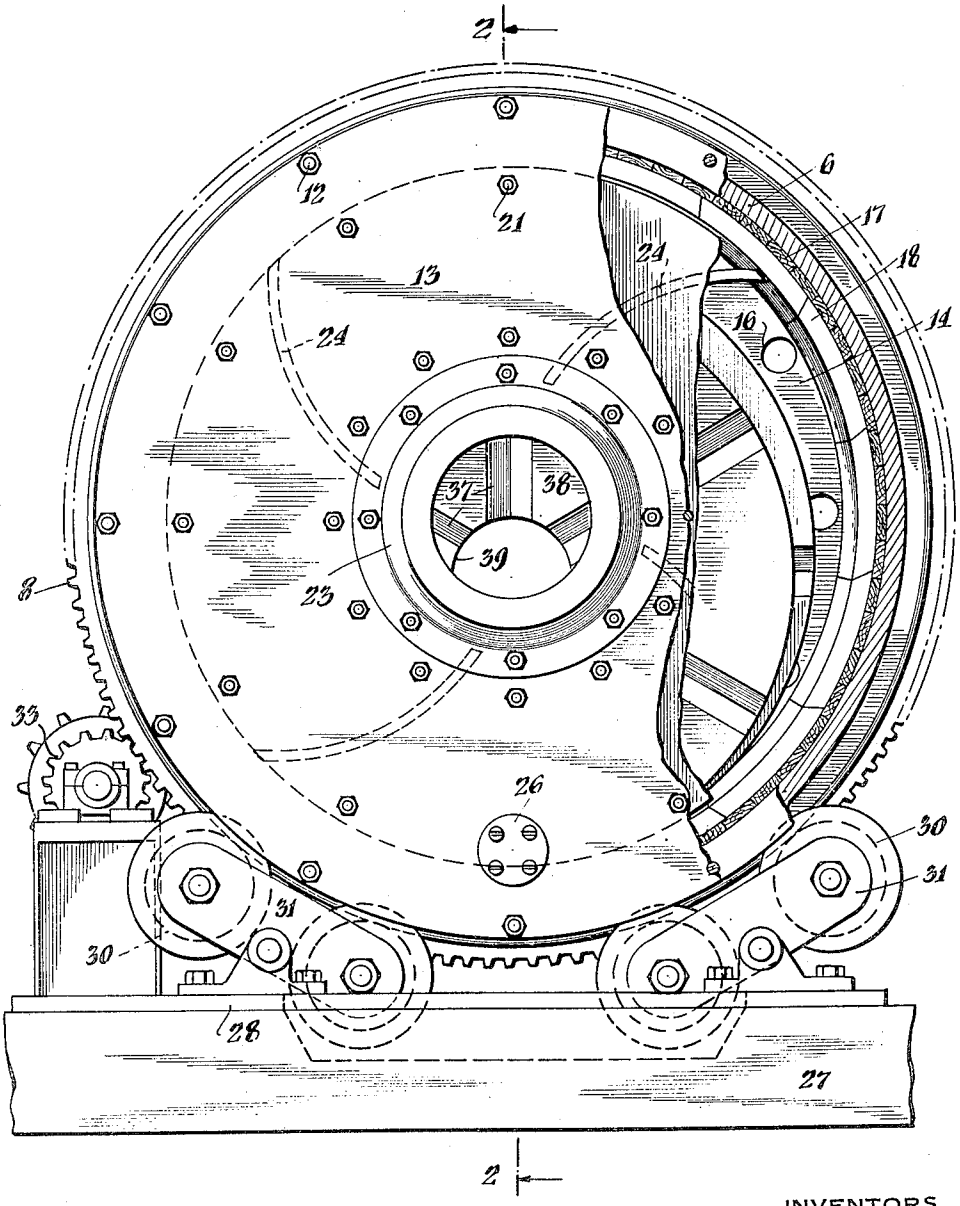
March 21, 1950 R. S. FRASER ET AL 2,501,166

PLURAL STAGE TUBE MILL

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Fig. 1



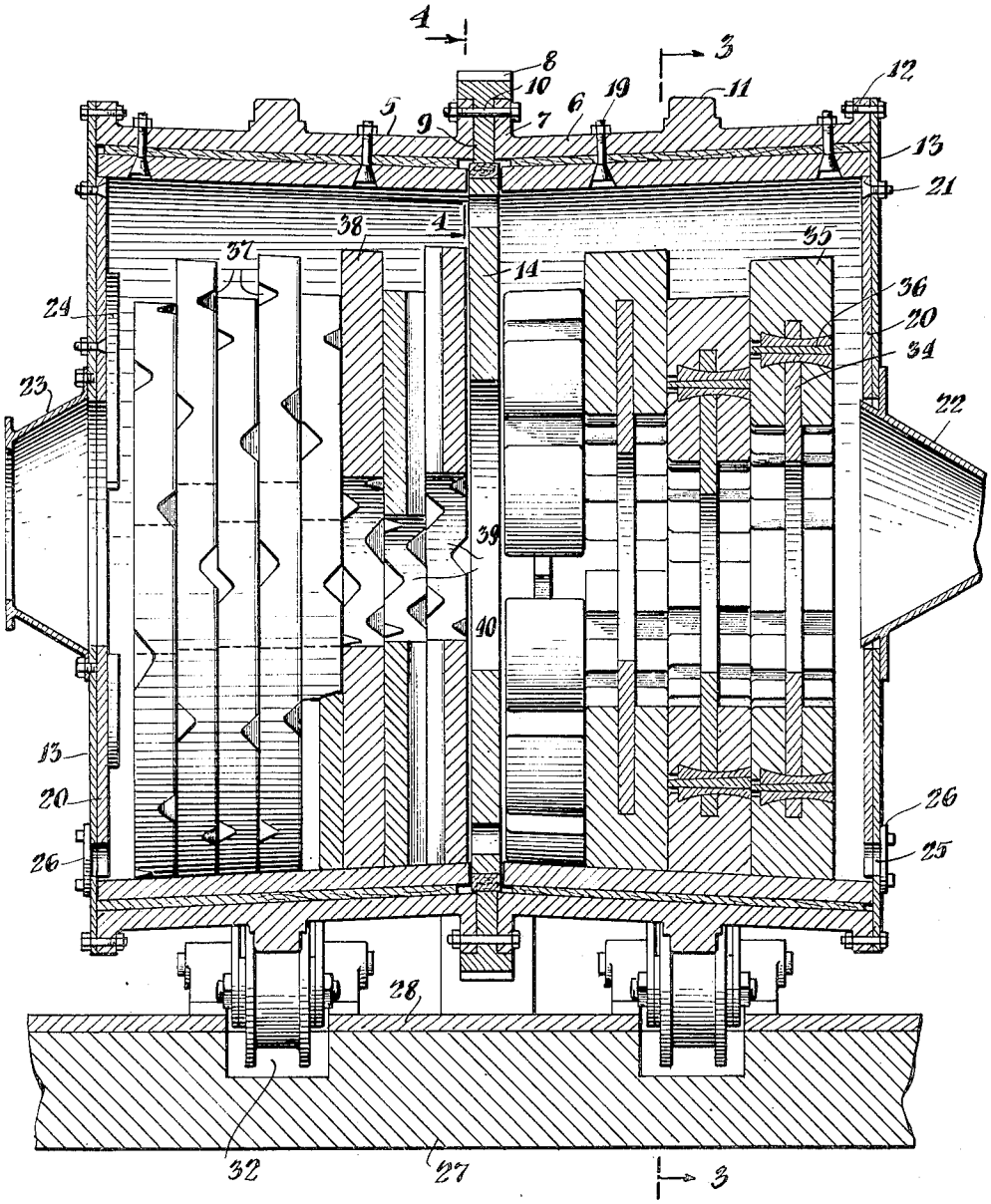
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PLURAL STAGE TUBE MILL

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Fig. 2



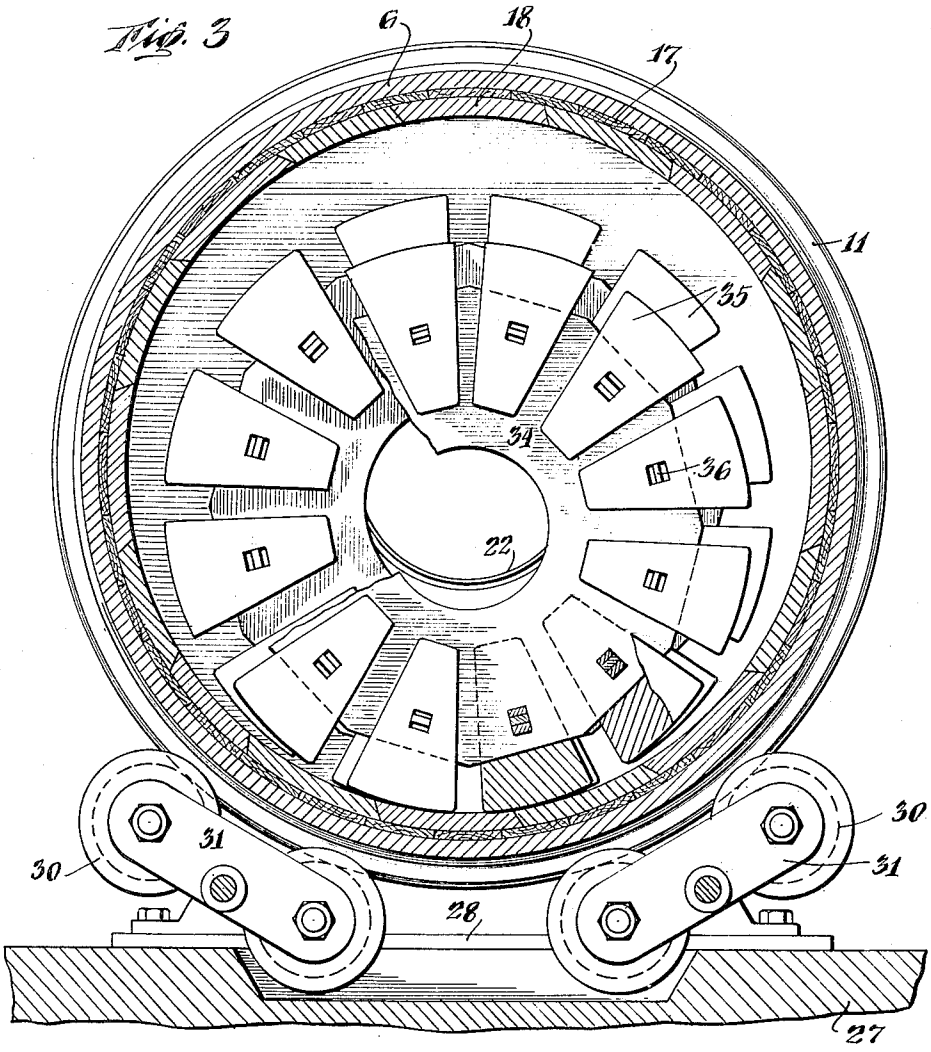
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PLURAL STAGE TUBE MILL

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Fig. 3



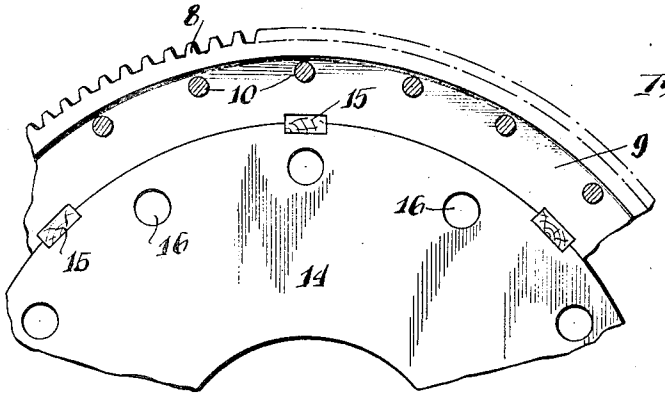


Fig. 4

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PLURAL STAGE TUBE MILL

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2 Claims. (Cl. 241—153)

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This invention relates to a structurally and functionally improved grinding mill, and especially a mill for use in connection with the crushing or reducing of ores such as gold-bearing rock and similar substances.

It is an object of the invention to furnish a mechanism of this type which may be operated at relatively high speed without such operation in any way detracting from the thoroughness of the manner in which the ore is crushed or ground.

Thus, a grinding mill will be furnished which may occupy a relatively small amount of space, despite the fact that its output will be equivalent to that of a much larger unit of apparatus as heretofore constructed. As will be obvious, this is an extremely desirable result. Also, as will be apparent, it permits of the production of a unit of this type at relatively low cost, it being therefore a further object of the invention to provide a mill of a given capacity which may be sold for a figure less than that at which a unit having an equivalent capacity may be sold.

A still further object is that of providing a mill in which those parts which are subjected to the greatest amount of wear will be capable of being readily replaced with the expenditure of but a minimum amount of time, energy, and money. Thus, aside from the fact that the expense in connection wtih both labor and material will be nominal, it will only be necessary to interrupt the operation of the mill for a relatively small time interval, thus reducing costs in that connection.

An additional object is that of furnishing a mechanism of this type which will embody relatively few parts, each individually simple and rugged in construction, such parts being capable of ready assemblage and when so assembled operating over long periods of time with freedom from all difficulties.

With these and other objects in mind, reference is had to the attached sheets of drawings illustrating one practical embodiment of the invention and in which:

Fig. 1 is an elevation of the rear or discharge end of the mill, with certain of the parts broken away to disclose underlying constructions;

Fig. 2 is a sectional side view taken along the lines 2—2 and in the direction of the arrows as indicated in Fig. 1;

Fig. 3 is a transverse sectional view taken along the lines 3—3 and in the direction of the arrows as indicated in Fig. 2; and

Fig. 4 is a sectional view of a portion of the mill structure taken along the lines 4—4 and in

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the direction of the arrows as indicated in Fig. 2.

In these views, the reference numerals 5 and 6 indicate a pair of ring-shaped members formed of steel or other suitable material and which are of tapered configuration. Thus, a pair of truncated cone elements are provided, the base portions of which are arranged adjacent opposite ends of the unit, while the inner or reduced-diameter portions thereof are disposed adjacent each other. At such inner ends, flange portions 7 may form a part of each of the elements 5 and 6. An annular member 8, conveniently T-shaped in cross section, has its shank 9 disposed to extend between the flanges 7 of the elements. Bolts 10 may extend through the flanges 7 and the shank 9 to maintain the parts in assembled relationship. Conveniently, the annular member 8 has teeth formed on its outer periphery so that it may serve as a driving ring in a manner hereinafter brought out.

Preferably integral with the shells or elements 5 and 6 are annular portions 11. Again, as hereinafter brought out, they will serve as supporting rails. Adjacent their outer ends, the elements 5 and 6 are formed with flanges 12. End walls 13 are conveniently secured to these flanges by fastening elements which will permit of the removal of the end walls when this is desirable and necessary. A partition 14 is disposed in line with the zone of juncture of the sections or elements 5 and 6. As will be appreciated, no difficulty will be experienced in assembling the several components of the mill in that this may readily be accomplished by, for example, disposing the annular member 8 adjacent the flange 7 of the section 5 and at that time also disposing the partition 14 in line with the stem 9 of the annular member. Thereupon, the section 6 may be brought to a position adjacent the annular member 8 with its flange in contact with the stem 9. When now the fastening elements 10 are disposed to secure these units to each other, it is apparent that in effect a single unitary structure will be provided, the several parts of which will be immovable with respect to each other.

As shown especially in Fig. 4, both the shank 9 of the annular member 8 as well as the partition 14 may be formed with notches or recesses. These spaces are aligned with the different members by, for example, rotating the partition with respect to the shank 9. Thereupon, securing elements 15 are disposed to extend into these recesses. Consequently, relative rotation of the parts will thereupon be precluded.

Therefore, as member 8 is turned, not alone will the truncated cone elements 5 and 6 be rotated in synchronism therewith, but also partition 14 will turn as a unit with the member 8. This partition may conveniently be formed with an annular series of openings 16, the purpose of which will be hereinafter more fully brought out. In an ordinary size, these openings may for example have a 3-inch diameter.

As shown especially in Figs. 2 and 3, the inner faces of the sections 5 and 6 do not provide the operative surfaces of the mill. Rather, a sound-absorbing layer of material is applied to these faces, and which layer will also serve as a cushioning agent. As shown in these views, strips 17 may be employed to line the entire inner faces of the rings 5 and 6. These strips may be formed of wood, cork, or other suitable material. In turn, providing a liner beyond this layer, are strips 18 which may be formed of steel. As shown especially in Fig. 3, the strips 18 have their edges undercut so that a certain interlocking relationship is established. Obviously, other configurations could be adopted. However, when fastening elements such as bolts 19 are employed, it is apparent that the layers composed of sections 17 and 18 will in effect be bound together and secured against movement with respect to the ring on which they are mounted.

As is apparent when one of these strips requires renewal, this may readily be achieved by simply loosening the proper number of bolts 19 which are preferably countersunk and thereupon removing one or more of the strips. These strips may be replaced and the parts then again secured in position. When so secured, it is apparent that one or both of the layers composed of the strip 17 and 18 will abut the periphery of the partition 14. This has been especially shown in Fig. 2. With such abutting relationship established, no lateral movement of the partition or the securing elements or keys 15 with respect to the remaining parts of the assembly may occur. Accordingly, all parts are securely anchored with respect to each other.

Lining layers 20 in the form of ring-shaped plates may be secured to the end plates 13 by, for example, bolts 21. These lining plates may conveniently be single units although of course separate sections might be employed if desired. In any event, wear-absorbing surfaces are thus furnished which may be renewed without such wear being absorbed by the outer members or shell of the mill. An intake or receiving member 22 may be secured against movement with respect to the right-hand end wall 13 as viewed in Fig. 2. This member is in registry with the central opening of that end wall and its lining layer 20. A discharge or delivery member 23 may be associated with the left-hand wall as viewed in that figure. At that end it is also disposed in registry with the outlet opening of that end wall. Adjacent such outlet opening, strips 24 are disposed, which may be curved throughout their length and integral with or otherwise secured to the adjacent layer 20. Both of the end walls 13 may be provided with openings 25, the purpose of which will be hereinafter brought out. These openings are normally sealed by plates or caps 26.

As shown in Figs. 1, 2, and 3, a foundation 27 may support the mill. This foundation may mount a base plate 28. Straps 31 may be pivotally supported upon the plate 28 and carry pairs of trunnions 30. The latter conveniently have grooved peripheral portions 32 which receive the

tracks 11 extending from the rings of sections 5 and 6. Consequently, the entire mill is mounted for rotation. Such rotation is achieved preferably by employing a suitable source of power (not shown) which will rotate a pinion 33. The teeth of the latter mesh with the teeth of the annular member 8. Therefore, when pinion 33 is rotated, the drum or mill body will likewise be rotated.

From the foregoing, it will be seen that a structure is furnished which preferably is divided into two compartments by means of the partition 14 or its equivalent. According to the teachings of the present invention, it is preferred that annular members be disposed in each compartment and that these members have different physical characteristics. As will be apparent, a different number of compartments might be employed and also in each of these compartments similar annular members might be disposed. If the structure as specifically illustrated in Fig. 2 is followed, then within the right-hand compartment, annular members which we prefer to term rotors, are arranged. Within the left-hand compartment, the annular members are of a different configuration and are termed discs. Adjacent members in each compartment are of different diameter according to a preferred type of construction.

As shown especially in Figs. 2 and 3, the rotors may include bodies 34, which are polygonal in outline. These bodies are relatively thin and are formed with openings, one adjacent each of the straight edges of such body. Contact shoes 35 are formed in their inner faces with grooves or recesses so that they may straddle and overlap the opposite surfaces of the bodies 34. Wedges or other securing elements 36 are disposed to extend through the openings of the bodies 34 and also into openings of the shoes 35. Consequently, these shoes will be securely locked against movement with respect to the bodies 34. However, should the detachment of one of these shoes be desirable or necessary, it may readily be achieved. The periphery of each of the shoes is inclined with respect to a line perpendicular to the axis of any given body 34. Such inclination will conform to the degree of inclination of the ring 6. Between the shoes 35, there will in effect be provided radially extending grooves. As the body of the mill is rotated, the rotors will also rotate. Due to the difference in diameter of adjacent rotors, a rubbing contact between the same will be established. As a consequence of the inclined peripheral edges or contact faces of the shoes 35, it will be found that with such rotation the rotors will tend to move toward partition 14 and into intimate contact with each other.

The discs within the left-hand compartment as viewed in Fig. 2 are best shown in that figure and in Fig. 1. These discs each preferably include ring-shaped solid bodies formed with radially extending grooves 37 in their opposite faces. These grooves are preferably disposed in staggered relationship with respect to each other in any given disc. Again, the peripheries of these discs 38 are inclined to correspond substantially to the degree of inclination of the inner liner face of the ring 5. As the mill is rotated, these discs will also tend to move toward the partition 14 or, in other words, to the right, as viewed in Fig. 2. This action follows because of the contouring of the adjacent movable surfaces of the assembly and the manner in which the material moves through the mill. More particularly, it will be understood that under the action of gravity the ore will tend to move downwardly. Therefore, a

greater accumulation of material will ordinarily exist adjacent the lower surfaces of the several rotors, rings and disks than exists adjacent the upper portions of the same. Consequently the base portions of these elements will tend to be spaced to the greatest extent. Therefore their bodies will tend to incline upwardly and inwardly. With such inclination and under the rotation of the parts the described action occurs. Incident to the fact that adjacent discs are of different diameters, a rubbing contact between their adjacent faces will occur with the parts moving in the manner described. As shown, each of these discs is formed with a central opening 39 which may be of smaller diameter than the opening 40 in the partition 14. However, at all times these openings 39 will be substantially in registry with each other and with the partition openings.

Now, assuming that the pinion 33 or equivalent driving unit is rotating the mill which is properly supported, for example, in the manner heretofore described, it will be understood that all of the fixed parts of the device will rotate as a unit. The discs and rotors being of smaller diameter than the inner diameter of the mill body, will also rotate but at speeds different than the speed of rotation of the mill body or shell. Incident to the fact that the diameters of adjacent rotors and discs are preferably different, an unequal rotation of these adjacent elements will occur. Because of the development of the various surfaces so that a truncated cone structure occurs and with which rotatable elements having relatively inclined peripheral portions cooperate, these elements will, under such rotation, tend to shift laterally toward the center of the mill or, in other words, toward the partition 14. Incident to such shifting, a somewhat intimate face-to-fact contact between the adjacent faces of the rotor and disc series, as well as between these series and the partition, will result. Incident to the differences in diameter, a rubbing or grinding effect will occur between the adjacent faces of the several elements of this structure.

Therefore, if the ore introduced through the opening defined by the member 22 is, for example, of ¾-inch size, it will be crushed under ordinary circumstances to a degree where it will pass through 30-mesh screen by the time it passes beyond the partition 14. This crushing will be effected by the action of the rotors in cooperation with each other and the liner of the ring 6. More especially, ore will be engaged by the contact shoes 35 and incident to the weight of the individual rotors will be fragmented. In continuing to move toward the partition, the ore fragments will in certain instances merely travel onto the peripheral edges of the successive rotors while in other instances they will be abraded between the adjacent faces of shoe element 35 and the successive rotors. Larger fragments will move within the channels defined between adjacent shoes and thereupon be reduced by contact between the edges of the shoes and successive rotors and the lining of the mill. All of the foregoing preferably occurs in conjunction with the use of water which may be caused to flow through the mill in, for example, the ratio of three parts of water to one part of ore.

The crushed ore will pass into the space defined by the ring or section 5, usually through the openings 16. It may also pass through the central opening 40 of the partition. In traversing the left-hand side of the mill, the ore under the given example will be reduced from 30-mesh to 100-mesh or, in other words, substantially completely pulverized so that thereupon it may move through an amalgamator or any other unit of apparatus which succeeds the mill.

As will be apparent, the action within the space defined by the ring 5 will be as follows: the particles of ore will be pulverized between adjacent faces of successive discs 38. Larger particles as well as small particles will be free to move outwardly or inwardly within the grooves or channels 37. Particles will also be crushed between the peripheral edges of the discs and the inner liner of the mill. Thus, a complete and effective reduction of the ore results. Adjacent the delivery end, this ore will flow—together with water—through the outlet or discharge member 23. Such flow may be assisted by the scooping effect achieved by the units 24 disposed adjacent such outlet end. A "backing-up" of the ore adjacent the delivery end will also be prevented by these elements.

While the speed of the mill may be varied in numerous respects, it has been found that under ordinary operating conditions 52 revolutions per minute may properly be maintained. This will result in 1,000 rim feet per minute being maintained. Under these circumstances, the output of the mill is exceedingly efficient. Obviously, the examples furnished with respect to the size of ore received by the mill as well as the fineness of the reduced ore after it has passed through the successive compartments of the mill, are not to be regarded as final. According to the mass, proportioning, and general size of the mechanism, as well as the hardness of the ore which is being operated upon, these results may vary in numerous respects. Also, a greater or lesser amount of water may be employed and in certain instances fluids other than water may be utilized. A recirculator may be associated with the mill structure so that, if desired, either the entire output or particles above a certain size may again pass through the mill until they have been reduced to the desired degree of fineness. Mercury may also be introduced into the mill and especially into the delivery compartment thereof, should this prove to be desirable.

As previously brought out, the construction and assembly of the several units forming the body of the apparatus is a relatively simple matter. When so assembled, an apparatus is furnished which will have virtually an indefinite length of life. The inner lining surfaces of the shell or casing which are subjected to wear may readily be renewed when necessary. Likewise, if rotors are used throughout, or in part as illustrated, the contact shoes of the rotors may readily be removed and they may be replaced. The bodies or discs of the rotors, being subjected to substantially no wear, will require no replacement or else replacement at only very prolonged intervals. If discs are employed partially or throughout the body of the mill, then at infrequent intervals they may be replaced. In this connection, it will be understood that due to the relatively great amount of exposed surface over which the grinding action occurs in connection with these discs, wear will be minimized. As will be understood, at the time any interior parts are to be renewed, the openings 25 may be uncovered to permit drainage of water and sediment from within the mill.

Thus, among others, the several objects of the invention as specifically aforenoted are achieved.

Obviously, numerous changes in construction and rearrangements of the parts might be resorted to without departing from the spirit of the invention as defined by the claims.

We claim:

1. A mill including in combination a pair of ring-shaped sections to be disposed adjacent each other, an annular member T-shaped in section, having its head disposed beyond the surfaces of said sections and its stem being interposed between the same, means for securing said sections and stem against movement with respect to each other, the inner edge of said stem extending beyond the inner faces of said sections, a partition disposed substantially in line with said stem, the inner edge of said stem being formed with notches, said partition being also formed with notches to align with said first-named notches, and means disposed within said notches to prevent relative rotation of said partition with respect to said stem.

2. A mill including in combination a pair of opposed truncated cone sections disposed in abutting relationship, a partition dividing said mill into compartments, each defined by one of said sections, rotatable elements disposed within each of said compartments and having inclined edge portions corresponding to the degree of inclination of the inner surfaces of said sections, and certain of said elements comprising ring-shaped members formed with apertures adjacent their edges, contact shoes spaced from each other and also formed with apertures to be aligned with said first-named apertures, removable fastening elements extending through said apertures to secure said shoes to said bodies, other of said elements comprising disc-shaped bodies formed with

radially extending grooves in their side faces; all of said elements being formed with central apertures and said partition being likewise formed with a central aperture and an annular series of smaller apertures formed in said partition and concentrically disposed with respect to said central aperture.

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