E. C. JOHNSON.

GRINDING MILL.

APPLICATION FILED OCT. 24, 1910.

1,016,272.

Patented Feb. 6, 1912.

2 SHEETS—SHEET 1.

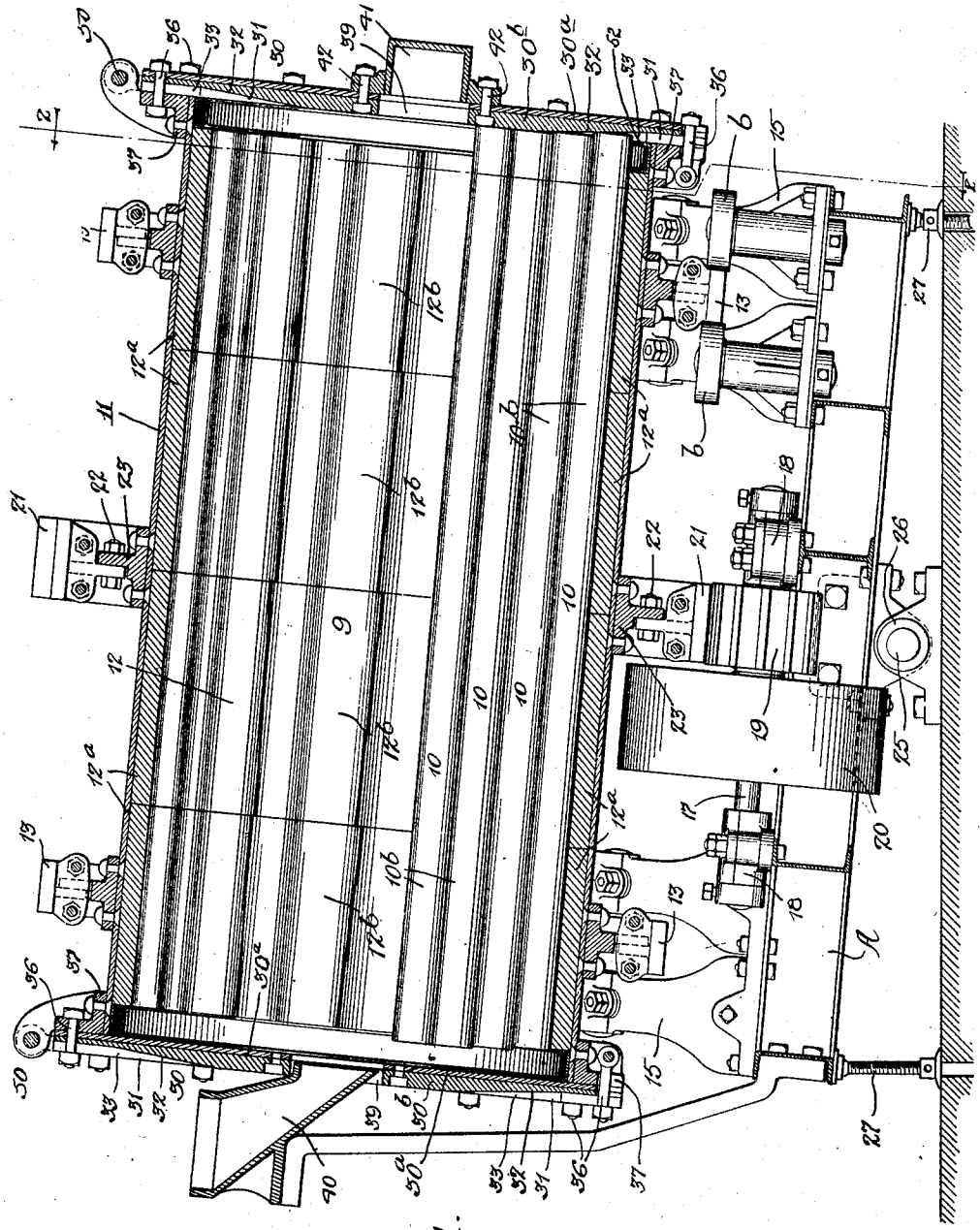

Fig. 1.

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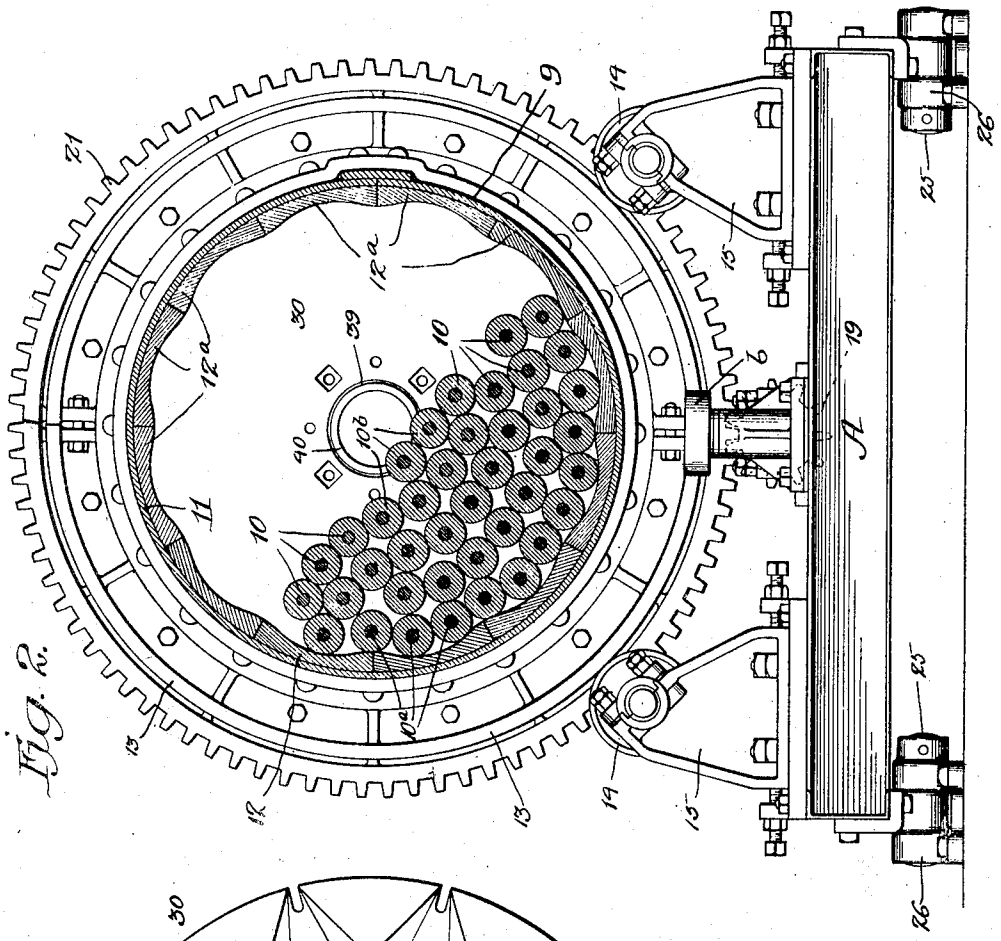

Fig. 2.

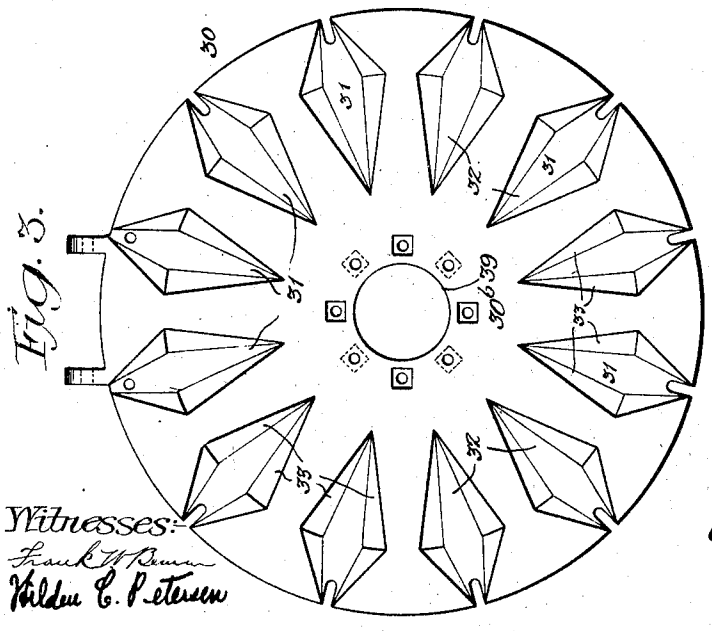

Fig. 3.

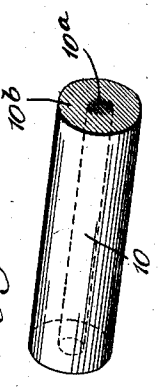

Fig. 4.

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UNITED STATES PATENT OFFICE.

ERNEST C. JOHNSON, OF HILL CITY, SOUTH DAKOTA.

GRINDING-MILL.

1,016,272. Specification of Letters Patent. Patented Feb. 6, 1912.

Application filed October 24, 1910. Serial No. 588,763.

To all whom it may concern:

Be it known that I, ERNEST C. JOHNSON, a resident of Hill City, in the county of Pennington and State of South Dakota, have invented certain new and useful Improvements in Grinding-Mills, of which the following is a full, clear, and exact description.

The present invention relates to grinding mills of that type which comprises a rotating shell or drum containing a number of longitudinally extending grinding members or rods which are adapted to reduce or grind material, such as rock or ore, by attrition, to the desired fineness and in such manner that the material will be reduced without the necessity of repeatedly treating the same in the mill and without separating the oversize material from the rest which has passed through the mill and re-grinding the former.

One feature of the invention consists in providing a drum having its lining or internal periphery formed, so that in rotation, the longitudinally extending grinding members will be rotated relatively to each other and rotated in the drum in such manner that the ore, in transit through the drum, will be quickly reduced to the desired fineness and in which this operation is efficiently and economically effected. By the provision of a slightly undulating or continuously corrugated internal periphery in the rotating drum, the loose grinding-members or rods will be caused to rotate relatively to one another and to the drum, rendering them more effective as grinders, as distinguished from an intermittent elevation and dropping of one of the grinding members upon the others, since constant relative rotation and movement of these grinding-rods will serve more efficiently, to bring all portions of the ore between the contacting surfaces thereof, and to reduce them to a mass of substantially uniform fineness.

The invention also designs to increase the efficiency of a grinding mill, by providing a structure whereby loose longitudinally extending grinding-members or rods in the drum will be operated longitudinally or in endwise direction relative to one another.

The invention also provides grinding-rods or members of improved construction whereby it will be rendered durable and whereby likelihood of breakage, resulting from operation in loose series in a drum, will be avoided.

The invention further designs to provide a grinding-mill with means for collecting metallic particles, such as gold, which have been separated from the ore by grinding.

The invention still further designs to provide a grinding-mill of improved construction and operation.

The invention consists in the several novel features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings: Figure 1 is a longitudinal section of a mill embodying the invention. Fig. 2 is a transverse section taken on line 2—2 of Fig. 1. Fig. 3 is a face view of one of the drum-heads, showing more particularly the formation of the discharge opening for the material and the surface on said head which cause the longitudinally extending grinding members to be operated longitudinally in the drum. Fig. 4 is a detail perspective of one of the grinding-members.

The improved grinding-mill comprises a rotatable drum 9 which is adapted to contain a number of loose longitudinally extending round grinding-rods or members 10 which extend substantially throughout the length of the chamber in the drum and are usually sufficient in number to fill up approximately one-half of said chamber. The drum is formed of an outer shell 11 and a lining 12, which are suitably secured together. The lining is composed of arcuate sections 12^a, and 12^b all being similarly wedge-shaped longitudinally so that when the other sections are placed in circular relation in the shell, section 12^b may be driven into place to firmly secure the lining and so that it will be self-retained in the shell. It will be understood that while I prefer to form all the sections, including the locking sections 12^b, of exactly the same shape, I may if desired employ as locking members sections 12^b of different shape from the other sections. Longitudinally, the lining is also composed of a number of annular series of sections, so that a complete lining will be built up of a number of annular series of sections and this construction adapts the lining-sections, for drums of different lengths and also makes it necessary in event of excessive wear or breakage of a section to remove and replace only the section or sections affected. The sections of the drum-lining are usually formed of chilled metal to provide an effective grinding surface and by

forming the lining in sections in longitudinal and arcuate sections, they may be readily chilled and handled.

The inner periphery or operative face of the drum, being the inner face of the drum-lining, is formed with alternating shallow depressions and raised portions, or shallow corrugations, to provide a constantly undulating surface. This undulating peripheral surface of the drum will cause, as the drum is rotated, constant relative displacement of the rods between one another and will cause constant relative rotation of all of the rods relatively to one another and to the drum, so that the material between the rods will be ground by attrition. Resultantly, the efficiency of the mill is materially increased by the rolling or rubbing action of the rods resulting from the rotation or relative movement of the undulating or corrugated surface, and more particularly in the ascending motion of the drum, to produce a most effective grinding action and furthermore the rods are caused to roll relatively to, over and between one another which causes a more efficient pulverization or grinding action than occurs in a machine in which the operative periphery is smoothly cylindrical or is equipped with means for periodically causing a rod to be carried upwardly with the drum, and then dropping it on the heap of grinding-members. The meeting or abutting edges between the sections of each annular series are disposed at the thickest portions of the lining, so that the broadest possible edge-surfaces are provided, and the keying-action of the lining sections is thus increased.

Each end of the drum 9 is provided with a removable head 30 which is formed so that one of its faces will provide a suitable closure for holding the material in the drum and so that its other face will provide peripheral or outwardly extending discharge openings through which the pulverized material will be discharged from the drum. Each drum-head 30 comprises a backing-plate 30^a and a lining 30^b. This lining has one face, being that face which forms the inner face of the drum-head at the discharge-end of the drum, formed with a series of radial grooves or channels 31. The back of each groove is inclined or tapered outwardly, as at 32, and the sides 33 of each channel 31 are also tapered. Bolts 36 are adapted to removably secure the heads to rings 37 which are riveted to the outer ends of the drum respectively, and hinges 50 pivotally connect the drum-heads to rings 37, so that the heads may be conveniently handled when access to the interior of the drum is desired. The outer face of each plate 30^a, being that which forms the inner surface of the head when it is secured at the ingress end of the drum, is substantially flat, so that it will provide a closure between the drum and the head which will not permit the material to escape between the drum and the head. As a result of providing these inclined surfaces on the drum-heads and at the discharge-end thereof, the grinding-rods work into them in their constant relative movement and rotation, gravity and such motion causing them to pass into the discharge grooves and thus move longitudinally relatively to one another, which results in additional grinding action by reason of the relative longitudinal movement of the rods and this action also increases the grinding efficiency and capacity of the mill. In ascending, the inclined faces of the channels 31 cause the rods to move longitudinally away from the discharge-end of the drum.

Each drum-head is provided with a central opening 39 through one of which the material to be crushed is adapted to be conducted to the grinding-chamber in the drum, by a hopper 40 suitably secured to a bed or frame A and the opening in the head at the discharge-end of the drum is closed by a cap 41, which is removably secured to the head by bolts 42, which permit the cap to be removed when the drum-head is to be employed at the ingress-end of the drum.

When the machine is to be used for wet grinding with water, the drum-head at the discharge-end may be reversed so that its flat face will abut against the end of the drum to close it around the periphery, and the cap 41 may be removed to cause material to be discharged through the central opening 39 in said head. Hinges 50 are suitably formed to permit this reversal.

It is desirable that the loose grinding-rods 10 should have hard rolling surfaces which contact with the material and with the other rods in the drum, but in practice, it has been found that if these rods are formed of uniform density and hardened throughout, they are so brittle that breakage frequently occurs from the stresses to which they are subjected in the drum. To overcome this objection without lessening the durability of the rods, each is formed of a core 10^a of soft or wrought metal, such as rolled iron or soft steel, and a surrounding body 10^b of hard chilled iron or steel is fused or cast around the core, and thus each rod is given a hard and efficient grinding surface and rendered less liable to breakage.

Bed A which supports the drum is tiltably mounted at its center, being pivoted, as at 25, in brackets 26 secured on the floor or support upon which the mill is to be operated. Suitable means, such as jacks 27 are provided for holding the bed and drum

at the desired inclination. By reason of the centrally disposed pivot for the drum-carrying frame, it may be tilted to incline in either direction to correspondingly vary the inclination of the drum and reverse the course of the material through the drum. The hopper 40 may be connected to either or the elevated end of the drum, and the reversibility of the drum-heads, makes it possible to discharge the material at either end of the drum.

Rings or bands 13 are secured to the shell 11 of the drum and each engages a pair of rollers 14, the rollers of each pair being disposed respectively at opposite sides of the axis of the drum and mounted in brackets 15, which are adjustably sustained by bed or frame A. This bed supports suitable driving-mechanism for the drum, which comprises a shaft 17 journaled in bearings 18 on said frame, a pinion 19 secured to said shaft and a driving pulley 20 whereby said shaft and pinion may be continuously driven. A gear-ring 21 is secured to the central portion of the drum, being bolted, as at 22, to a ring 23 riveted to the shell 11. Said gearing meshes with pinion 19 and causes the drum to rotate when the driving-mechanism is operated. A pair of rollers *b*, *b* engage the opposite edges of one of the rings 13 to confine the drum against longitudinal movement relatively to the frame or bed A.

The drum-lining is omitted at each end, to provide channels, in which a channeled copper ring 52 is placed. These rings have a coating or lining of quick-silver rubbed thereon, and may first be plated with silver, if desired. Metallic particles, such as gold, have a strong affinity for quicksilver and will amalgamate with it, and resultantly the gold particles in the grindings will be retained in these channels, while the remainder of the ground ore will be discharged through openings 31. At the end of a run, the gold may be removed from ring 52 and as the amalgam hardens and the gold is collected, additional quicksilver may be added. In practice, the ring 52 at the discharge-end only need be lined with quicksilver, but by providing a ring at each end, either end of the drum may be used as a discharge-end. These collecting channels are disposed outside of the grinding-members, so the latter will not disturb the quicksilver or amalgam in rings 52.

The operation of the improved mill will be as follows: Assuming the drum to be in the position illustrated in Fig. 1, that the material to be reduced is being supplied to the drum through hopper 40 and that the drum is being rotated by the driving-mechanism, the ore or other material entering the drum at the highest end thereof, will be caught between the constantly and relatively rotating grinding-rods, which in their rotation will cause the material to pass between the rods and be confined in the spaces therebetween. The constant rotation and motion of the rods on and between one another, the relative longitudinal movement of the rods, and the constant movement and rotation of the rods caused by, and relatively to, the undulating or corrugated internal periphery of the drum, together with the confinement of the material between the rods and the weight of the mass of rods on the material, will cause the material to be reduced or pulverized and during such treatment, it will progress through the inclined drum and when completely pulverized or reduced, will escape in radial direction through the peripheral discharge openings 31. This construction is one which results in increased capacity and efficiency of the machine and accomplishes this without subjecting the grinding-members to an impact or dropping thereof, and by consumption of little power. The free gold, released by grinding, will be collected in the rings 52 and remain there until it is removed, when desired.

The invention thus provides a grinding-mill which is efficient in operation and which reduces the material to an approximately uniform degree of fineness. The grinding-rods, formed of metals of different densities and flexibilities, are durable and have effective wearing surfaces. The drum-heads are reversible to adapt the drum for either dry or wet grinding. In event the drum-head at one end becomes worn, the drum may be discharged at the opposite end from which the worn head is located, or the drum-heads may be transposed. The drum may also be driven in either direction in event of uneven wear on the corrugations of the drum-lining.

The invention is not to be understood as restricted to the details shown and described, since these may be modified within the limits of the appended claims, without departing from the spirit and scope of the invention.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent, is:

1. A grinding-mill comprising a drum having a continuously undulating interior surface extending from end to end thereof, elongated grinding-rods of a length substantially equal to that of said drum loosely disposed therein in superimposed strata, said surface being formed to rotate and bodily shift the rods relatively to one another as said drum is rotated, and mechanism for rotating said drum.

2. A grinding-mill comprising a drum, mechanism for rotating the drum, elongated grinding-rods loosely disposed therein, and means carried by said drum for causing the

grinding-bars to move longitudinally relatively to one another.

3. A grinding-mill comprising a drum having an undulating periphery, mechanism for rotating the drum, elongated grinding rods loosely disposed therein, and on the undulating periphery, and means carried by said drum for causing the rods to move longitudinally relatively to one another.

4. A grinding-mill comprising a drum, mechanism for rotating the drum, a series of elongated grinding-rods loosely disposed therein, a head at one end of the drum, and means on the head for causing said rods to move longitudinally relatively to one another.

5. A grinding-mill comprising a drum, mechanism for rotating the drum, a series of elongated grinding-rods loosely disposed therein, a head at one end of the drum, and comprising a lining, and means on the lining for causing said rods to move longitudinally relatively to one another.

6. A grinding-mill comprising a drum, mechanism for rotating the drum, a series of elongated grinding-rods loosely disposed therein, and a head at one end of the drum, said head having outwardly extending channels therein, and inclined surfaces for shifting the rods longitudinally.

7. A grinding-mill comprising a drum, mechanism for rotating the drum, a series of elongated grinding-rods loosely disposed therein, and a head at one end of the drum with a lining having outwardly extending channels therein, and inclined surfaces for shifting the rods longitudinally.

8. A grinding-mill comprising a drum, mechanism for rotating the drum, a reversible drum-head, one of the faces whereof is provided with discharge-openings for the material and its other face being formed to close the end of the drum, and grinding-members in the drum.

9. A grinding-mill comprising a drum, mechanism for rotating the drum, a reversible drum-head, one of the faces whereof is provided with discharge-openings for the material and its other face being formed to close the end of the drum, and grinding-members in the drum, said head comprising a backing and a lining.

10. A grinding-mill comprising a drum, mechanism for rotating the drum, a reversible drum-head, one of the faces whereof is provided with discharge-openings for the material and its other face being formed to close the end of the drum, said head having a centrally disposed opening therein, removable means for closing the central opening, and grinding-members in the drum.

11. A grinding-mill comprising a drum, mechanism for rotating the drum, a reversible drum-head, one of the faces whereof is provided with discharge-openings for the material and its other face being formed to close the end of the drum, said head having a centrally disposed opening therein, removable means for closing the central opening, said head comprising a backing and a lining, and grinding-members in the drum.

12. A grinding-mill comprising a drum, mechanism for rotating the drum, a drum-head having a series of discharge-channels in one of its faces, and a central opening therein, means on the head for closing the drum against discharge of material through said channels, and a removable cap for closing the central opening.

13. A grinding-mill rod composed of a core and a surrounding peripheral or grinding portion, the latter being formed of hard metal to provide an efficient grinding-surface and the core being of relatively softer metal to prevent breakage.

14. A grinding-mill rod composed of a core and a surrounding peripheral or grinding portion, the core being formed of non-frangible metal, and the surrounding portion being formed of relatively hard metal fused upon the core.

15. A grinding-mill including a drum, and a removable sectional lining within the drum, said sections having abutting straight edges, there being longitudinal corrugations upon the inner faces of the sections, one of said sections being tapered in the direction of its length and shiftable longitudinally to bind the remaining sections together.

16. A grinding-mill comprising a revoluble drum, and a head connected to the end of the drum and having radial peripheral discharge openings in one of its faces only, communicating with the interior of the drum.

17. In a grinding-mill, a tiltable revoluble drum, a head connected to each end of the drum, each head having peripheral discharge openings communicating with the interior of the body, and being formed with a central opening, crushing members loosely mounted within the body, and means for rotating the body in either direction.

18. A grinding-mill comprising a drum, a reversible head at each end of the drum comprising a lining having peripheral discharge openings therein communicating with the interior of the drum, and means for tilting the drum to direct the contents against either head.

19. A grinding-mill comprising a drum, a head at each end of the drum having peripheral discharge openings therein communicating with the interior of the drum, and having a central opening therein, removable means for closing the central opening in one of the heads, and means for tilting the drum to direct the contents against either head.

20. A grinding-mill comprising a drum, a head at each end of the drum comprising a

lining having peripheral discharge openings therein communicating with the interior of the drum, and having a central opening therein, removable means for closing the central opening in one of the heads, and means for tilting the drum to direct the contents against either head.

21. In a grinding-mill, a centrally pivoted bed, a revoluble drum supported upon the platform, a head removably connected to each end of the body and having a central opening, a feed device mounted upon the bed and directing material into one end of the body, means for rotating the body, and means for tilting the body to direct the contents thereof against either head.

22. In a grinding-mill, a centrally pivoted bed, a revoluble drum supported upon the platform, a head removably connected to each end of the body and having a central opening, a feed device mounted upon the bed and directing material into one end of the body, means rotating the body in either direction, and means for tilting the body to direct the contents thereof against either head.

23. A grinding-mill comprising a drum having terminal outlets, grinding-bars, and inwardly inclined deflectors for shifting the bars away from the outlets.

24. A grinding-mill including a revoluble drum, grinding-bars, and a head having peripheral outlet openings, said head having inwardly inclined deflecting portions for shifting the bars away from the outlets.

25. A grinding-mill comprising a drum, a drum-head having outwardly extending discharge-openings therein, the drum being provided with a channel at its discharge-end for retaining the particles released from the ore by grinding.

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