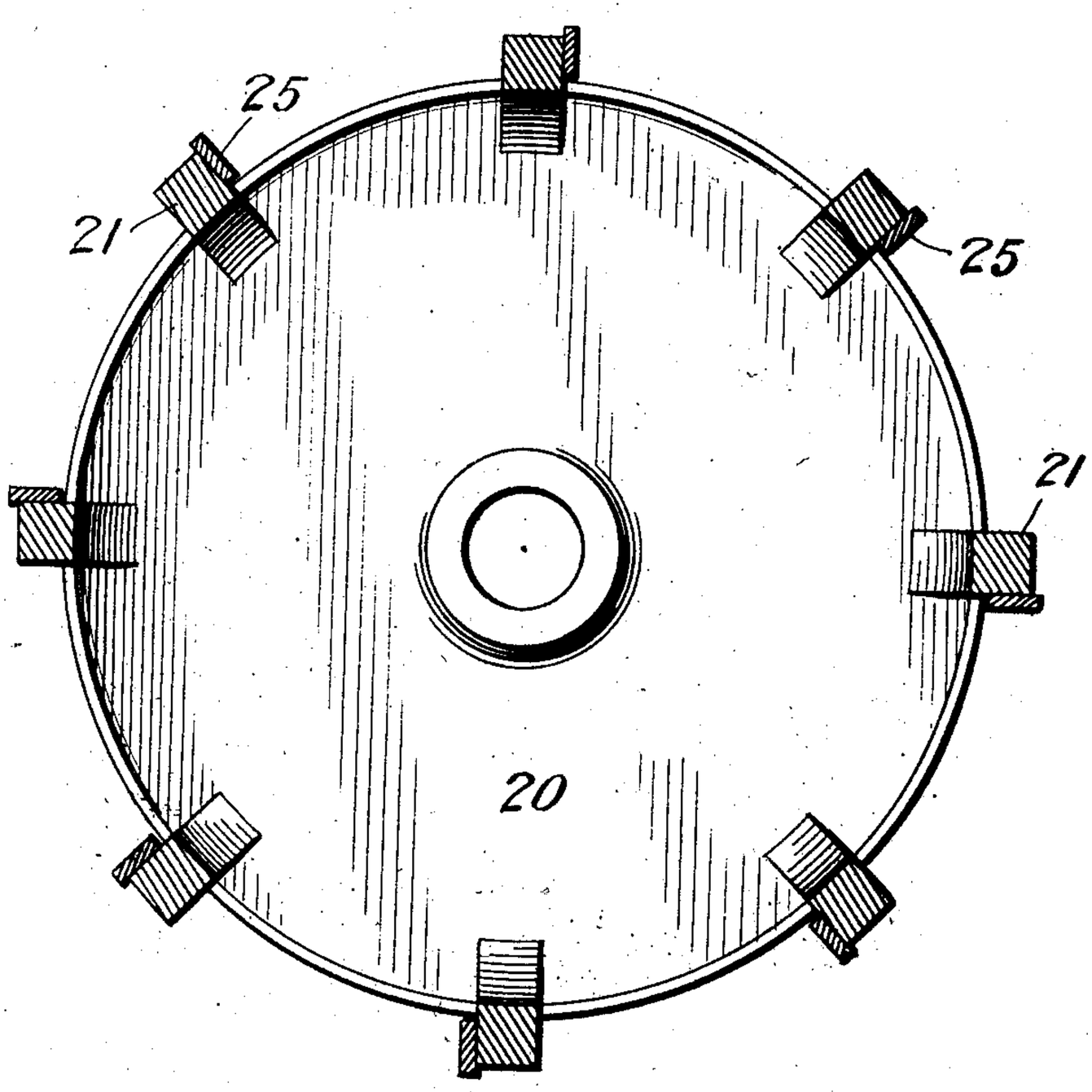
4 SHEETS—SHEET 4.

*Fig. 4*

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# UNITED STATES PATENT OFFICE.

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## CRUSHING-MILL.

No. 906,829. Specification of Letters Patent. Patented Dec. 15, 1908.

Application filed March 28, 1907. Serial No. 365,054.

*To all whom it may concern:*

Be it known that we, THOMAS LEGGETT STURTEVANT and THOMAS JOSEPH STURTEVANT, citizens of the United States, residing, respectively, at Quincy and Wellesley, in the county of Norfolk and State of Massachusetts, have invented or discovered certain new and useful Improvements in Crushing-Mills, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to that class of mills used for the reduction of ore, cement and similar materials and in which the material to be pulverized is held by centrifugal force on the inner circumference of an anvil ring, and in this position is crushed or reduced by the pressure of a roll or series of rolls acting outwardly in a radial direction against the inner surfaces of the ring, and which rolls are driven by friction from the rotation of the said ring.

One object of the invention is to provide an automatically regulated feeding device for supplying the material to be reduced to a mill of the character above referred to, which shall operate to maintain a substantially constant amount of material in the proper position to be crushed, and which will prevent clogging of the mill by the overfeeding of material thereto.

Further objects of the invention are to increase the efficiency, convenience and durability of the mills of the character above referred to, and to make the same more positive in action and more reliable and even in output.

To these ends the improved machine preferably comprises means for separating the properly crushed material from that which has been only partially reduced, together with a feeding device adapted to receive from the mill such material as has been imperfectly reduced and return this material into a proper position for further reduction, adding thereto sufficient new material to maintain a constant supply of material between the crushing elements of the mill. The amount of new material thus supplied to the mill is automatically regulated by and dependent upon the amount of partially reduced material which is returned to the mill in the manner above referred to.

The improved machine also comprises an anvil ring having means for positively and rigidly connecting the same to a driving shaft, thereby causing the same to rotate about a fixed axis and making its action more positive and reliable, such means being constructed to permit the discharge of reduced material at both sides of the anvil ring; said machine preferably having a plurality of yieldingly and independently mounted crushing rolls within said anvil ring and deriving their motion from frictional contact.

A preferred form of the invention is illustrated in the accompanying drawings, in which

Figure 1 is a longitudinal sectional view taken on line 1—1, Fig. 3, with the lower crushing roll in elevation. Fig. 2 is an end view of the machine as viewed from the right of Fig. 1. Fig. 3 is a transverse sectional view on the line 3—3, Fig. 1. Fig. 4 is a section of the driving wheel or head on line 4—4, Fig. 1.

As shown in the drawings the working parts of the machine are inclosed in a casing comprising a base or bed-piece 12, provided with a suitable discharge opening 13, two end heads 14, 15, removably attached to said base, and a hinged top or cover 16 between said heads and preferably pivoted to the base 12 at 17, said top or cover being adapted to be easily swung upwardly in order to give access to the interior of the mill.

Mounted in suitable bearings in the heads 14, 15 is the driving shaft 18 carrying a driving pulley 19. Attached to said driving shaft within the casing of the mill, to rotate therewith, is a hollow driving wheel or head 20 comprising a hub and disk-like part from which extend horizontal arms 21 carrying an annulus 22 to which is secured the anvil ring 23. It will thus be seen that the anvil ring is positively driven from the driving shaft of the mill and rotates about a fixed axis. Said anvil ring is preferably constructed with a slightly tapered or frusto-conical outer surface fitting a corresponding face in the annulus 22, and is preferably secured in working position in said annulus

by draw-bolts 24, the inclined contiguous faces of the said annulus and anvil ring providing for a wedge-like action in firmly securing the anvil ring in place. The arms 21, forming part of the driving wheel or head, and connecting the annulus 22 with the disk-portion of said wheel, provide means for mounting in proper working position scrapers 25 which will be hereinafter referred to. The annulus 22, carrying the anvil ring 23, being connected with the disk portion of the driving wheel 20 only by the arms 21, proper spaces or openings are afforded between the annulus and the disk portion of said wheel for the proper discharge of the crushed material between said annulus and the disk portion of said wheel, so that the crushed material may be freely discharged from the inner as well as from the outer or entirely open side of the anvil ring.

The crushing rolls 27 are supported by bearing-pins 28 carried by bearing-carriers 29 pivoted at 30 to the head 15 at the outer side thereof. The bearing-carriers 29 are swung on their pivots, to hold the crushing rolls 27 in contact with the interior surface of the anvil ring 23, by means of springs 31, all of which are preferably mounted in a single spring holder or case 32 which is bolted or otherwise suitably secured to the head 15 or to the shaft-bearing carried thereby. The pressure of the springs 31 is communicated to the bearing-carriers 29 through the struts or push-bars 33. Means are preferably provided for adjusting the tension of the springs 31, such means, as herein shown, comprising adjusting screws 34 and disks 26 against which latter said springs bear.

It will be observed that the supports for the crushing rolls 27, and which supports comprise the bearing pins 28 and the bell-crank bearing-carriers 29, are pivoted outside of the chamber of the casing to the end head 15 said supports extending through openings 44 in the casing head 15 into the chamber of the casing, where the crushing elements are located; this construction affording means whereby the bearings for the said crushing rolls may be properly lubricated, as also means whereby dust from the interior of the casing may be excluded from the bearings of said rolls, as will hereinafter appear.

As the bearing-carriers 29 for the hammer rolls are pivotally mounted on the end head 15, and as said end head is removable, as hereinbefore stated, it will be understood that the said hammer rolls and their carriers may be bodily removed from the chamber of the mill, when necessary, by removing said end head from which said parts are supported; and in thus removing said end head the springs 31 which act on said bearing-carriers to force the hammer rolls towards the inner or crushing face of the anvil ring, as also the holder 32 for said springs, and which is mounted on said end head, will also be removed with the latter.

Each of the crushing rolls 27 is carried upon a tapering portion 35 of a sleeve 36 and is securely held thereon by a clamp-collar 37, a key 38 interposed between the roll 27 and the collar 37 and the sleeve 36 holding these parts against rotation upon the said sleeve. By reference to Fig. 1 of the drawings it will be seen that the sleeves 36, to which the crushing rolls 27 are attached so as to rotate therewith, project to a considerable distance horizontally on both sides of said rolls, or, in other words, to a considerable distance on both sides of a plane passing centrally through the anvil ring 23 and the said rolls. The said sleeves thus have wide bearings on the bearing pins 28 and the said bearing sleeves are centrally disposed with relation to a vertical plane passing through the anvil ring 23 and the hammer or crushing rolls 27. This construction is important in that it affords proper bearings for the rolls such as will enable them to produce the best results in operation and enable the bearings to withstand the wear to which they are subjected. A dust-guard collar 39 is preferably mounted upon the end of each sleeve 36 and is preferably held thereon to rotate therewith by means of screw threads, said collars 37 and 39 being held against rotation with respect to the sleeves 36 by means of set screws 40 interposed between said dust-guard collars 39 and said clamp-collars 37. The heads of the screws 40 are preferably conical in form and enter suitable recesses in the collars 37, thereby retaining both the collars 37 and the collars 39 in proper operative position.

Interposed between the bearing pins 28 and sleeves 36 are semi-cylindrical wear bushings or sleeves 41 rigidly or non-rotatively mounted on the outer or supporting faces of the spring-pressed bearing-pins 28 and providing bearings for the sleeves 36. An oil pipe 42, mounted in a suitable groove in each bearing-pin 28, provides means for oiling the bearing of each sleeve 36 from the exterior of the mill. The dust collars 39 are preferably provided with inwardly extending flanges 43 to form oil guards or locks for the bearings of the crushing or hammer rolls 27, the oil being held in contact with the interior surfaces of the sleeves 36 by centrifugal force when the rolls are in motion.

The openings 44 in the end head 15, through which the bearing carriers 29 enter the casing, are closed by dust guard collars 45 mounted in said bearing carriers and which are held in place by elastic rings or

washers 46 which serve to press the said collars firmly against the face of the said head. The inside of the casing is provided with suitable linings or wearing parts, as 70, wherever there is danger of wear taking place, except in that portion of the lower half and sides occupied by a curved screen 47. This screen is held in position by being clamped between inwardly projecting portions of the end heads 14 and 15, or against the linings 70, and suitable clamping bands 48; the ends of said screen being riveted or otherwise secured to cross pieces 49 preferably integral with said clamping bands 48. Any suitable means may be provided for securing the clamping bands 48 in place. In the construction herein shown holding rods 71, engaging at their upper ends undercut lips 72 on the said clamping bands, are provided for holding said bands in place. The lower ends of said rods pass through lugs 73 on the frame or casing of the machine, said lower ends being screw-threaded for the reception of nuts 74 abutting against said lugs; so that by turning said nuts, to raise or lower said rods, the clamping bands may be tightened or loosened. The completely reduced material leaving the anvil ring 18 passes freely through the screen 47, and out at the discharge opening 13.

As hereinbefore described, scrapers 25 are mounted on the arms 21 of the rotating driving wheel or head 20, these scrapers being adapted to pick up the partly reduced material which fails to pass through the screen 47 and discharge the same into a pocket 50, preferably formed in the upper portion of the side of the casing, as shown in Fig. 3. Instead of the curved screen 47 a curved plate or surface of any kind, and arranged for coöperation with the rotating scrapers, might be employed.

Arranged in the pocket 50 is a feeding device herein shown as a screw or helix 51 arranged in a trough 75 communicating with the pocket 50 which extends across the chamber of the mill. The feed screw 51 is driven by a sprocket-wheel 52 connected by a suitable chain with a corresponding sprocket wheel 53 on the main or driving shaft 18 of the machine. This screw feeds the material, discharged by the scrapers into the pocket 50, to a point at the front of the mill, thence past the discharge opening of a feed hopper 54, said discharge opening communicating with the said trough 75 which in turn communicates with a chute or pipe 55 down which the material passes to a second feeding device 56, preferably also in the form of a screw or helix, and which is adapted to convey the material back to the crushing surface of the anvil ring 23. The feed screw 56 is preferably driven by a sprocket wheel 57 connected by a suitable chain with a sprocket 58, carried by the forward end of the feed screw 51, and operates in a trough or tube 59 having a discharge opening at its bottom over the anvil ring. The hopper 54 communicates with the trough 75 of the upper feed screw 51 between the pocket 50 and the pipe or chute 55. The position of this feed hopper is of considerable importance, as, when the feed screw 51 is full of material, practically no fresh material will be taken by the said feed screw from the feed hopper, and this feed screw will be more or less full, depending upon the amount of partially reduced material delivered by the scrapers 25 to the pocket 50. From these conditions it follows that the mill cannot be choked by fresh material, because the carrying capacity of the feed screw 51 for new material is limited by the amount of material taken from the pocket 50, and if the screw be full of partially reduced material taken from this pocket practically no more material can be received at this time, and the entrance of fresh material to the screw is thus shut off and remains so until a diminishing return of partially reduced material permits fresh material to be taken by the said feed screw.

It will be noticed that the wear bushings 41 of the bearings for the crushing rolls are held in place on the outer or supporting faces of the spring-pressed bearing pins 28. By referring to Fig. 3 it will be seen that the several bushings 41 are held stationary or rendered non-rotatable on the pins 28 by longitudinal ribs on said bushings fitting grooves in said pins. It follows from this that when the circles of the bearing surfaces of the sleeves 36 increase in diameter, through wear, the bushings 41 wear to fit, and the bearing surfaces remain nearly constant; while if the sleeves 36 contained attached bushings as in ordinary loose pulleys these bushings, wearing faster than the bearing pins 28, would soon not fit the said bearing pins, and bearing surfaces eccentric with the said bearing pins would result. The dust-guard collars 39 are each preferably provided with an annular flange 60 extending into an annular recess 61 in a bearing-carrier 29, said recess 61 terminating in an enlarged annular space 62 adapted to contain packing and to prevent any excess of oil from escaping to the interior of the mill where it might do harm to the material being reduced.

The construction of the mill is such that either end head 14 or 15 can be removed, for the repair or replacement of parts, while the top case or cover 16 can be swung on its hinge so as to expose the working parts to afford access to the anvil-ring and crushing or hammer rolls in the chamber of the mill, or for the purpose of replacing the scrapers, screen or linings. The spring holder or casing 32, bolted to the head 15, or to the shaft-

bearing 63 carried by said head, centrally locates all of the springs nested about the line of the axis of the driving shaft and controls the contact or crushing pressure of the crushing or hammer rolls 27. This is a feature of considerable practical importance on account of its convenience.

The inner or crushing face of the anvil ring 23 is preferably formed concave, and the outer faces of the crushing or hammer rolls 27 are preferably formed convex with a curvature corresponding to the curvature of the concave face of the anvil ring. This construction not only provides a hollow receptacle for the material being crushed but also provides a grooved track in which the hammer rolls run so that they will be more or less restrained from lateral movements as their convex faces run in the said grooved track.

It will be observed that the end head 15, which is bolted in place in such a manner as to be removed when desired, carries the pivoted bearing-carriers 29 which are mounted on said end head, the latter also providing one of the bearings 63 for the main or driving shaft 18, the other bearing 65 for said shaft being on the opposite end head 14. Also the said end head 15 supports the springs 31 exerting pressure on the push-rods or bars 33 acting on the pivoted bearing-carriers 29, and which springs serve to yieldingly press the crushing or hammer rolls 27 outwardly towards the anvil ring 23.

The operation of the mill is as follows: Assume the pulley 19 to be belted to a suitable source of power and the mill to be operated at a speed sufficient to hold the material to be reduced on the anvil ring by centrifugal force; if, under these conditions, ore or other material of the right size be fed to the mill-hopper 54 the rotating feed screw 51 at the bottom of this hopper conveys this material to the pipe or chute 55 discharging upon the lower feed screw 56, and this screw delivers the material to the reducing surface of the anvil ring 23 where it is more or less pulverized by passing between the crushing or hammer rolls 27 and the said anvil ring, said rolls 27 rotating by frictional contact with said ring or with the interposed material. The material in process of reduction works to the edges of the ring and drops therefrom upon the screen 47 and is moved along the same by the scrapers, the fine material passing through the screen and out at the discharge opening 13, while the remainder or partly reduced material is lifted by the scrapers to the pocket 50 to be returned to the anvil ring, for further reduction, by the system of feed screws as hereinbefore described. Under normal conditions the upper feed screw or conveyer 51 will take all the material which is in the pocket 50 and as much fresh material as the capacity of the said feed-screw or conveyer will permit. This makes the feeding of the material automatic and prevents clogging from over-feeding.

It will be understood that, if desired, the mill may be operated without the screen or scrapers, under which circumstances the reduced material will be discharged directly from the mill; and, if desired, may be separated or screened by external means and the coarse material be returned to the mill for further reduction.

While, in order that our invention may be properly understood, we have described the same as embodied in a specific construction, we wish it to be distinctly understood that we do not limit ourselves to the precise construction shown; it being obvious that many changes might be made therein without departing from the spirit and scope of our invention. For example, while we have herein shown our improved crushing or pulverizing mill as being constructed with four spring-pressed hammer-rolls, operating in connection with the positively driven rotating anvil ring, it will be understood that any desired number of said rolls, from one to four or more, may be employed without departing from our invention.

While we have herein shown a horizontally disposed driving shaft 18 rotating in fixed bearings and carrying an anvil ring 23 rotating in a vertical plane within the casing forming the chamber of the mill, we do not wish the term "horizontal", as used with reference to the position of the driving shaft, or the term "vertical", referring to the position of the anvil ring, in the appended claims, to be strictly limited to horizontal or vertical planes; as it is obvious that the mill might be tilted slightly, thereby changing the positions or planes of the said shaft and ring, without departing from the invention; so that the terms "horizontal" and "vertical", as used in the claims in connection with the driving shaft and anvil ring, may be understood to mean approximately horizontal and vertical.

Having thus described our invention we claim and desire to secure by Letters Patent:

1. In a crushing mill, the combination with an anvil ring having an interior crushing surface, of a horizontal shaft by which said ring is carried, a fixed bearing for said shaft, a plurality of frictionally driven crushing or hammer rolls, bearings on which said rolls are journaled, bell-crank carriers for said bearings, a stationary part to which said carriers are pivoted, and springs acting on said carriers and serving to force said hammer rolls toward the crushing surface of the said anvil ring.

2. In a crushing mill, the combination with a suitable casing, of an anvil ring rotating vertically within said casing, a horizon-

tal shaft by which said ring is carried, a fixed bearing for said shaft, a plurality of crushing or hammer rolls, coöperating with the interior crushing surface of said anvil ring, within said casing, a plurality of supports for said rolls pivotally mounted outside of said casing and extending into the chamber of the latter through openings in said casing, and springs, acting on said supports, for yieldingly forcing said hammer rolls toward the crushing surface of said anvil ring.

3. In a crushing mill, the combination with a suitable casing, of a horizontal shaft having a fixed bearing, an anvil ring mounted on said shaft and rotating in a vertical plane within said casing, a plurality of hammer rolls coöperating with said anvil ring, a plurality of bell-crank bearing-carriers pivotally mounted outside of said casing and extending inward through openings in said casing, bearing pins secured to said carriers and supporting said hammer rolls within said casing, and springs acting on said bearing carriers, at points remote from their pivots, and serving to yieldingly force the said hammer rolls toward the interior crushing surface of said anvil ring.

4. In a crushing mill, the combination with a suitable casing, of a horizontal shaft having a fixed bearing, an anvil ring mounted on said shaft and rotating in a vertical plane within said casing, a plurality of hammer rolls coöperating with said anvil ring, a plurality of bell-crank bearing-carriers pivotally mounted outside of said casing and extending inward through openings in said casing, bearing pins secured to said carriers and supporting said hammer rolls within said casing, and springs acting on said bearing carriers at points remote from their pivots, and serving to yieldingly force the said hammer rolls toward the interior crushing surface of said anvil ring, said anvil ring being an open one so that the crushed material may be discharged from both sides of its crushing face.

5. In a crushing mill, the combination with a horizontal shaft mounted to rotate in a fixed bearing or bearings, and an anvil ring carried by said shaft and having a concave crushing face, of a plurality of convex-faced hammer rolls, a plurality of pivoted supports for said rolls, a stationary part to which said supports are pivoted, and springs acting on said pivoted supports and serving to press said hammer rolls toward the crushing face of the said anvil ring so as to cause said rolls to rotate frictionally whenever said anvil ring is in rotation.

6. In a crushing mill, the combination with a horizontal shaft journaled in fixed bearings, of a hollow driving wheel or head carried by said shaft and arranged to rotate in a vertical plane, an anvil ring connected with said hollow driving wheel or head by suitable arms leaving the said anvil ring open so that the material may be discharged from both sides thereof, a plurality of crushing or hammer rolls, supports by which said rolls are carried, a stationary part to which said supports are pivoted, and springs acting on said supports and serving to force said crushing rolls yieldingly toward the inner or crushing face of the said anvil ring.

7. In a crushing mill, the combination with a casing having a side opening or openings, of an anvil ring entirely inclosed by said casing and rotating in a vertical plane within the same, a horizontal shaft by which said ring is carried, fixed bearings in which said shaft rotates, a plurality of crushing or hammer rolls coöperating with said anvil ring, supports for said hammer rolls pivoted outside of said casing and extending within the same through the said opening or openings, and springs, acting on said supports, for forcing the said hammer rolls toward the interior crushing face of said anvil ring.

8. In a crushing mill, the combination with a suitable casing, of a horizontal shaft journaled in fixed bearings, a hollow driving wheel or head carried by said shaft within said casing and arranged to rotate in a vertical plane, scrapers carried by said wheel or head, an anvil ring connected with said hollow driving wheel or head by suitable arms leaving the said anvil ring open so that the material may be discharged from both sides thereof, a plurality of crushing or hammer rolls, supports by which said rolls are carried, a curved screen mounted in said casing and from which said scrapers can take partly crushed material, and means for returning such partly crushed material raised by said scrapers to said anvil ring for further crushing.

9. In a crushing mill, the combination with a casing having a side opening or openings, of an anvil ring rotating in a vertical plane within said casing, means for supporting and rotating said anvil ring, scrapers rotating with said anvil ring, a plurality of crushing or hammer rolls coöperating with said anvil ring, supports for said hammer rolls pivoted outside of said casing and extending within the same through the said opening or openings, a curved screen mounted in said casing and from which said scrapers can take the partly crushed material, and means for returning such partly crushed material raised by said scrapers to said anvil ring for further crushing.

10. In a crushing mill, comprising a casing, the combination with a positively-driven wheel or head rotating in a vertical plane within said casing, of an anvil-ring carried by said wheel or head, scrapers also carried by said wheel or head, one or more frictionally driven crushing or hammer rolls yield-

ingly pressed toward said ring and coöperating therewith, a curved screen mounted in said casing and partially surrounding said wheel or head, and from which screen said scrapers can take partly crushed material, and means for returning such partly crushed material to said anvil-ring for further crushing.

11. In a crushing mill, the combination with a suitable casing provided at or near its top with a pocket, of a positively driven wheel or head rotating in a vertical plane within said casing, an anvil-ring carried by said wheel or head, scrapers also carried by said wheel or head, a screen partly surrounding said wheel or head and from which the said scrapers can take partly crushed material and carry it to said pocket, and means for returning such material to the anvil ring for further crushing.

12. In a crushing mill, the combination with an anvil ring rotating in a vertical plane, of one or more crushing or hammer rolls coöperating with said anvil ring, a screen partly surrounding said anvil ring circumferentially, and scrapers operatively connected with said anvil ring and adapted to collect partly crushed material from said screen.

13. In a crushing mill, the combination with a suitable casing provided with a pocket, of crushing elements within said casing, means for feeding material to be crushed to said crushing elements and means for conveying partly reduced material to said pocket whence it will be returned by the feeding means to said crushing elements for further reduction together with a greater or less amount of fresh material depending upon the amount of material carried to the said pocket for re-crushing.

14. In a crushing mill, the combination with a rotating anvil ring and crushing or hammer rolls coöperating therewith, of a casing provided with a pocket exterior to said ring, a feeding device in said pocket, a souree of supply for fresh material with which said feeding device communicates, means for separating the completely reduced material discharged from said ring from partially reduced material so discharged, and means for conveying such partially reduced material to the said pocket; whereby the amount of fresh material fed to the mill will be regulated by the amount of partially reduced material returned to said pocket for further crushing, and overfeeding of the mill will thereby be automatically avoided.

15. In a crushing mill, the combination with a casing provided with a pocket, of a feeding device in said pocket, a souree of supply for fresh material with which said feeding device communicates, a curved screen within said casing, and scrapers rotating with said ring and serving, in coöperation with said screen, to return the partially reduced material to the said pocket; whereby the amount of fresh material fed to the mill will be regulated by the amount of partially reduced material returned to said pocket for further crushing, and overfeeding of the mill will thereby be automatically avoided.

16. In a crushing mill, the combination with a casing comprising a removable end head, a horizontal shaft having one or more fixed bearings afforded by said casing, an anvil ring carried by said shaft and rotating in a vertical plane, hammer rolls coöperating with said ring, and bearing-carriers from which said rolls are supported and which are mounted on said end head, so that the said rolls with their carriers may be removed by removing said end head.

17. In a crushing mill, the combination with a casing comprising a removable end head, a horizontal shaft having one or more fixed bearings afforded by said casing, an anvil ring carried by said shaft and rotating in a vertical plane, hammer rolls coöperating with said ring, bearing-carriers from which said rolls are supported and which are mounted on said end head, springs, acting on said bearing-carriers, for forcing said rolls towards the inner face of said anvil ring, and a holder for said springs also mounted on said end head, so that the said rolls with their carriers and also said springs and their holder may be removed by removing said end head.

18. In a crushing mill, the combination with the frame of the machine and a horizontal driving shaft, of a vertically rotating wheel or head fixed to said shaft, an anvil ring carried by said wheel or head, a plurality of crushing or hammer rolls coöperating with said ring, a plurality of pivoted bearing-carriers from which said rolls are supported, and springs acting on said bearing-carriers and serving to press said rolls yieldingly toward said anvil ring, said springs being contained in a single holder or casing removably mounted on the said frame of the machine.

19. In a crushing mill, the combination with a horizontal shaft rotating on fixed bearings, of a vertically disposed anvil ring carried by said shaft, a crushing or hammer roll coöperating with said anvil ring, a pivoted bearing-carrier provided with a

20. In a crushing mill, the combination with a horizontal shaft rotating in fixed bearings, of a vertically disposed anvil ring carried by said shaft, a plurality of crushing or hammer rolls within the said ring, sleeves to which said rolls are connected to rotate therewith, bearing pins or studs on which said sleeves rotate, pivoted bell-crank carriers supporting said pins or studs, springs acting on said carriers and serving to yieldingly press said rolls radially outwardly towards said ring, and means for supporting said springs.

21. In a crushing mill, the combination with an anvil ring mounted to rotate on a fixed horizontal axis, and having an interior crushing surface, a crushing roll arranged to be frictionally driven by the rotation of said interior ring surface, a shaft on which said roll rotates and which is yieldingly supported, the said roll having a bearing which projects on both sides of a vertical plane passing through the center of said rotary anvil ring and said roll.

22. In a crushing mill, the combination with a horizontal shaft and fixed bearings in which said shaft rotates, of an anvil ring rotating in a vertical plane, crushing or hammer rolls coöperating with said ring, said hammer rolls having bearing-sleeves projecting on both sides of a vertical plane passing through the centers of said rolls, shafts on which said sleeves are journaled, and yielding supports for said shafts.

23. In a crushing mill, the combination with a casing comprising an end head having an opening, a horizontal shaft mounted in fixed bearings afforded by said casing, an anvil ring carried by said shaft and rotating in a vertical plane within the chamber of said casing, a spring-pressed bearing carrier pivotally mounted on said head, a bearing pin or shaft fixed to said carrier and extending through said opening into the chamber of said casing, and a crushing or hammer roll rotatively mounted on said bearing pin or shaft and having a bearing extending to a considerable distance to each side of a vertical plane passing centrally through said ring and roll.

24. The combination with a rotating anvil-ring, of a crushing or hammer-roll cooperating therewith, a bearing-carrier, a bearing pin or stud supported by said carrier and on which the said roll is journaled, means for conducting a lubricant to the bearing of said roll, and an oil- and dust-guard between said bearing carrier and the bearing of said roll afforded by said pin or stud, said oil- and dust-guard serving to prevent the escape of oil from the bearing of said roll and to exclude dust from said bearing, and said oil- and dust-guard consisting of a collar having an inwardly extending flange to prevent the escape of oil, and a longitudinally extending flange entering a recess in said bearing-carrier to prevent the entrance of dust.

25. In a crushing mill, the combination with a rotating anvil-ring, of a crushing or hammer roll coöperating with said ring, a sleeve to which said roll is attached to rotate therewith, parts of said sleeve and roll having inclined or tapered faces, a collar for retaining said roll in place on said sleeve, and adjusting means for forcing said collar against said roll.

26. In a crushing mill, the combination with a rotating anvil-ring, of a crushing or hammer roll coöperating with said ring, a sleeve to which said roll is attached to rotate therewith and between which sleeve and roll are inclined or tapered faces, a collar for retaining said roll in place on said sleeve, adjusting means for forcing said collar against said roll, a second collar on said sleeve constructed to form an oil- and dust-guard, and means between the said collars by which they may be retained in position on said sleeve, and by which also the first-named collar may be held in contact with the said roll.

27. In a crushing mill, the combination with a rotating anvil-ring, of a crushing or hammer roll coöperating therewith, an end head having an opening, a pivoted bearing-carrier from which said roll is supported, said bearing-carrier being mainly exterior to said end head but having a portion extending into said opening, and a dust-guard closing said opening, said dust-guard comprising a collar and an elastic washer both mounted on said bearing-carrier.

28. In a crushing mill, the combination with a casing comprising a removable end head, a horizontal shaft within said casing, a hollow wheel or head mounted on said shaft, and an anvil ring within said casing, of a plurality of crushing or hammer rolls, bearings for said rolls, pivoted carriers for said bearings, springs acting on said carriers and adapted to cause said rolls to coact with said ring, and a spring-holding case attached to said casing and providing an abutment for said springs, said carriers, springs and spring-holding case being mounted on and thus removable with said end head.

29. In a crushing mill, the combination with an anvil ring and a horizontal shaft by which said ring is carried, of a crushing roll coöperating with said ring, a pivoted, bell-crank bearing-carrier from which said roll is supported, a spring for holding said roll in engagement with said ring, and a push-bar or rod connecting said spring and said carrier, and acting on the latter at a point remote from its pivot.

30. In a crushing mill, the combination with a rotating anvil-ring, of a crushing or hammer roll, means for yieldingly-pressing said roll toward said ring, a bearing-pin upon which said roll is mounted, said bearing-pin being provided with a groove, a non-rotatable wear-bushing interposed between said pin and roll, and an oil tube located in said groove and extending outward therefrom.

31. In a crushing mill, the combination with a casing comprising a removable end head having an opening, a horizontal shaft mounted in fixed bearings afforded by said casing, an anvil ring carried by said shaft and rotating in a vertical plane within the chamber of said casing, a spring-pressed bearing-carrier pivotally mounted on and thus removable with said head, a bearing pin or shaft fixed to said carrier and extending through said opening into the chamber of said casing, and a crushing or hammer roll rotatively mounted on said bearing pin or shaft within the chamber of said casing and coöperating with the said anvil ring.

32. In a crushing mill, the combination with an anvil ring rotating in a vertical plane, of a casing comprising a removable, vertical, end head having an opening or openings; pivoted, spring-pressed bearing carriers mounted on the exterior of said head; bearing pins or shafts fixed to said bearing carriers and extending through said opening or openings into the chamber of said casing, and crushing or hammer rolls rotatively mounted on said bearing pins or shafts within said casing and yieldingly pressed towards the crushing surface of the said anvil ring.

In testimony whereof we affix our signatures, in presence of two witnesses.

THOMAS LEGGETT STURTEVANT.
THOMAS JOSEPH STURTEVANT.

Witnesses:
W. H. Ellis,
H. G. Allbright.