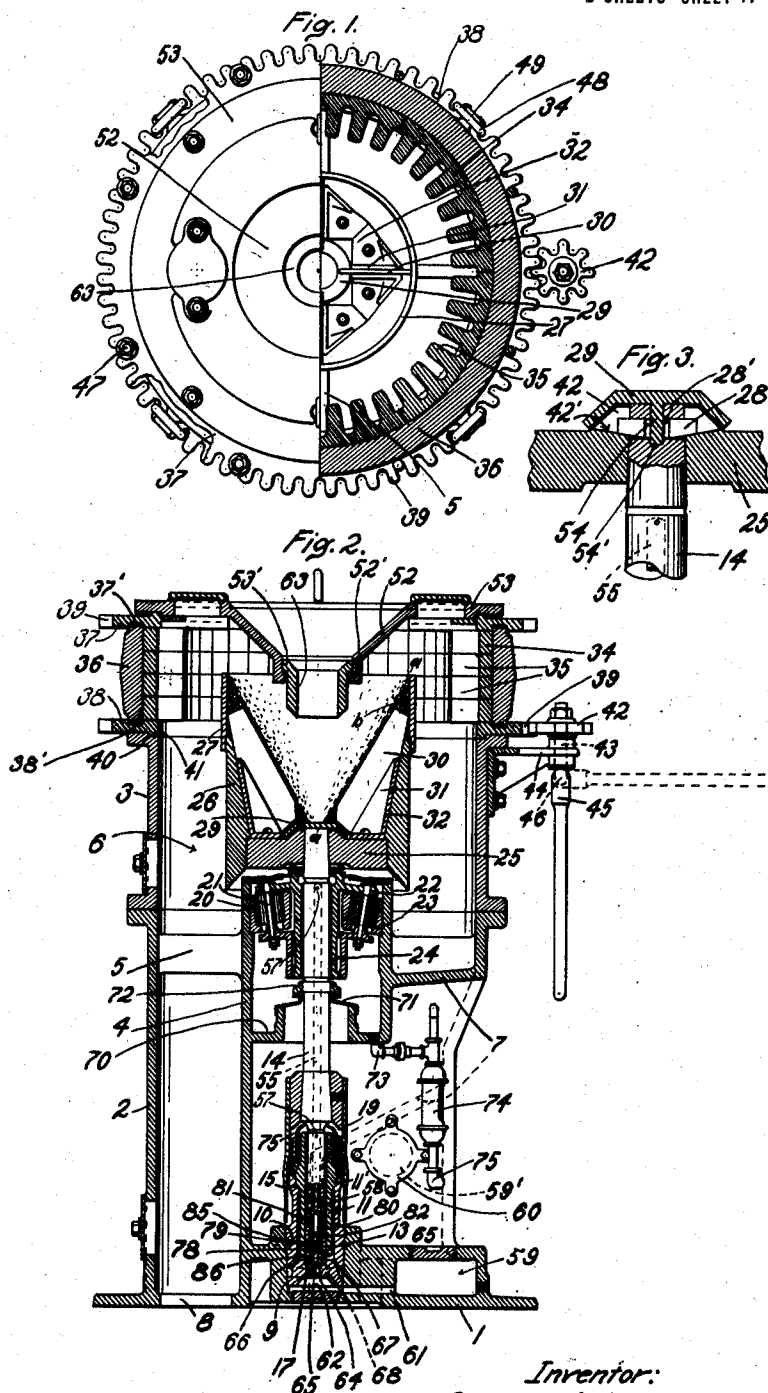


G. A. OVERSTROM.
 METHOD OF AND APPARATUS FOR PULVERIZING FRANGIBLE SUBSTANCES.
 APPLICATION FILED AUG. 21, 1916.

1,300,192.

Patented Apr. 8, 1919.

2 SHEETS—SHEET 1.



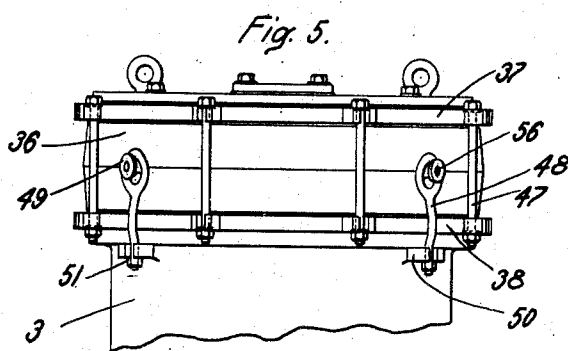
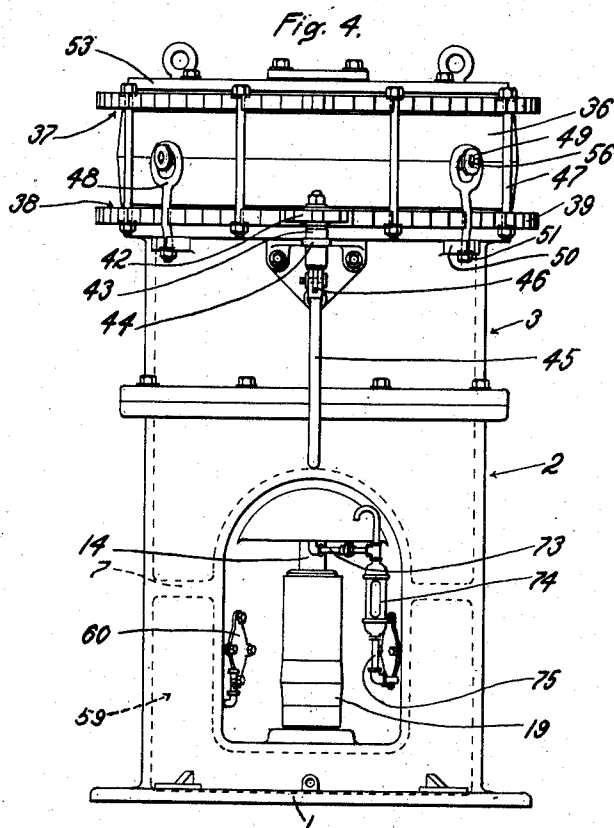
Inventor:
 Gustave A. Overstrom
 by Arthur P. Knight
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UNITED STATES PATENT OFFICE.

GUSTAVE A. OVERSTROM, OF PASADENA, CALIFORNIA.

METHOD OF AND APPARATUS FOR PULVERIZING FRANGIBLE SUBSTANCES.

1,300,192.

Specification of Letters Patent.

Patented Apr. 8, 1919.

Application filed August 21, 1916. Serial No. 115,947.

To all whom it may concern:

Be it known that I, GUSTAVE A. OVERSTROM, a citizen of the United States of America, residing at Pasadena, in the county of Los Angeles and State of California, have invented a new and useful Method of and Apparatus for Pulverizing Frangible Substances, of which the following is a specification.

This invention relates to the art of pulverizing ore, rock or similar material, and particularly to improvements in the method and apparatus wherein the ore is pulverized by being thrown from an impeller, rotating at high speed and caused to strike an obstructing surface at such high velocity as to break the ore or rock by the force of the impact. An important object of the invention is to utilize the material which is being subjected to the centrifugal operation to form a protective surface for the impeller body and to form an abrading means for assisting in pulverizing the material. For this purpose I provide for retaining a bed or body of such material on or within the impeller in such manner that the impact and abrasion due to passage of the material over or through the impeller are taken by such bed or body which thus protects the impeller from wear and at the same time assists in the comminution of the material.

Another object of the invention is to provide for convenient and economical renewal of such parts as are unavoidably subject to wear.

Another object of the invention is to provide an improved construction of the die or stationary means for receiving the impact of the material when it is thrown from the impeller, whereby it may more effectively resist the wear due to the operation of the apparatus.

Other objects and advantages of my invention will appear hereinafter.

The accompanying drawings illustrate an apparatus suitable for carrying out my invention, and referring thereto:

Figure 1 is a plan view partly in section, the impeller being shown as empty.

Fig. 2 is a vertical section, the impeller being shown as containing a bed of protective material.

Fig. 3 is a detail sectional view of the head of the impeller spindle.

Fig. 4 is a side elevation of the machine. Fig. 5 is a partial side elevation of a modification.

The invention comprises a frame, a vertically extending spindle mounted in said frame, an impeller carried by said spindle, means carried by said frame for receiving the impact of the material discharged from the impeller, and means for feeding material to the impeller. The frame of the machine may be of any suitable construction, comprising, for example, a base 1, a casing 2 thereon, and an upper casing 3 mounted on the casing 2. An interior frame member 4 is mounted within the casing 2, for example by means of arms 5 and a web 7. All of the members 2, 3 and 4 are substantially cylindrical in shape, the frame member 4 being mounted coaxially with the members 2 and 3, so as to form an annular space 6 between the inner member 4 and the outer members 2 and 3, and the frame is formed with an inclined web 7 connecting the casing 2 and the inner frame member 4, so as to form an inclined chute at the bottom of said space 6, whereby the pulverized material is conducted by gravity to a discharge opening 8 in the base 1.

Base 1 is provided with a taper seat 9 for a bearing support 10, which is tapered to fit said seat. Said support 10 supports a bearing sleeve 11 which is formed with a bearing surface for engaging the spindle 14 for the impeller, said bearing support 10 being provided with a ball and socket bearing for sleeve 11 and with a lower bearing plate 17 engaging a member 13 on the lower end of said sleeve, the engaging faces of said plate and sleeve being rounded concentrically with the center of the ball and socket bearing, so that the spindle may gyrate on this center. A driving pulley 19 is mounted on the spindle 14 around the bearing portion thereof, so that the lateral stress of the belt running on said pulley is substantially balanced with respect to the center of support of the spindle, and the spindle is therefore free to rock on said support. Such rocking or gyrating motion of the spindle on its support is resisted and controlled by resilient supporting means consisting, for example, of spiral springs 20 arranged in an annular series around the spindle and having their inner portions connected by bolts 21 to a

spider 22 provided with a bearing 24 for the spindle, and said springs having their outer portions connected to a ring 23 secured to the stationary frame member 4. The construction of this yielding support for the spindle may be substantially as shown in my application filed May 9, 1916, Serial No. 96275, for flexible bearing for high speed spindles.

10 An impeller is mounted on the upper end of spindle 14, said impeller being preferably formed as a bowl or cup-shaped member consisting, for example, of a disk 25 secured to the upper end of spindle 14, an annular member 26 secured to the disk 25 and extending upwardly therefrom, and a ring 27 secured to the annular member 26 and extending above the same to form a removable lip or rim for the bowl. The annular member 26 is preferably flared upwardly on its inside. Disk 25 is secured to the spindle by a taper fit and is held in position by wedge keys 28 in a recess 28' in said spindle and extending out into keyways 88 in the bottom member of the impeller, said keyways having inclines 88' for engaging said keys so that centrifugal action in the keys will hold the parts fast. A circular cap 29 covers the top of spindle 14, a lug 54 on the bottom thereof resting in a recess 54' in the top of the spindle, said cap covering the adjacent portions of the impeller bottom.

An important feature of my invention in connection with the impeller, is the provision of means for maintaining a portion of the ore or rock in position within the impeller, so as to form a wearing face consisting of the ore or rock itself which takes the impact and abrasion of the ore or rock in passing through the impeller. For this purpose the walls of the impeller are so formed as to hold the ore or rock therein against the action of centrifugal force, the steeply inclined peripheral walls of the bowl shaped impeller, for example, serving to hold a bed of ore or rock in this manner, as indicated at *b*, the bed or body of ore accumulating within the impeller until its upper surface assumes the angle of repose proper to the material being handled, as indicated by the line *a-a*, in Fig. 2. To prevent relative displacement of the bed or body of ore or rock, in the impeller, during sudden acceleration or retardation of the impeller in starting or stopping, wings or blades 30 may be provided, formed as flat strips or plates extending between flanges 31 on brackets 32 which are bolted or otherwise fastened to the bottom disk of the impeller, said brackets being arranged in pairs so that a space is left between the opposing flanges 31 of each pair of brackets adapted to receive and fit a corresponding strip or plate 30, said strip or plate projecting beyond flanges 31 sufficiently to form wings extending inwardly

into the bowl. The inner edges of these wings are preferably inclined along a line parallel to and somewhat below the line *a-a* above referred to, the same being a line drawn from the upper edge of the impeller bowl obliquely downward to the bottom of the bowl at or within the center thereof, the obliquity of this line being substantially that represented by the "angle of repose," the inclination of the bed or body of pulverized material in the bowl under the combined action of gravity and centrifugal force at normal speed of the machine, so that the upper edge of the blades or wings 30 will be slightly below the surface of the bed or body of pulverized material in the impeller bowl, and the wings or plates will therefore be protected by said body of ore or rock, while at the same time being embedded in and engaging such body of ore or rock in such manner as to cause the ore or rock to move rotatively with the impeller bowl. The blades or wings provide transverse pockets on the peripheral wall.

A die or impact receiving member is provided on top of the frame member 3, and around the lip of the impeller bowl, preferably comprising a plurality of annular members arranged one above another, each annular member preferably being built up of a plurality of sections or segments 34 of chilled steel, white iron, or other suitable material. Each of these segments is preferably formed with teeth or projections 35 extending inwardly toward the center of the machine. All of the said series of segments are maintained within a frame or retaining ring 36, and for convenience in construction and operation this ring is preferably provided with upper and lower annular flanges 37 and 38, each of which is provided with means for engaging the top of the frame member 3 so that the ring may be reversed as a whole if desired. For this purpose, each of the flanges 37 and 38 may be provided with an annular rib 41 adapted to engage in an annular rabbet 40 on the top of frame 3, the construction being such that the entire member consisting of ring 36 and annular flanges 37 and 38 with the segments 34 carried thereby, can be turned around the axis of the machine to shift the point of greatest wear on the segments 34, as may be found necessary. In case of a small machine, this rotative movement of the parts aforesaid may be effected by a capstan bar inserted in holes 56 in studs 49 or in case of a large machine, this may be effected by gearing, the annular flanges 37 and 38 being provided in that case with gear teeth, indicated at 39 and a pinion 42 being mounted on a shaft 43 journaled in a bearing 44 on the frame member 3 and provided with an operating handle 45, said pinion being adapted to engage the gear teeth on the

lower annular flange aforesaid to rotate the said parts. Said handle 45 is preferably mounted on its shaft 43 by a hinge connection 46, to enable it to be swung to one side or the other, or to hang vertically, as shown in Fig. 2.

The annular flanges 37 and 38 may be formed as clamp rings having annular grooves 37' and 38' to fit the upper and lower edges of ring 36, these members 37, 36 and 38 being clamped together, to form a rigid body, by means of bolts 47. Said body may be held rigidly in position on frame member 3 by eyebolts 48 having eyes engaging studs 49 on ring 36, said bolts extending between lugs 50 on frame member 3 and being secured by nuts 51 on said bolts and engaging said lugs.

Suitable feed means are provided for the machine, comprising for example a hopper or funnel 52 carried by a top member 53 resting on top of the upper annular flange 37, said hopper or funnel having a removable mouthpiece 63 whose discharge opening extends centrally within the impeller bowl above described, so as to conduct the material to be pulverized, into the bowl below the discharge lip thereof, said mouthpiece having a flange 53' resting on a shoulder 52' on funnel 52. Any suitable means may be provided for oiling the spindle and its bearings. For example:—As shown in Fig. 2, the spindle 14 may be provided with an axial bore 55, extending from its lower end to near the upper end of the spindle and provided with openings 57, through which oil may be discharged to the outside of the shaft within the upper and lower bearings therefor, and a screw 58 is provided within this bore for forcing oil upwardly by the rotation of the spindle. An oil well or reservoir 59 is formed in the lower frame member or casing 2, suitable means, such as openings 59' closed by caps 60, being provided within the wall of said casing for supplying such reservoir with oil. A duct 61 leads from a portion of such reservoir to a chamber 62 in the base 1 directly underneath the bearing support 10 aforesaid, said bearing support being provided with a passage 64 communicating with a passage 65 which extends through the bottom bearing plate 17 aforesaid, so as to communicate with an opening in the bottom of the spindle. A duct 66 in the side of the bearing support 10 for the lower bearing opens into an annular passage 67 communicating through a passage 68 with the oil well or reservoir aforesaid. The inner casing 4 is provided with an annular trough 70 and with an inclined annular apron 71 extending inwardly from the upper edge of said trough, and spindle 14 is provided with an oil shedding collar 72 above said apron so that any oil running down from the upper bearing into

said trough will pass through a pipe 73, a sight-feed device 74 and a pipe 75 to the oil well or reservoir aforesaid.

My invention is not limited to any special form of bearing for the machine. I prefer however, for convenience of construction and efficiency in operation to use, for the lower bearing, the form shown in Fig. 2 of the drawing and comprising the bearing sleeve 11 formed with a bearing in which the spindle 14 rotates and provided exteriorly with the rounded portion 11' formed as a zone of a sphere and fitting within the concave spherical bearing 15 formed on the supporting member 10 and on a sleeve 75 screwed on said supporting member and extending upwardly therefrom. Said bearing further comprises a bottom member 13 formed as a cup, resting on the bottom plate 17 aforesaid inclosing a series of superposed disks 78 and 79, said disks being conical and alternately convexly and concavely faced, so as to centralize themselves under the vertical pressure of the spindle. A foot or step member 80, formed as a hollow taper plug, fits in a corresponding socket 81 in the lower end of the spindle 14, and engages by a concave face at its lower end, the top of the uppermost disk 78, said plug having a passage 82 communicating at its upper end with the bore 55 in the spindle and at its lower end through passages 85 in the disks 79 and 78 and through passage 86 in the bottom member 13 with the opening 65 aforesaid, in the bottom plate 17.

In the operation of the machine, the spindle 14 is rotated rapidly by power applied to pulley 19, and ore is fed to the impeller through hopper 52, the mouthpiece of which delivers the ore or rock into the impeller bowl below the upper edge or rim thereof. The material such as ore or rock accumulates in the impeller until it fills against the side wall thereof sufficiently to cause any further amount of material to ride over the surface of the material already accumulated and to be discharged from the impeller at the upper edge or rim of the impeller bowl. The material thus discharged from the impeller moves tangentially with about 75% of the full peripheral velocity of the impeller, and strikes the die means 34, so as to be pulverized or broken by impact. The pulverized pieces descend by gravity through the space 6 within the casings 3 and 2 and through the opening 8 to any suitable receiving means. It will be understood that the bed or body of material in the impeller is in general being continually worn or carried away and continually built up or renewed in the operation of the machine, but its general shape and effect will be maintained at all times. In starting or stopping the machine there is a tendency of the material to swirl backward or forward rela-

tively to the impeller but this relative motion is prevented by the action of the wings 30 as above set forth. These wings are effectively protected from wear by the bed of material extending over the same. The only part of the impeller subjected to serious wear is the rim member 27, which, being shrunk on, may be renewed whenever necessary.

In general the material fed to the machine, for example from an overlying feeder, will tend to fall into a more or less definite part of the impeller, and will consequently be discharged therefrom so as to strike a more or less definite part of the die. This results in excessive wear at such part of the die, and in order to obviate this without the necessity of stopping the machine for replacement or shifting of the die parts, the die may be rotated from time to time, by means of a capstan bar placed in one of the holes 56 in the studs 49 on the retaining ring 36 for the die means, or by operation of gear means 39 by pinion 42 operated by handle or crank 45, so as to bring a different portion of the die means into position to receive the greater wearing action. Eventually the die means will be worn so as to be concave along its inner face, by reason of the greater wearing action near the plane of the upper edge of the impeller, from which the material is discharged, and this condition may be corrected by removing the upper clamping member 38 and rearranging the die sections 34, so that the sections that were on the top and bottom rows will be brought into the middle rows, and vice versa. The die ring may also be reversed or inverted as a whole, when desired in case of unequal wear on the upper and lower parts thereof or of any of the die sections. It will be understood that the resilient bearing support for the upper bearing of the spindle permits the spindle to rotate at the required high speed, and to gyrate as may be required for proper spinning action under varying conditions of load. In case of a large rock entering the impeller it may pass under the lower edge of the mouthpiece 63 which may be lifted thereby so as not to clog the machine.

In further explanation of the operation of the machine it may be stated that usually it is required to pulverize a material to any given limiting size. In such a case the material is handled same as in any other pulverizing device in which the screen is not a part of the pulverizer. The pulverized material drops by gravity into an elevator, onto a screen, and undersize of screen is the desired product; the oversize goes back to the hopper and enters the impeller together with the original feed. Or the pulverized material may go direct from pulverizer to screen, and oversize elevated to enter im-

peller again together with original feed. For very fine pulverizing such as to 100 mesh, air classification in place of screening has been employed to advantage with this pulverizer. The oversize is ground to a large extent in this type of impeller by the force of the original large pieces of rock grinding on the smaller, when all is trying to get up from a standstill to the discharge speed. The returning oversize having less mass come up to nearly the speed of the contact surface sooner than the large lumps, and the small pieces also attain a somewhat higher discharge speed than the larger lumps; hence in "relation to the rotation of the bowl" the larger lumps travel "backward" faster than the smaller. The result is that the smaller is ground by the coarser before it leaves the edge of the bowl impeller. The finer material does not accumulate enough kinetic energy to be broken with the same relative efficiency as the coarser when it strikes the die, and for this reason a wing type of impeller is not as efficient for fine pulverizing as the bowl type here described. Rounded rocks do not attain as high a speed before leaving the edge of the bowl as flat rocks, but still the efficiency is not impaired when doing fine pulverizing as there is more backward travel of the rounded masses, hence they grind up the smaller about as well.

The action of the rocks in the bowl is as follows: In a short while the surface of material formed in the bowl at the angle of repose becomes more or less finely pulverized up to a depth of about $\frac{3}{8}$ "; if the plates 30 should happen to extend out of the material they are worn down to surface of the material in a few minutes; the larger rocks become buried to some extent in the fine surface material, while they are being brought up to the speed of the surface in contact therewith, and they move backward in relation to the rotation of the bowl and at same time move up the inclined surface, that is they plow and roll a path represented by a conical spiral up the inclined surface. This path is immediately filled in by the displaced as well as new oversize material. The wings 30 also soon wear down to a point about $\frac{5}{8}$ " to $\frac{3}{4}$ " below the surface and this relation is from that time on maintained showing that the rocks actually plow below the surface of the material filling the bowl. I have found that an iron bowl formed to correspond with the angle of repose as given by rock material produced but very little pulverizing effect as all the material slid up the iron surface so easily that very little work was done; it is therefore necessary to make the impeller bowl less flaring than the angle of repose for the material being pulverized. The circumferential speed of the bowl is usually from

16000 to 17000 ft. per minute. There is practically no vibration as the machine runs like a gyroscope, it is practically noiseless, the rocks striking the die produce hardly any noise as long as rocks break; if a rock does not break the blow can be heard. The machine is very light for its capacity, power consumption and iron loss from wear is comparatively small. It requires no special foundation and can be erected on building frames etc. If the feed for any reason should stop, nothing happens except practically no power is consumed, so that attendance is practically eliminated. It will do the same uniform work consuming same amount of power for the same amount of work no matter what state of wear the wearing parts may be in, etc.

The oil level in the well 59 is kept high enough so that oil flows by gravity into the screw pump 58 which rotates with the spindle. In a small very fast running machine centrifugal force alone will raise the oil to the upper bearing, but in the larger and slower running machines it is necessary to augment this force by use of some pumping device such as the screw shown.

The oil level is usually kept below the center of ball and socket or universal lower bearing, as otherwise oil may overflow from the ball-socket bearing.

The oil flows in a continuous circulation from well 59, through passages 61, 64 and 86 to the screw means 58 the motion of which together with centrifugal action, forces the oil up through passage 55 and out through openings 57 into the bearings. From the upper bearing the oil runs to trough 70 and by pipes 73 and 75 back to the oil well. From the lower bearing the oil runs through passages 66 and 67 back to the oil well.

In case of a small machine, the gearing for turning the die may be omitted as shown in Fig. 5, the construction being otherwise as above described.

What I claim is:

1. The method of pulverizing frangible substances which consists in feeding the same upon a rotary centrifugal surface, accumulating a layer of said substances by and upon said centrifugal surface, centrifugally discharging the substances and pulverizing

the same over said layer of substances against an impact surface.

2. An apparatus for pulverizing frangible substances comprising a rotatable centrifugal surface upon which the substances are fed, means upon said centrifugal surface for accumulating a layer of said substances, means for causing said surface to centrifugally discharge the substances to be pulverized over said layer of substances, and an annular fixed impact surface against which the substances are thrown over said layer of substances.

3. An apparatus for pulverizing frangible substances comprising a rotatable centrifugal surface provided with an upwardly extending peripheral wall having transverse pockets for accumulating a bed of the substances thereon to receive the impact and abrasion of the substances passing over the centrifugal surface, and an annular fixed impact member surrounding and spaced apart from the upper part of said centrifugal surface.

4. An apparatus for pulverizing frangible substances comprising a rotatable centrifugal surface provided with an approximately flat bottom part and a peripheral wall extending upwardly from the periphery of said flat bottom part providing an angular construction capable of accumulating a bed of the substances thereon to receive the impact and abrasion of the substances passing over the centrifugal surface, and an annular fixed impact member surrounding and spaced apart from the upper part of said centrifugal surface.

5. An apparatus for pulverizing frangible substances comprising a rotatable centrifugal surface, a fixed frame member, a normally stationary impact receiving means adjustably mounted on said frame member, operating means for shifting said impact receiving means to different angular positions, and releasable securing means for retaining said impact receiving means in any one of such different angular positions.

In testimony whereof I have hereunto set my hand, at Los Angeles, California, this 14th day of August 1916.

GUSTAVE A. OVERSTROM.