F. E. MARCY.

ROLLER MILL.

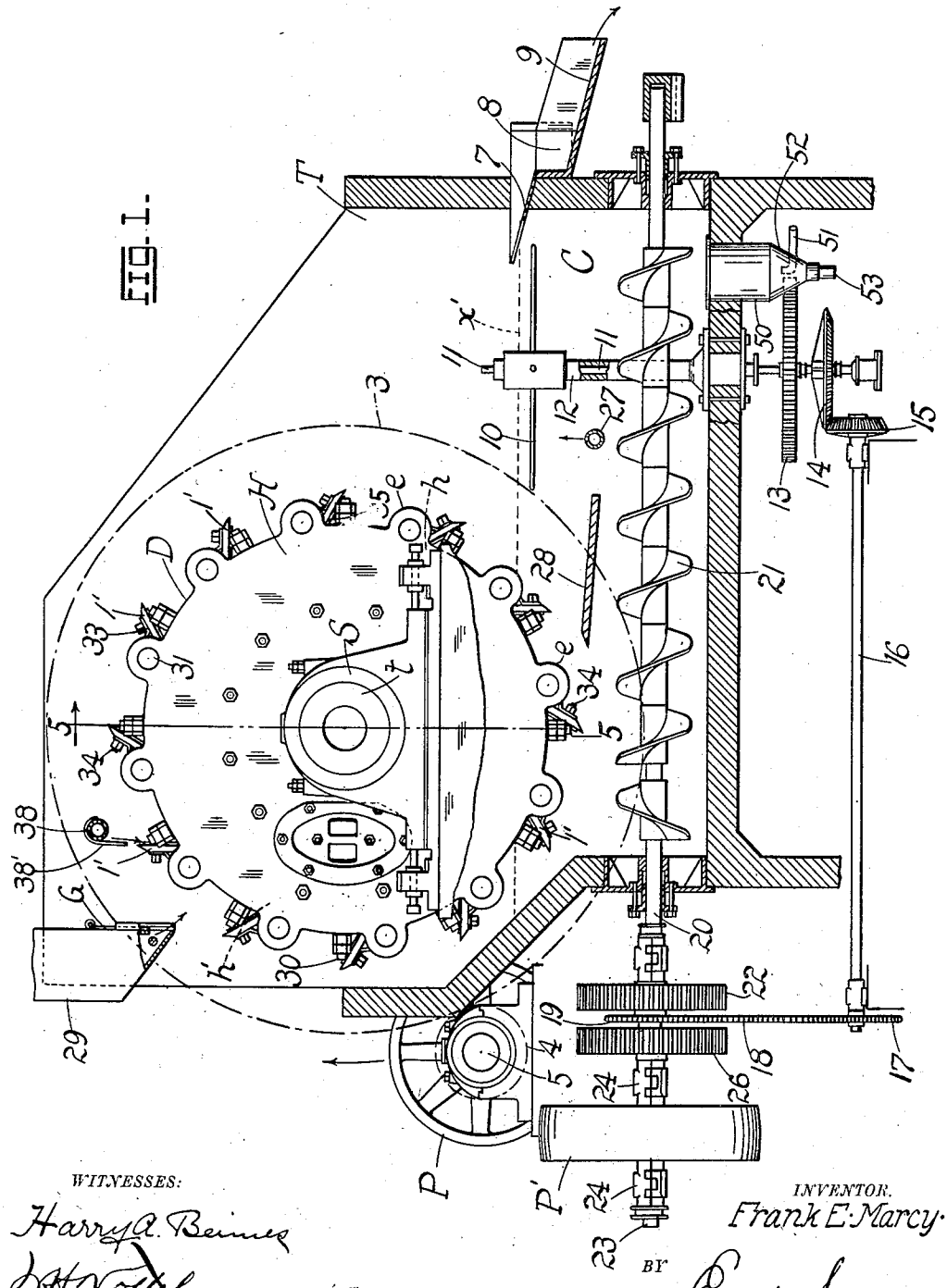
APPLICATION FILED AUG. 2, 1916.

1,239,286.

Patented Sept. 4, 1917.

4 SHEETS—SHEET 1.

FIG. 1.



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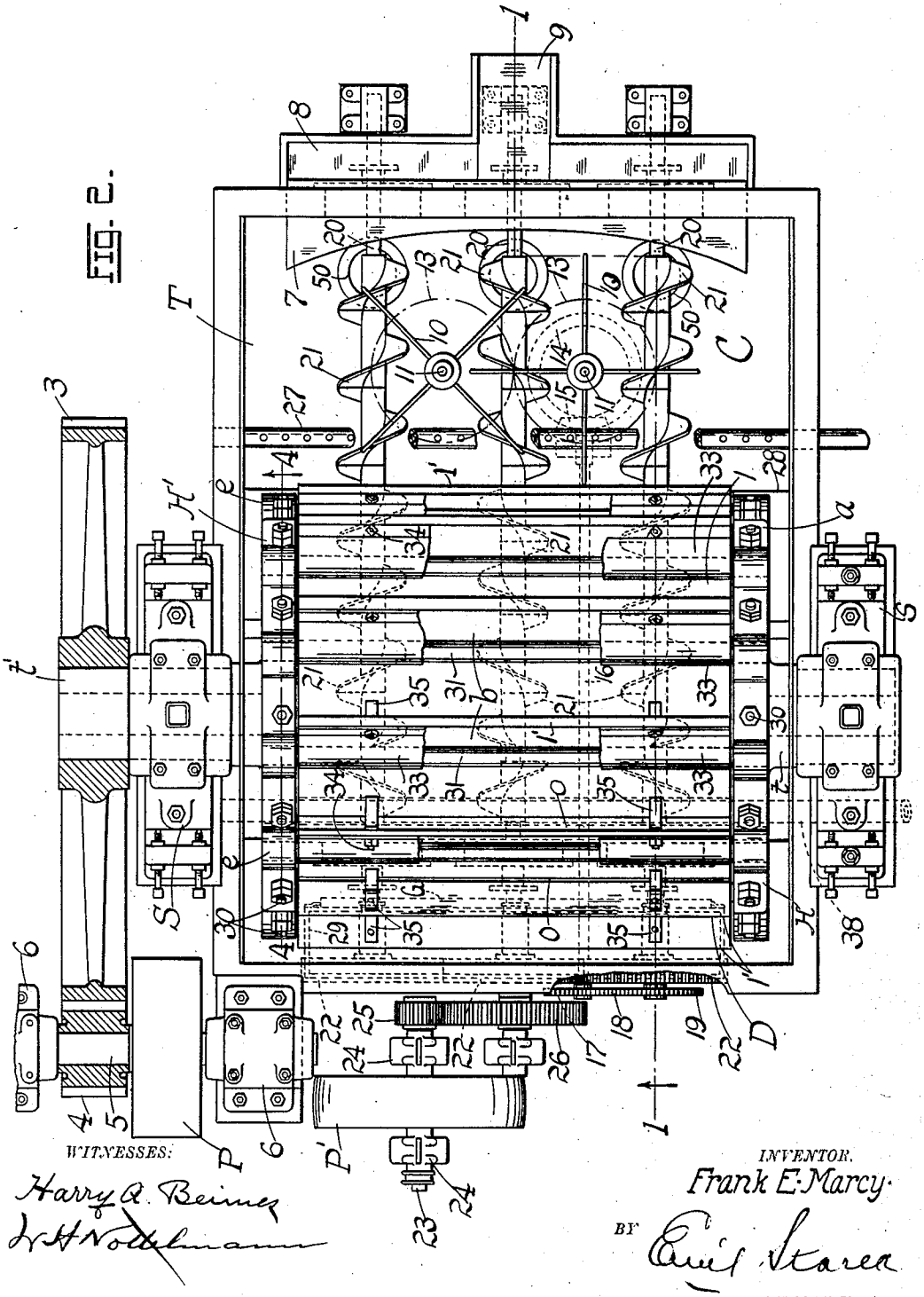
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4 SHEETS—SHEET 2.

FIG. 2.



WITNESSES:

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4 SHEETS—SHEET 3.

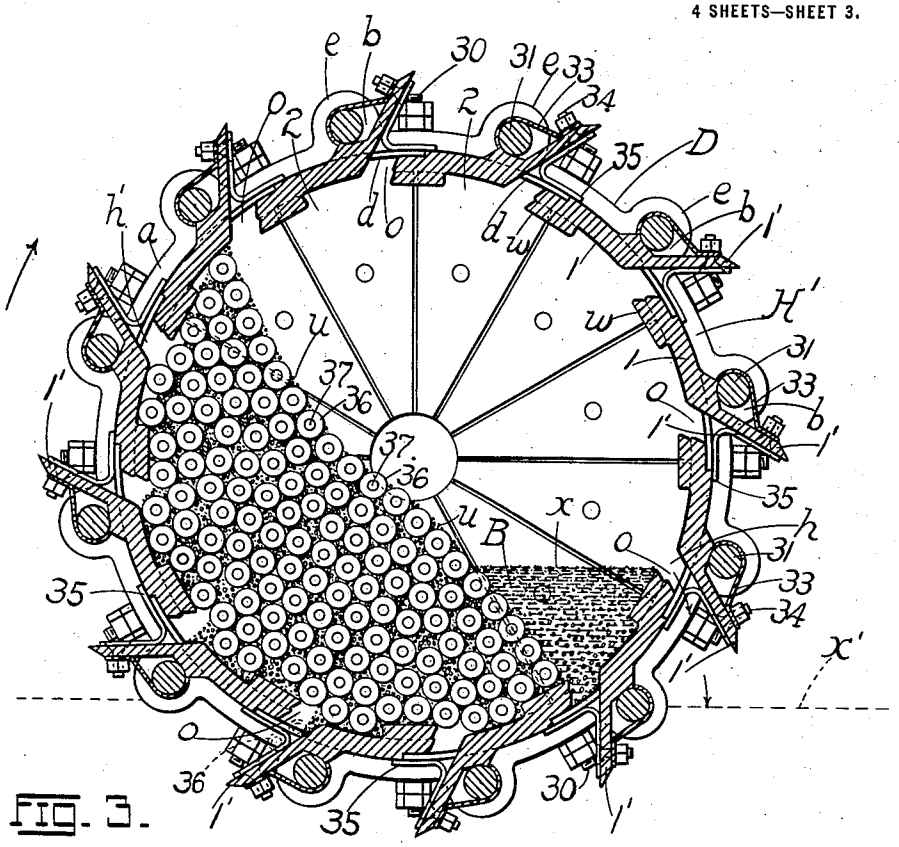


FIG. 3.

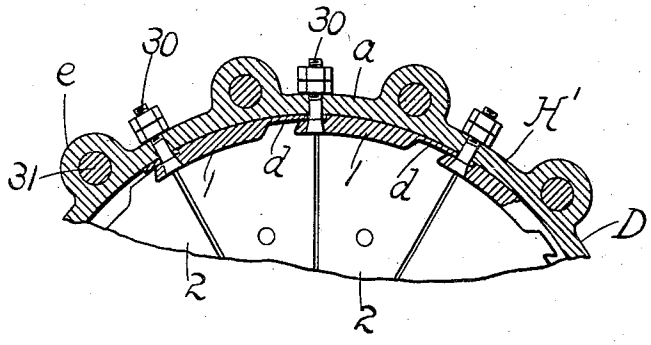


FIG. 4.

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1,239,286.

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4 SHEETS—SHEET 4.

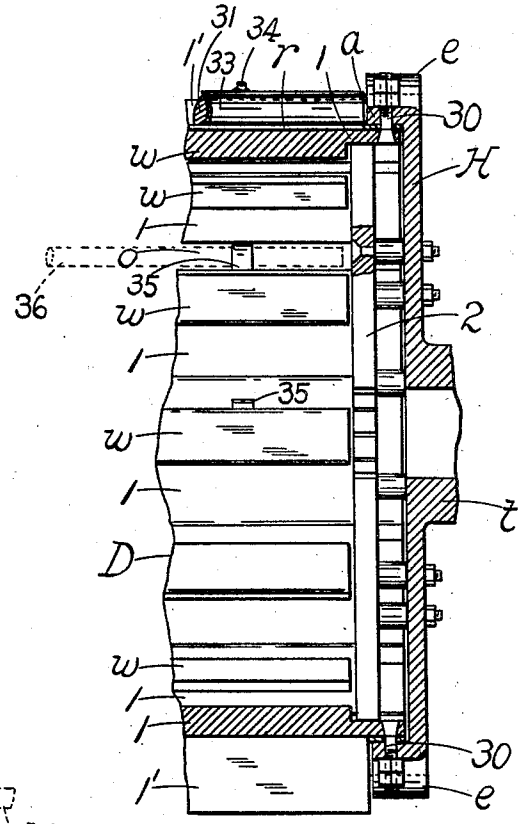
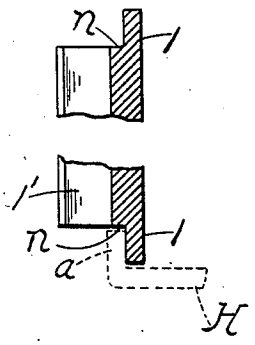


FIG. 5.

FIG. 8.



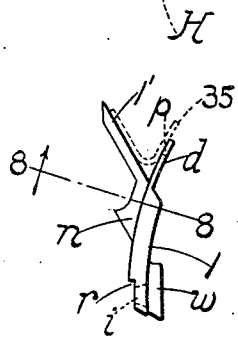


FIG. 7.

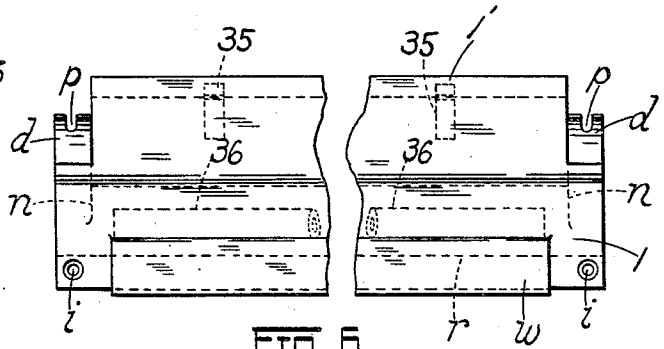


FIG. 6.

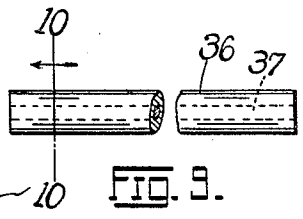


FIG. 9.

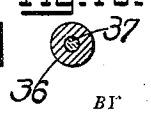


FIG. 10.

WITNESSES:

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UNITED STATES PATENT OFFICE.

FRANK E. MARCY, OF SALT LAKE CITY, UTAH.

ROLLER-MILL.

1,239,286. Specification of Letters Patent. Patented Sept. 4, 1917.

Application filed August 2, 1916. Serial No. 112,747.

To all whom it may concern:

Be it known that I, FRANK E. MARCY, a citizen of the United States, residing at Salt Lake City, in the count of Salt Lake and State of Utah, have invented certain new and useful Improvements in Roller-Mills, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention has relation to improvements in roller-mills; and it consists in the novel features of construction more fully set forth in the specification and pointed out in the claims.

The present invention is directed to that class of crushing and disintegrating apparatus wherein the material is reduced to particles of the desired size by means of (preferably) cylindrical freely movable crushing bodies, rolls, or rods acting by impact and attrition upon the charge temporarily confined within a suitable tumbling barrel, drum, or equivalent container or vessel constituting the mill proper, usually rotated about a fixed axis, the intake and discharge openings in the present embodiment of my invention being disposed on the periphery of the drum, in contradictinction to that type in which the intake and discharge openings are located in the heads of the drum.

The object of my invention is to construct an ore crusher or mill of the character referred to, capable of treating or crushing by way of example, a feed from 2″ to 20 mesh and deliver a finished product varying in size from 20 to minus 150 mesh, the feed being taken from primary crushers such as the Blake or gyratory, or other available type. A further object is to construct a mill which shall attain a maximum output for a given size of mill; one capable of wet and (with slight modification) dry crushing; one in which the discharge of the mill acts as an overflow, the same taking place through a peripheral slot disposed parallel to the axis of the mill; one operating in conjunction with an adjacent classifying or sorting chamber from which the coarse sands are returned to the mill (for further grinding) through the peripheral slots serving as feed or intake openings for the mill; one in which the classifying or sorting chamber is provided with agitating means for varying at will the character of the finished product, and of the coarse sands returned to the drum for further grinding; one permitting a rapid circulation of the sands through the mill, thereby effecting a quick liberation of the fines from the coarse material and thus adding to the efficiency of the mill, it being understood by those skilled in the art that the more rapid the liberation of the fines is, the greater the capacity of the mill; one in which the finished product (or fines) is not allowed to accumulate at the points of discharge but is immediately removed, thus contributing to the rapid circulation above referred to; one in which a comparatively small amount of pulp is present in the crushing chamber of the mill, the overflow level being near the bottom of the mill thereby giving a longer effective path for the grinding rods to travel, experience showing that an excess of pulp in the drum or mill (say if the mill were half full of pulp) interferes with the grinding efficiency of the rods, thereby reducing the output of the mill; one from which the worn out rods may be removed through the peripheral slots of the mill by a mere reversal of the rotation of the mill; and one containing features of construction whose advantages will be apparent from a detailed description of the invention in connection with the accompanying drawings in which—

Figure 1 represents a vertical longitudinal section of the outer tank on the zig-zag line 1—1 of Fig. 2, the mill proper being in end elevation; Fig. 2 is a top plan of the mill and tank; Fig. 3 is an enlarged middle vertical cross-section of the mill proper; Fig. 4 is an enlarged sectional detail on the line 4—4 of Fig. 2 showing manner of connection between the shell or wall sections of the mill and the head; Fig. 5 is an enlarged longitudinal vertical section through one end of the mill on the line 5—5 of Fig. 1; Fig. 6 is an inside plan of one of the shell and liner sections of the drum or mill proper; Fig. 7 is an end view thereof; Fig. 8 is a longitudinal section of the shell and liner section of member on the line 8—8 of Fig. 7; Fig. 9 is a plan of one of the grinding rods or rollers; and Fig. 10 is a cross-section on the line 10—10 of Fig. 9.

Referring to the drawings, D represents a

cylindrical drum or equivalent container rotatable about its longitudinal axis, the heads H, H′, whereof are provided with trunnions *t*, *t′*, respectively (one or both of which may be hollow) supported in the bearings or standards S, S, as shown. The heads are provided with marginal flanges *a* to the inside of which are bolted the peripheral wall sections 1, collectively forming the shell of the drum, these sections serving likewise in the capacity of a wall liner, the inner faces of the heads being protected by the end liner sections 2, bolted to the heads, said liner sections being preferably in the form of radial sectors as shown. The trunnion *t′* extends a suitable distance beyond its supporting bearing S, and carries a gear wheel 3 which meshes with a pinion 4 on the drive shaft 5, the latter being supported in bearings 6, 6, between which the shaft has secured thereto a belt pulley P to which rotation may be imparted from any suitable source of power (not shown) as well understood in the art. The speed of rotation of the pulley P is such as to impart about twenty revolutions per minute to the gear 3 and hence to the drum D. The drum operates between the side walls of a tank T one end of which is provided at a suitable level with an overflow apron or platform 7 for the fines or finished product, the latter being discharged into a trough 8 from which leads a central discharge spout 9 for conducting the material to any suitable point for further treatment, as well understood in the art. The apron 7 is positioned in a plane substantially at the same elevation as the bottom of the mill, being located adjacent to what may be termed the sorting end or chamber C of the tank, the material in said chamber becoming sorted or classified, the fines flowing over the apron 7 and the heavier sands gravitating toward the bottom of the chamber whence they are returned to the crushing chamber of the drum or mill for further grinding as presently to be described. Assuming that the mill is operating on wet material or pulp, it is apparent that if the pulp is allowed to remain in a comparatively quiescent state in the sorting chamber C, only the finest particles will flow over the apron 7, the quiescent state of the water allowing the heavier sands to settle. If the material is ground to an impalpable powder it will settle slowly; if comparatively coarse, it will settle faster. If now we equip this sorting chamber with an agitator of some kind, we can impart a velocity to the mass thus floating off with the fines a certain percentage of the coarser sands. The percentage of coarse sands which can thus be floated off will depend on the degree of agitation imparted to the mass, such degree being regulated by the speed of the agitator (where a mechanical agitator is employed) or by the pressure of air or gas where a pneumatic agitator is utilized.

In the present embodiment of my invention I show the sorting chamber C equipped with both a mechanical agitator and an air pipe, either or both of which may be availed of for agitating the mass to any degree, depending on the character of overflow material desired. In the present illustration I show two mechanical agitators in the form of horizontally revolving armed spiders 10, 10, mounted so the arms of one spider will clear the arms of the opposite spider, the agitators being secured to the upper ends of the vertical shafts 11, 11, mounted in tubular bearings 12, 12, leading from the bottom of the tank T, the lower ends of the shafts below the bottom of the tank being provided with intermeshing gears 13, 13, whereby simultaneous rotation may be imparted to both shafts. One of the vertical agitator shafts is provided below the gear 13 with a bevel gear wheel 14 with which meshes a bevel pinion 15 at the inner end of a horizontal shaft 16, whose outer end carries a sprocket wheel 17 from which leads a sprocket chain 18 over a similar sprocket wheel 19 at the adjacent end of the shaft 20 of the outer member of a series of screw conveyers 21 (three in the present example) mounted longitudinally of the tank T below the grinding mill and traversing the sorting compartment C, the purpose of which conveyers is to conduct the coarse sands allowed to settle in the compartment C, back to a point where they can be picked up by the mill for further grinding. The forward ends of the parallel conveyer shafts 20 are provided with intermeshing gears 22 whereby, upon rotation being imparted to one shaft the others will operate simultaneously therewith, the pitch of the screw of the middle conveyer shaft being necessarily opposite to those of the outer shafts (on account of the opposite rotation imparted thereto) to cause the material to be conveyed in the same direction as that conveyed by the outer shafts (Fig. 2). The conveyer shafts are driven independently of the mill or drum by a belt pulley P′ on a short shaft 23 supported in bearings 24, 24, the inner terminal pinion 25 on said shaft meshing with a gear 26 at the adjacent terminal of the middle screw conveyer-shaft of the series. This independent drive (as quite obvious from the connections described) will drive not only the several conveyers, but the agitators as well, it being possible to impose any desired rate of speed thereon. Should it be desired to change the speed of the agitators without a change in the speed of the conveyers, this may be done by the skilled mechanic by simply changing the gears, as well understood in the art. The drives for the agitators and conveyers here shown need not of course be

adhered to, any other form of drive falling within the contemplation of my invention. Neither do I wish to restrict the agitators to revolving agitators, or agitators revolving in horizontal planes, those here shown serving merely as examples.

The mechanical agitators may be supplemented (or even displaced) by a peripherally perforated air pipe 27 disposed across the sorting chamber C, an air pipe being specially applicable in cases where it is found desirable to add to the pulp a suitable proportion of oil to gather the fine sulfid particles of ore in the form of a froth as is the practice in flotation processes, the air injected into the mass contributing to the formation of the froth which then would flow over the apron 7 as previously described. Of course the use of the mechanical agitators or beaters 10 alone would in a measure tend to froth formation, but not as effectively as the air or gas pipe 27.

In the present invention the material to be ground is fed to the mill through the peripheral walls or shell of the mill, the crushed material being likewise discharged through said walls, after which it is evenly distributed across the tank T by the deflector 28 disposed across the tank between the mill and the sorting chamber C. The feed (material from the primary crushers) is supplied to the mill from any convenient hopper or spout 29 whose discharge is controlled by a gate or door G or its equivalent, well understood in the art, the same being here shown more or less conventionally.

As pointed out above, the shell of the drum or mill is composed of a series of longitudinal sections 1 (which serve also as wall liners) arcuate in cross section, the same being bolted or otherwise secured to the flanges *a* of the heads H, H′, of the drum, and spaced sufficiently apart to provide longitudinal peripheral slots or openings *o* for the intake of the material into, and its subsequent discharge from, the crushing chamber of the drum, said discharge, in the normal operation of the drum being substantially at the point *h* in the plane of the level *x* of the pulp in the drum, and above the plane of overflow *x′* from the tank T, the deflector 28 being of course below the plane of the drum discharge. The position of the intake of the original feed may be said to be at the point *h′* (Figs. 1, 3). The terminals of the shell sections 1 enter the flanges *a* of the drum heads H, H′, and are secured thereto by bolts 30, the portions of the shell section received by the flanges being thinner than the main body of the section whereby an offset or shoulder *n* is formed between the main body and the portion entering the flange *a* (Figs. 7, 8). When the parts are assembled the shoulders *n* bear or abut against the inner edges of the flanges *a*. The outer face of the body portion of each shell section 1 forms a supporting ledge for a cylindrical peripheral stiffener rod 31 disposed between the drum heads H, H′, and received by the perforated lugs *e* thereof, said rods performing additional functions presently to be referred to. The reduced terminals of the shell section 1 are provided on one side with a further reduced extension or tongue *d*, the opposite side of the section having formed thereon a recess or rabbet *r*, whereby the tongues of one section are received by the recess of an adjacent section when the several sections are assembled, the widths of the recesses being uniform so that the sections are uniformly spaced from one another. The tongue terminals are provided with openings or recesses *p* for the reception of the bolts 30. Each section 1 has formed on its inner face adjacent one edge thereof opposite the recess *r* and between the bolt-receiving openings *i*, suitable rib formations *w* terminating within the vertical planes of the inner edges of the flanges *a* (Fig. 5), said ribs serving as lifters to carry up for a certain distance the grinding bodies with the rotation of the drum, said bodies at a given elevation becoming released from the ribs, and rolling down the remaining bodies and over the material and crushing the latter as well understood in the art. Formed integrally with the shell sections 1 and disposed at an angle to the arcuate portions thereof, are the wings, shoes, or equivalent formations 1′, the same being disposed adjacent the slots *o* and projecting beyond and outside the periphery of the drum, said wings being disposed at an angle to the radii of the drum, whereby in the drum's normal direction of rotation, they operate as shovels to return the coarse sands delivered thereto by the conveyers 21 back into the drum through the slots *o* thereof. The spaces *b* between the rods 31 and shovels 1′ are bridged or spanned by the sheets or plates 33 secured along one edge to the shovel by bolts 34, the opposite edge of the plate looping over the rod as fully shown in Fig. 3. The object of the plates 33 is to prevent the pulp from accumulating in the spaces *b*, thereby keeping the periphery of the drum always clean and free from pulp.

The present is primarily designed to operate as a roller mill, the crushing or attrition bodies being in the form of loose rods or rollers well understood in the art. As is well known, these rods soon wear down, and, as grinding bodies, are no longer serviceable. Initially, the rods are introduced through the hollow trunnion of either head H, H′, of the drum where both trunnions are hollow, or through the trunnion *t′* where only this is hollow. To discharge the worn down rods where they have not become unduly bent or kinked, the operator

simply reverses the rotation of the drum or mill from normal, the ribs *w* positioned as they are adjacent the longitudinal edges of the slots *o* causing the thinned rods to automatically discharge through the slots in such reverse rotation, the discharged rods dropping into the tank T whence they can be quickly removed by the operator. To effect such discharge however it is necessary to first remove the clips 35 by which the slots *o* are spanned at suitable points, the clips being secured to the shovels 1′, and so positioned as to prevent the grinding rods from dropping out through the slots in the normal operation of the mill should the rods wear down to the point where this was possible. These clips (two for each slot *o*) are secured in place by the same bolts 34 which secure the bridge plates 33 to the shovels 1′. To permit the rods to discharge however, only a portion of the clips need be temporarily detached from the shovels. In the present embodiment of my invention however I prefer to employ a composite roller or grinding rod in the form of an outer tubular section 36 of cast steel or iron filled with a core 37 of friable material such as cement, wood pulp or the like which is readily disintegrable by attrition, the purpose of such a composite roller or grinding rod being to overcome the tendency of the rollers to bend or kink as they wear down to a small cross-sectional diameter where they can no longer resist the impact of fresh and heavier rollers introduced into the drum. In the prevailing mills of this class where steel or iron rollers are employed, by the time the roller wears down say to an inch or less in cross sectional diameter, such a roller not only is apt to work out of parallelism with the axis of rotation of the drum, but when impinged against by a much heavier roller of full weight and diameter, it is apt to become bent, and after a while the drum fills up with a mass of bent or kinked metal rods which it is difficult to remove from the mill. With my improvement however, by the time the roller wears down to the point where the friable core or filler is reached, such core body simply disintegrates or is ground up with the ore and is thus rendered harmless. It follows therefore that the grinding bodies or rollers need only be fed into the mill as they gradually disappear with wear, and the objection of an accumulation of twisted rods and kinked metal in the mill, and its subsequent removal therefrom does not arise. Should however a composite roller at any time necessitate removal from the drum when worn down sufficiently to pass through a slot *o* it may be discharged by simply reversing the drum as already pointed out (Fig. 3). To prevent an accumulation of sand on the shovels 1′, I provide at the proper point a spray pipe 38 which washes the shovels clean, this pipe being positioned beyond the point of discharge from the feed hopper or spout 29 and preferably provided with an apron 38′ for converting the spray jets into a sheet of water which will play against the shovels.

The operation of the mill is too obvious to require detailed description, but briefly stated is substantially as follows: Rotation in proper direction being imparted to the mill or drum (see arrows Figs. 1, 3) and to the agitators and screw conveyers through the systems of gearing previously described, and the pulp being fed from the hopper 29 on the drum, the pulp enters the crushing chamber of the drum through the peripheral slots *o* and falls immediately on the grinding rods 36, the grinding action commencing at once. The water from the spray pipe 38 assists in delivering quickly to the mill the ore from the feeder 29, at the same time cleaning the shovels 1′ as previously pointed out. The wet material traverses the crushing chamber of the mill or drum in paths transverse to the axis of rotation of the drum, (or parallel to the plane of rotation of the drum) the virtue of the present arrangement being that the circulation of the pulp through the mill is rapid; and since the overflow level in the tank T is substantially at the same elevation at the bottom of the mill, there is comparatively little pulp in the mill while the mill is in operation. This gives a longer effective path for the rods to travel, experience proving that if the mill were filled half full of pulp, the efficiency drops. This is due to the fact that there is not as much sand on the rods as when the mill is nearly empty of pulp. The material crushed in the mill will collect in the pool or basin B between the inner face *u* of the grinding rods and the opposite inner surface of the drum, whence it discharges at the point *h* into the tank T and over the deflector 28. The discharge from the mill being peripheral, and the material being put through the mill quickly, prevents accumulation of the finished product inside the mill, thereby increasing its efficiency, it being possible to treat the coarse sands as fast as the fines are gotten rid of. In the present embodiment of my invention the coarse sands not carried over the apron 7 are returned to the crushing compartment through the slots *o* by the shovels 1′ which pick up the sands as fast as they are delivered thereto from the sorting compartment C by the conveyers 21, these coarse sands being kept suspended in the water in the tank within reach of the shovels dipping below the overflow level *x′* in said tank as plainly obvious from Figs. 1, 3, of the drawings. The coarse sands returned from the sorting chamber C (as well as the coarse sands from

the original feed) being applied directly to the grinding rods by reason of the peripheral feed to the crushing chamber of the drum, add to the efficiency of the mill as the rods roll down the incline of the face *u* of the body of rods in the drum. The material not returned to the mill by the conveyers 21 and shovels 1′ passes from the sorting chamber C over the apron 7 into the trough 8, it being possible to deliver a uniform finished product by a proper regulation of the classifying or sorting action in said chamber, brought about by proper regulation of the speed of the agitators or their equivalent. In this way we can deliver over the apron 7 a uniform product in which for example the coarse material is limited by a certain mesh screen, as a minus 20, 60, 100 or 150 and possibly 200. Anything coarser is returned by the conveyers and shovels, back to the mill. Obviously, there will always be mixed with these coarser sands mineral particles which need not be returned to the mill for regrinding, these particles tending to settle to the bottom of the tank T. To recover these before their possible return to the mill by the conveyers 21, I provide the sorting chamber or compartment C with a series of hydraulic classifiers 50 well understood in the art, said classifiers being below, and operating through, the tank bottom, the water feed-pipe 51 of the classifier producing a sufficient upward current to prevent the lighter sands from settling, but allowing the heavier mineral particles above referred to, to fall through the current into the hopper bottom 52 whence they can be discharged by a removal of the plug 53. It will thus be seen that the sorting chamber C may be drawn on for the recovery (1) of the finished fine product, (2) for the recovery of coarse mineral particles settling in the classifier bottom 52, and (3) for the return of a certain portion of the mill discharges, back to the mill for further treatment. The sorting chamber furthermore is so positioned as to permit the application of flotation should it be desired, as fully described above.

It is to be understood that the screw-conveyers here shown and described are not indispensable. Any other form of conveyer if convenient may be substituted therefor. In fact, the mill may be changed in many particulars without involving a departure from either the nature or spirit of my invention. Features shown but not referred to are well known in the art and a description thereof in the present connection is unnecessary. It is of course to be understood that the feed hopper 29 extends substantially the length of the drum so as to feed the material the full length of the slot *o*. This insures an even distribution of the pulp on the grinding rods, and a rapid and uniform crushing of the material throughout the mill.

Having described my invention what I claim is:

1. In a mill of the character described, a rotatable drum provided with peripheral openings serving as intake and discharge means for the material, crushing bodies operating in the crushing chamber of the drum, devices in the crushing chamber for lifting the crushing bodies and retaining the same in the chamber with a rotation of the drum in a direction to effect grinding, and suitable formations adjacent the openings operating to direct the crushing bodies through the openings to effect their discharge with a reverse rotation of the drum.

2. In combination with a tank provided at a given point with an overflow, a rotatable drum mounted to operate therein, said drum being provided with a crushing chamber having intake and discharge openings for the material, said drum discharging the crushed material into said tank at a point removed from the overflow from the tank, thereby forming a sorting or classifying compartment for the discharged material adjacent the overflow from the tank, means in said sorting compartment for conveying the coarse sands to the region of the drum, and means on said drum for returning the sands back to the crushing chamber thereof.

3. In combination with a tank provided at a given point with an overflow, a rotatable grinding drum mounted to operate in said tank and discharge thereinto at a point removed from the point of overflow aforesaid, and forming in the tank a sorting compartment between the drum and point of tank overflow, an agitator in said sorting compartment for regulating the character of the material allowed to escape by way of the overflow aforesaid, means for conveying the coarse sands not affected by the agitator back to the drum, and means on the drum for returning said coarse sands to the crushing chamber of the drum for further treatment.

4. In combination with a tank provided at a given point with an overflow for the fines or finished product, a rotatable grinding drum mounted to operate in said tank and discharge thereinto at a point removed from the point of overflow aforesaid, and forming in the tank a sorting compartment between the drum and tank overflow, an agitator in said compartment operating to regulate the size of the particles intended to be removed by way of the overflow, a conveyer for conducting the coarse sands not removed by the overflow to a point adjacent the drum, means on the drum for returning said coarse sands back to the crushing chamber of the drum, and a deflector interposed

between the drum and conveyer for receiving the initial discharges from the drum into the tank.

5. In a mill of the character described, a shell section comprising a member disposable lengthwise the periphery of the shell, and provided on one side and along one edge thereof with a rib, or lifter formation facing the axis of the shell, and provided at the opposite edge with a shoe or wing adapted to project beyond the periphery of the shell.

6. In a mill of the character described, a shell section comprising a longitudinal member terminating in end portions offset from the main body of the member, a suitable wing leading from the body portion at an angle thereto, the end portions being provided with reduced tongues on one side and the body portion with a recess on the opposite side to receive the tongue of an adjacent section.

7. In a mill of the character described, a suitable rotatable container provided with loose grinding bodies and having peripheral openings for the intake and discharge of the material, and means for causing the grinding bodies to discharge through the openings with a rotation of the container in a given direction.

8. In a mill of the character described provided with peripheral openings and containing loose grinding bodies, suitable devices spanning said openings to prevent the grinding bodies from falling out through the openings.

9. In a mill of the character described provided with peripheral slots for the intake and discharge of the material, suitable detachable clips spanning the slots at suitable points spaced apart, to prevent the grinding bodies from falling out through the slots.

In testimony whereof I affix my signature, in presence of two witnesses.

FRANK E. MARCY.

Witnesses:
EMIL STAREK,
SARAH M. HAWLEY.