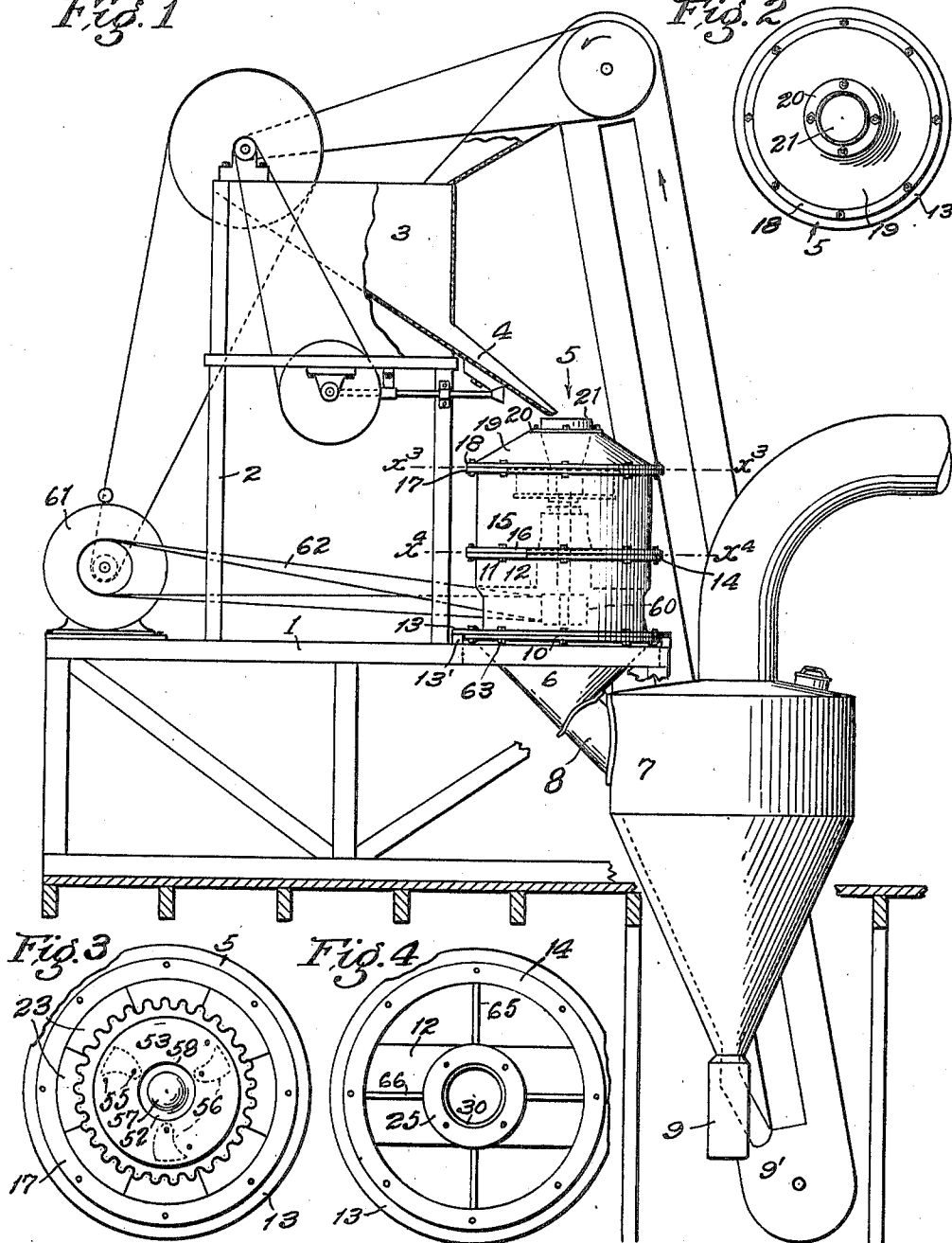


1,228,338.

Fig. 1

Fig. 2



Witnesses
C. C. Holly
L. Belle Weaver

Inventor

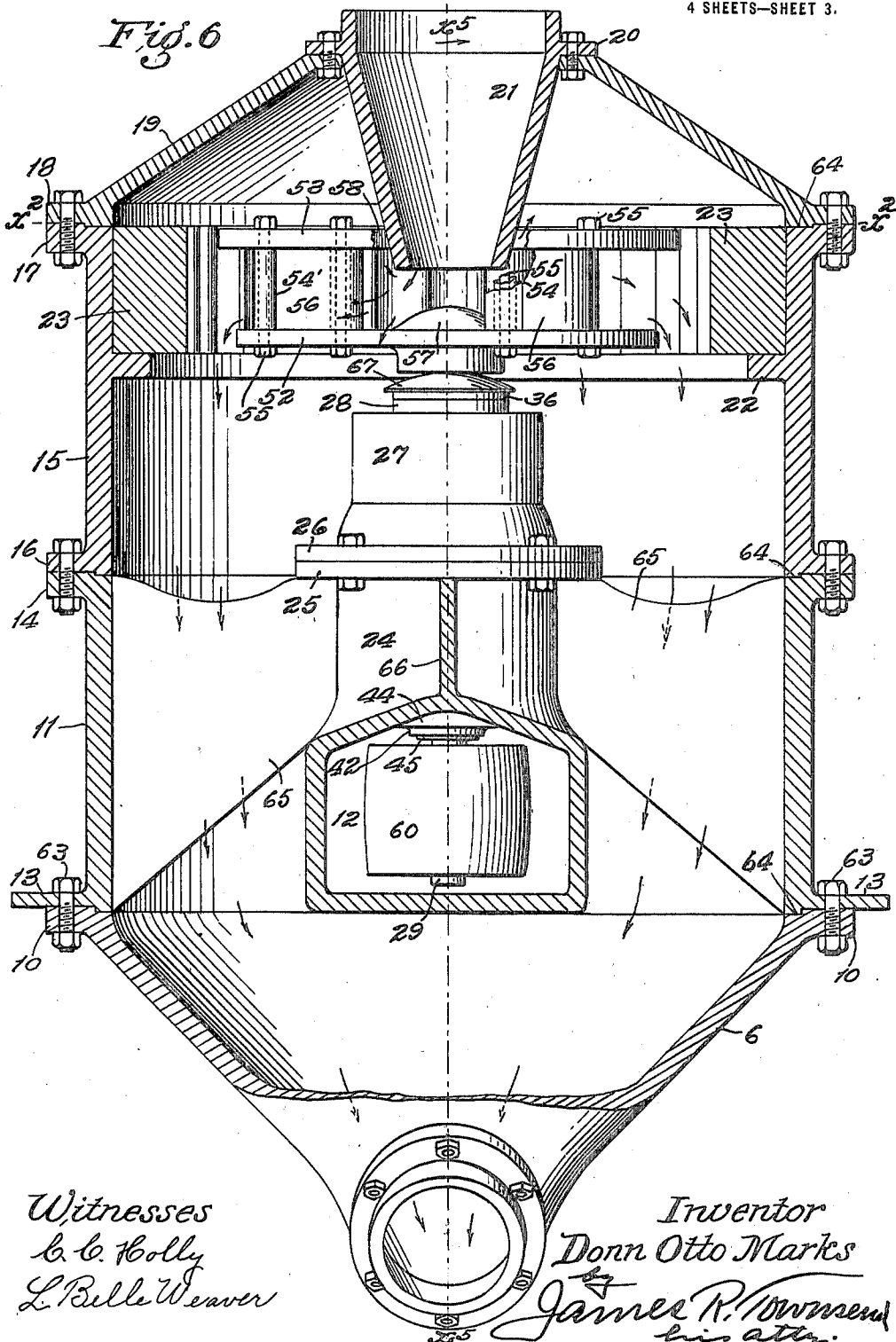
by Donn Otto Marks
James R. Townsend
his atty.

D. O. MARKS.
CENTRIFUGAL IMPACT PULVERIZING APPARATUS.
APPLICATION FILED DEC. 11, 1913.

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Patented May 29, 1917.

4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

Fig. 7

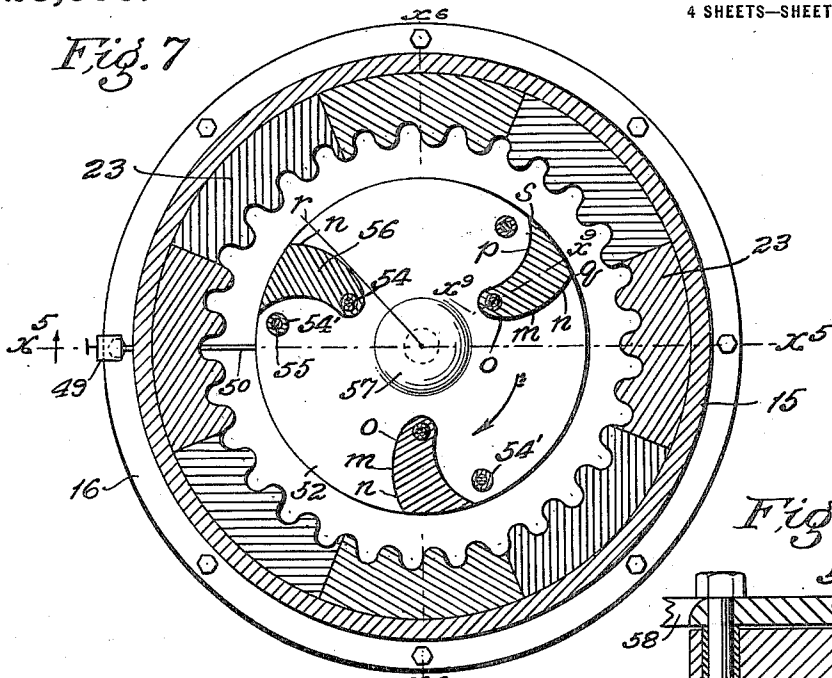


Fig. 9

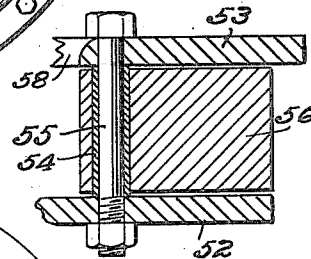
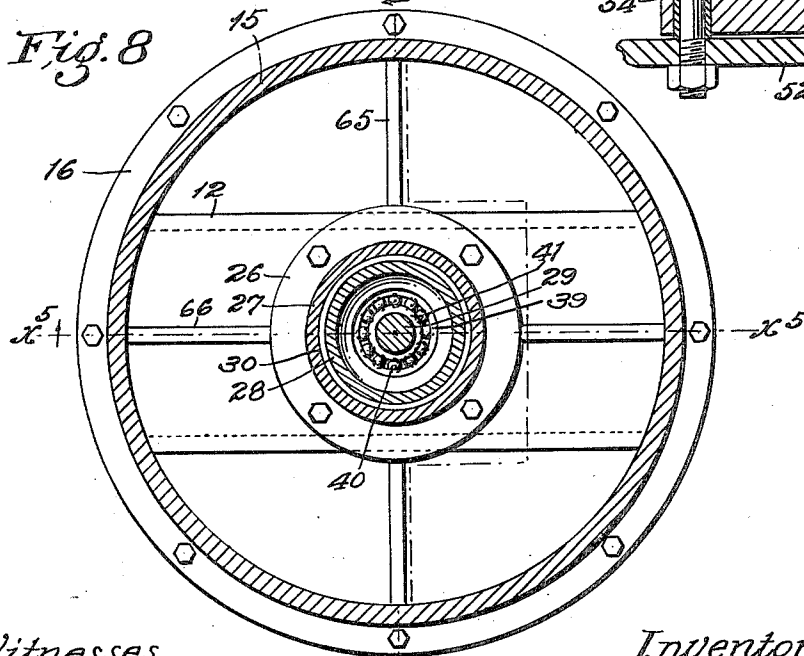


Fig. 8



Witnesses
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UNITED STATES PATENT OFFICE.

DONN O. MARKS, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR OF ONE-HALF TO LYNN S. ATKINSON, OF LOS ANGELES, CALIFORNIA.

CENTRIFUGAL IMPACT PULVERIZING APPARATUS.

1,228,338.

Specification of Letters Patent.

Patented May 29, 1917.

Application filed December 11, 1913. Serial No. 806,104.

To all whom it may concern:

Be it known that I, DONN OTO MARKS, a citizen of the United States, residing in the city and county of San Francisco, in the State of California, have invented certain new and useful Improvements in Centrifugal Impact Pulverizing Apparatus, of which the following is a specification.

This invention relates to machines which pulverize and disintegrate ores or the like by means of centrifugal force produced by rotors mounted on vertical shafts driven at high speed and having a disk-like head provided on an upper face with impellers for impelling the material to be pulverized or disintegrated and setting up circular motion thereof and consequent centrifugal forces that cause it to fly from the rotor to strike a hard surface where it becomes split along the planes of cleavage.

This invention is not of the class of machines which grind the material in the operation of pulverizing material and is particularly distinguished therefrom in having a self-balancing rotor run at a very high speed and provided with devices that form centrifugal cushions to yieldingly take on the material that is to be crushed and to set up centrifugal force therein to drive it against a surrounding wall where the material is disintegrated by impact therewith and then at once passes on out of the way without being ground or further acted on for the purpose of reducing to fineness; the complete reduction being practically instantaneous at the moment of impact upon the surrounding wall.

In the operation of machines of this character great difficulties are encountered which heretofore have proven serious obstacles in the way of prolonged successful use.

Among such difficulties may be mentioned the following:

First, the high speed of rotation causes violent vibrations, oscillations, radial thrust and internal strains likely to result in rapid destruction of the machine;

Second, the impact between the impellers and the rock fed to the rotors and rebounding from the hard surface is tremendous, obstructive and destructive;

Third, a greater or less amount of the product is in the form of an impalpable dust which is liable to permeate the air and difficult to be taken care of.

An object of the invention is to provide

improved means to overcome, avoid and take care of the above mentioned difficulties and effects and to construct a machine in which the leverage with which the centrifugal force of the impellers is applied to the disk is minimized, and whereby the generated forces are allowed to adjust the parts to such relation with each other that the radial thrust, oscillations, impacts, vibrations, and internal strains are minimized, counterbalanced and counteracted; and to effect this by simple, strong, light and durable apparatus easy to make, assemble, disassemble, ship and operate.

An object is to so construct and arrange the impellers with relation to the disk of the rotor that the impact spoken of will be cushioned through centrifugal force generated by the rotor, and the invention is pioneer with respect to the means whereby this is effected.

The radial thrust practically only comes into play when the rotor shaft does not operate in a line running through its center of gravity. It is important therefore that the rotor be self adjusting to such line.

Objects of the invention are:

To provide novel means to permit the rotor to find its own center of gravity, thus to avoid or to compensate for radial thrust, so that the pressure of the bearings will be equal throughout, and so that there will be no destructive oscillation or vibration of the rotary parts.

In machines of this kind the rotor shaft is vertically mounted, and consequently, gravity is a considerable factor in the way of practical success and the machine is so constructed that a satisfactory anti-frictional support for the rotor is provided.

Such construction, however, forms the subject-matter for a separate application Serial No. 129,200, filed on the 2nd day of November, 1916, forming in part a division of this application.

Another object of the invention is to provide means whereby a source of power may be connected to the apparatus at any desirable radial or vertical direction to the rotor shaft, and the dust will be excluded from the connecting means.

An object is to provide a construction and arrangement of parts that will admit of vertical drive connection with motor located below and close to the rotor disk.

In carrying out the invention I provide a

comparatively light and strong frame having channels whereby the disintegrated or pulverized substances may be dropped or passed down on either side of the rotor shaft and power appliances and I provide a case particularly adapted to convey the properly disintegrated material from the rotor to a suitable receptacle and to return the insufficiently disintegrated material back to the rotor for further disintegration.

The important features, capabilities and advantages of the invention will become apparent from the detailed subjoined description of one specific embodiment thereof.

The invention may be variously embodied either with a vertical drive motor or with a pulley and belt drive and in the drawings will be shown only with the pulley and belt drive.

It is understood that one great source of trouble with apparatus of this kind arises from the liability that the load fed to the rotary head will be unequally distributed thereon, thus making one side of the rotor momentarily heavier than another and thereby increasing the radial thrust and an object is to take care of such radial thrust in a satisfactory way by allowing instant response of the rotor to such variations of load center.

The accompanying drawings illustrate the invention.

Figure 1 is a broken elevation, more or less diagrammatic, of a pulverizing plant constructed in accordance with this invention.

Fig. 2 is a broken plan view of the pulverizer.

Fig. 3 is a broken plan on line x^3-x^3 , Fig. 1, showing the parts exposed by removing the top section.

Fig. 4 is a plan from line x^4-x^4 , Fig. 1, showing the lower cylindrical shell section detached.

Fig. 5 is an axial section of the pulverizer on line x^5-x^5 , Figs. 6, 7 and 8.

Fig. 6 is an elevation partly in section on irregular line x^6-x^6 , Figs. 5, 7 and 8.

Figs. 7 and 8 are plan sections respectively, at lines x^7-x^7 and x^8-x^8 , Fig. 5, reduced in size.

Fig. 9 is an enlarged fragmental sectional elevation from x^9-x^9 , Fig. 7, showing one of the impellers, wings or throwers pivoted in place.

In the embodiment shown, a frame is provided having a suitable platform 1 on which are positioned standards 2, supporting the hopper 3 that is provided with a chute 4 which is adapted to discharge into the pulverizer 5 that is suitably mounted on the platform 1. The pulverizer is provided with a bottom discharge section 6 which leads into a cyclone dust collector and separator 7 into which the pulverized material is directed by means of the spout 8.

Said separator 7 operates in practically the same manner as that shown in my previous United States Patent No. 994596 of June 6, 1911, and delivers the finished pulverized material through the mouth 9 from which it may be conveyed by any suitable means to the place of treatment or use.

The outer housing or shell of the pulverizer is built up of sections and comprises said downwardly tapering bottom discharge section 6 which has an upper circular opening around which is provided a flange 10 that in the present instance is shown as positioned above and supported indirectly by the platform 1. A lower cylindrical shell section 11 having a power appliance way as the tunnel 12 passed therethrough (see Figs. 4, 5, 6, 7) has a suitable lower flange 13 to fit onto the flange 10 and to be suitably bolted thereto, and an upper flange 14. The flange 13 forms projecting means overhanging the flange 10 to rest on any suitable support as the sills 13' carried by the platform 1 so that the discharge section 6 may be removed from or rotatively adjusted relative to the shell section 11 without disturbing such shell section.

An upper cylindrical shell section 15 is provided with a lower flange 16 to fit and to be suitably bolted onto the upper flange 14 of the lower section 11. The upper section 15 has an upper flange 17 adapted to receive a flange 18 provided on the lower end of an upwardly tapering top section 19 which has a central circular opening to receive the external annular flange 20 of a downwardly tapering funnel 21, serving as the inlet mouth of the pulverizer.

The several flanges are formed to constitute annular seats by which the several sections are jointed together and secured by bolts.

The chute 4 extends over the funnel 21 to feed thereinto the material to be disintegrated. The upper cylindrical shell 15 is provided with an internal annular ledge 22 on which the removable corrugated segments or rifled blocks 23 are mounted having their outer faces arc-shaped and their inner faces corrugated, as shown in Figs. 3, 5, 6 and 7; there being a sufficient number of these blocks to complete an annular ring inwardly overhanging the ledge 22. These rifled blocks form the impact wall having a hardened surface against which the material to be disintegrated is thrown in the operation of the pulverizer.

The upper wall of the tunnel 12 is provided with an upwardly extending lower annular collar 24 integral with said wall; the upper edge of said annular collar being provided with an annular flange 25 practically at the level of the top of the lower cylindrical shell section to receive an annular flange 26 formed on the lower end of an upper annular crown collar 27. The collars

24 and 27 are bolted together and are of particular interior conformation and provide a chamber to receive a universal joint ball sleeve 28 in which the vertical shaft 29 of the rotor is adapted to operate. Surrounding the meeting portions of the two collars 24, 27, their interiors are formed to produce the intermediate frusto-spherical socket 30 for the ball of said sleeve 28. The upper end of the wall of the chamber formed in the collar 27 is offset to form a shoulder 31 and the lower end of the wall of the chamber formed in the collar 24 is offset to form a shoulder 32. On the shoulder 31 and resting against the interior of the annular collar 27 is located an upper resilient sleeve-like ring 33, in the present instance made of india rubber. Abutting against the shoulder 32 and lying against the inner surface of the annular collar 24 is located a lower resilient sleeve-like ring 34, also made of india rubber. The socket 30 is provided with an anti-friction metal lining or band 35, made of babbitt in the present instance, and forming the inside of the socket. The ball sleeve 28 has an upper cylindrical portion *a* to locate in and abut against the rubber ring 33, a lower cylindrical portion *b* to locate in and abut against the rubber ring 34 and an intermediate ball portion *c* to locate in and abut against the Babbitt ball-socket liner or band 35.

The rotor shaft 29 has an intermediate body *d*, and above such intermediate body the successively reduced upper spindle portions *e*, *f*, and the screw-threaded tip *g*. Said rotor shaft also has below said intermediate body the successively reduced lower spindle portions *h*, *i*, *j* and *k*, the second one, *i*, of which is threaded.

The upper end of the ball sleeve 28 is internally screw-threaded to receive the lower screw-threaded portion of a flanged dust-tight or retaining cap 36, the annular flange of which rests on the upper end of the ball sleeve 28. A cylindrical lock sleeve 37 is located inside the annular cap 36 and surrounds the vertical shaft 29 of the rotor. The rotor is provided with an upper ball bearing 38 around the first upper reduced portion *e* and supported by the main body *d* of the rotor shaft.

The rotor supporting ball bearing outer raceway 39 is located inside the lower cylindrical portion *b* of the ball sleeve 28 and around the first lower reduced portion *h* of the rotor shaft 29. The balls 40 are carried by the outer raceway 39 and support the raceway collar 41, which is mounted on said reduced portion *h* of the rotor shaft and supports said shaft; the annular shoulder formed by the lower end of the shaft body *d* resting on the raceway collar 41 for this purpose.

The lower cylindrical end of the ball

sleeve 28 is internally and externally screw-threaded to receive internally the dust-tight oil-retaining thrust cap or bearing step 42 that supports the outer raceway 39, and to receive externally the ring 43 which serves to retain the lower rubber ring 34 and support it in place. The thrust cap 42 has an annular flange 44 to abut against the lower end of the ball sleeve 28 and is screwed home tight.

The thrust cap 42 is provided with a central screw-threaded orifice to receive an oil-retaining gland 45 that surrounds the smooth cylindrical portion *j* of the shaft. Above and free from the thrust cap 42 and gland 45 there is screwed on the threaded portion *i* of the shaft a retaining nut 46 to retain on the shaft the inner raceway collar 41 of the radial and axial thrust bearing.

In the chamber 47 formed in the ball sleeve 28 surrounding the vertical rotor shaft 29 between the lower bearing balls 40 and the upper bearing balls 48, lubricant, such as hard grease, 47', is packed and is afterward replenished with lubricant from the compression grease cup 49 through a pipe connection 50 communicating with a grease chamber 51 above the upper ball bearing 38.

The parts of the shaft between the threaded portions *g* and *i* are smooth and cylindrical, and run smoothly in the hard grease.

The arrangement described is such that if the center of gravity of the rotor lies outside the axis of revolution so that there will be radial thrust from the unbalanced rotor when the shaft is rotated, the shaft may readily yield to such radial thrust and gyrate freely without strain or jar. That is to say, as the rotor speeds up, the universal ball and socket joint and the rubber rings 33 and 34 will permit the sleeve to assume that angle in which the rotor finds its proper position so as to rotate without oscillation, vibration or wobbling.

It thus spins as a top supported at the ball and socket joint. The ball sleeve thus forms an oscillating support for the rotor.

The rotor head is constructed with lower and upper disk members 52, 53 spaced apart a determined distance by inner and outer spacers 54, 54' and held together by bolts 55 extending through the spacers respectively; there being impellers, wings or throwers 56 of less thickness than the space between said disks, mounted loosely between the disks and pivoted on the inner spacers 54 and extending into the path of the outer spacers 54', which are spaced rearwardly from the impellers when the impellers are freely responding to the centrifugal force generated by rotation of the rotor, so that the impellers are free to swing their longitudinal axes to and fro across those radii of the rotor

in which the impeller pivots are located respectively. The lower disk 52 has on its top surface a central distributing boss 57 and in its underside below such boss a central-threaded socket screwed onto the threaded tip *g* of the rotor shaft.

The upper disk member 53 has a centrally-located circular funnel-receiving opening 58 through which the lower end of the funnel 21 extends to a level below that of the upper disk, there being an open way between said funnel and the margin of the opening 58 for central return of dust-laden air.

Said wings 56 are of less height than the spacers so that they are capable of swinging horizontally in the space between the upper and lower disks.

Said wings are rounding at their inner ends and widen outwardly therefrom, their sides being in diverging curves forming comet-like tails.

A pair of spacers 54, 54' and bolts therefor are provided for each of the wings, the inner one of said spacers forming a pivot for the inner end of the wing, the periphery of such inner end being rounded to allow the material to freely pass and practically stationary relative to the boss 57 of the rotor irrespective of the oscillations of the wings. The spacers of each pair are practically arranged in a line parallel to a line that is tangent to the periphery of the distributing boss 57 of the lower disk member, the outer spaces forming stops impinging against the rear faces of the wings to start said wings when rotation is first set up; each outer spacer 54', however, being set far enough back to allow the outer end of the wing in front of it to swing forwardly therefrom under the centrifugal force generated by rotating the rotor.

The proper location of the spacer 54' may readily be determined by pivoting one of the wings on an inner spacer of a detached lower disk and then standing the disk on edge to bring the centers of the spacer and the disk in vertical alinement so that the impeller will hang down as suggested by the lower impeller in Fig. 7; said impellers, thus mounted, being free to oscillate sufficiently to swing their axes to and fro across those radii of said rotor in which the impeller pivots 54 are located respectively. The line x^9 in Fig. 7 indicates one of said radii.

The impeller when thus hanging free, will be in the normal operating or impelling position and the outer spacer 54' should be located rearwardly therefrom a desirable distance sufficient to allow considerable backward swing of the impeller from said normal impelling position but close enough to the impeller to engage it and start it forward.

Said wings are of hard heavy material

and may be made of cast steel or of reinforced carborundum or the like, and during practical operation swing forward from the stops by centrifugal force and are thus centrifugally cushioned to receive the impact of the outlying and rebounding material with which they may collide; and the strains applied by said wings on the disks are effective only at an inner part of the rotor disks, and, consequently, the danger of breaking such disks is minimized.

The front faces of the wings or impellers are curved as shown at *o*, *m*, *n*, being curved outward forwardly at the inner limb *o* of said face and rearwardly outward at the outer limb *n*, so that the inner forwardly curved limb *o* will first pick up the material moving outward from the boss 57 and will give it a forward circular impetus thus setting up great centrifugal force that carries the material past the middle bend *m* that is tangent to a radius *r* of the rotor. The outer limb *n* is rearwardly curved, so that the material may receive impetus therefrom but may escape outward with minimum friction.

The rear face *p* of the wing is curved rearwardly outwardly and is divergent from the front face, so that the center of gravity of each wing will lie nearer to the outer front corner *q* of the wing than to the outer rear corner *s*, so that when the wing responds freely to centrifugal force as the rotor is revolved, the front face of the wing will stand as stated above.

In practical use the rotor is driven at a high speed say from 1500 to 3000 revolutions per minute, more or less, and the broken rock or other material to be reduced is fed through the funnel 21 onto the outwardly sloping central portion or boss 57 down the sides of which it will move onto the plane surface of the disk 52, meanwhile taking on centrifugal force imparted through frictional contact with disk 52 until it collides with the wings 56 which impart to it the high speed of the rotor so that it is thrown by centrifugal force against the corrugated blocks 23 where it is shattered by one blow for each piece of the material. In some instances the lump or piece of material is thus broken fine enough by this one blow; but it is possible that some fragments may be thus produced that may rebound across the narrow space between the wall and the wings which will collide with the fragments and throw them off at a tangent so that the fragments will again strike the corrugated wall there to again shatter them.

The wings also act as the wings of a blower and air is sucked in through the funnel 21 and driven out at the periphery of the rotor head and onto the ruffled wall 23 thus creating an air pressure which can only be relieved in vertical directions up and

down. The face of the wall formed at 23 is vertical, the lower disk 52 is of less diameter than the upper disk 53, there is no external outlet upward, there is a wider passageway from the wall 23 downward than upward, and there is also a final outlet to the external air through the hollow body on each side of the tunnel and then through the dust collector 7; and therefore the air blast from the blower is mainly downward and this blast helps to carry the fine material from the space between the head and wall downward past the power appliance housing formed by the tunnel and into the dust collector and separator from which the fine material passes through the spout 9 to be stored or treated and the larger size passes through spout 9' to the elevator and back to the hopper 3 where it is mixed with the material in said hopper and passes on into the machine for further shattering.

There may also be a circulation of air and dust up from the inner face of wall 23, over the upper disk between such disk and the top section and thence down through the space between such disk and the lower end of the funnel and thence out between the disks, and so on, or vice versa.

The lower end of the shaft 29 is designed to be connected to any suitable source of power to drive the shaft, and in the present instance is shown as provided with a pulley 60 connected to a motor 61 by means of a belt 62 which is passed to the pulley through the tunnel 12 into which the shaft extends.

In order to allow great freedom in relatively positioning the power source, the shell and the dust collector, the sections of the device are rotatively mounted one on another and can easily be adjusted to change the position of the tunnel. This is done by merely removing the bolts 63 which fasten the flanges 13 and 10 together, whereupon the workman may turn the upper body of the pulverizer to the desired position, so that the tunnel 12 will be in proper alinement, and may then return the bolts 63 to again fasten the flanges 13 and 10 together.

To securely position the upper cylindrical shell 14 onto the lower cylindrical shell 11, complementary or shouldered seats are provided as shown at 64 in Figs. 5 and 6.

Ribs are provided to properly reinforce the lower cylindrical shell 11; there being on each side of the collar 24 a rib 65 extending substantially diametrical of the shell, being cast integral with the tunnel 12 and the annular collar 24; and second ribs 66 arranged along and made integral with the top of the tunnel and with the collar and at right angles to the first ribs 65. These ribs serve furthermore to reinforce the tunnel 12 and the shell thus constructed affords strong and rigid support for the lower collar 24 and the bearing for the rotor shaft.

Mounted on the shaft 29 between the cylindrical lock sleeve 37 and the rotor disk 52 is provided an inverted dish-shaped dust-deflector 67 which prevents dust of the pulverized material entering into the bearing of the shaft 29. The dust-deflector 67 and lock sleeve 37 rotate with the shaft 29, but the cap 36 is fixed to the sleeve 28 and only moves therewith. The lock sleeve holds the top bearing in place.

The lubricating tube 50 is of such flexible construction as to yield to accommodate the slight movement to which the top of said sleeve is subjected by reason of any shifting of the axis that may occur.

The annular cap 36 may be grooved internally to receive the packing rings 68 of felt or hard grease that may encircle the spindle portion *e* of the shaft 29 thus to assist in excluding dust and grit from the interior of the bearing sleeve 28.

By arranging the oscillating impellers as shown in Fig. 7 with their pivots arranged at the inner ends of the impellers, so that the centers of gravity of the impellers are between the impellers and the outer free ends of the impellers, said impellers under centrifugal force swing into position with their centers of gravity alined with the propeller pivots, that is to say, said impellers are pivotally connected to the rotor body at one side of their centers of gravity and extend only part of the way to said annular wall so as to leave at all times an unobstructed space between the impeller and the wall, so that the impellers are free to swing their longitudinal axes to and fro across those radii of the rotor in which the impeller pivots are located respectively without touching the impact wall, and the material is free to pass out of the way of the impellers and in parallelism with the face of the wall on its way out of the machine after being disintegrated by impact with the wall, and the rotor axis and the axes of the said impellers are free to oscillate to swing their centers of gravity across such radii, so that when impact occurs between newly introduced material and the outer free ends of the impellers, said free ends of the impellers constitute centrifugal cushions, being yieldingly held by the centrifugal force to rotate in a circular path in which they will strike upon the ore or other material that is to be driven out by centrifugal force upon the annular wall; said impellers yieldingly responding to the impact to an extent sufficient to take up the jar which otherwise would be transmitted to the machine by the impact of the impellers against the material if said impellers were rigid with the rotor body made up of the disks 52, 53 and the connecting parts 54, 54'; and, furthermore, by combining the rotating head and the impellers thus mounted with a shaft, and a

ball-and-socket bearing for said shaft, and applying the power on the side of the ball-and-socket joint away from the rotor, the deflection of the shaft is minimized and the likelihood of irregular action under varying loads as applied to the various portions of the rotor and impact with the various impellers is avoided.

It is noted that the impellers are pivoted at their inner ends so as to offer as little surface as possible subject to the impact of the material at the moment of starting it to revolve for generating the centrifugal force therein; that said impellers do not rub upon or come into contact with any part of the machine excepting the disks 52, 53 and the spacers 54, 54', and that said rotor body is rotated at a high speed and free from frictional contact with any element except the impellers.

It is obvious that various modifications and changes in the detail construction may be made without departing from the general scope of the invention.

I claim:

1. In an impact pulverizing apparatus having an annular impact wall; a rotor provided with impellers pivotally connected to the rotor body at one side of their centers of gravity and extending only part of the way from their pivots to said wall, so as to leave at all times an unobstructed space between the impeller and the wall, and so that the impellers are free to swing their longitudinal axes to and fro across those radii of the rotor in which the impeller pivots are located, respectively, without touching the impeller wall; for the purpose of yieldingly taking on the material to be impelled outward for disintegrating impact with the surrounding wall.

2. The combination with a disk; of a shaft fixed to the center of the disk; a ball-and-socket support in which the shaft is journaled; and impellers pivotally mounted on the disk at one side of their centers of gravity respectively, said impellers being free to swing their axes to and fro across those radii of said rotor in which the impeller pivots are located respectively.

3. The combination with a disk; of a shaft fixed to the center of the disk; a ball-and-socket support in which the shaft is journaled; impellers pivotally mounted on the disk at one side of their centers of gravity respectively, said impellers being free to swing their axes to and fro across those

radii of said rotor in which the impeller pivots are located respectively; and yielding means to normally hold the shaft in vertical position.

4. The combination with a shaft; of a sleeve having a portion that is the segment of a sphere; anti-friction bearings on opposite sides of the spheric portion; a socket to support said spheric portion; a rotary head fixed on the upper end of the shaft; impellers pivoted to the rotary head, said impellers being free to swing their axes to and fro across those radii of said rotor in which the impeller pivots are located respectively; and means at the lower end of the shaft to impart rotary action to the shaft.

5. In a centrifugal impact pulverizer; a rotor comprising a shaft, a head on said shaft, said head being constructed with two disks spaced apart, one above the other; centrifugally cushioned impellers pivoted between the disks; a universal joint; a bearing for the shaft; said bearing being located near the lower end of the shaft and supported by the universal joint, and power applying means connected below the bearing to drive the shaft.

6. In a pulverizer, the combination with a rotary disk, of an impeller pivoted by its inner end to the disk, said propeller being free to swing its axis to and fro across that radius of said disk which the pivot intersects, said inner end being rounded and the front and rear faces of said impeller being divergent from said rounded end; and means to feed material centrally to the disk.

7. In a pulverizer, the combination with a rotating disk having a central boss; of impellers pivoted by their inner ends to the disk around the boss; said inner ends being rounded and the front sides of said impellers being bent forwardly outward from the rounded portion to set up circular motion in material on the disk, and being bent rearward outwardly at their outer ends to allow the material to pass freely, and to give a final impetus to such material; said impeller being free to swing its axis to and fro past that radius of the disk which the pivot intersects.

In testimony whereof, I have hereunto set my hand at San Francisco, California, this 1st day of December, 1913.

DONN O. MARKS.

In presence of—
MATTIE G. STIRLING,
M. ARNESON.