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Francis

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[54] **IMPACT-ATTRITION MILL UTILIZING AIR FLOW**

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[52] **U.S. Cl.** .... **241/52**; 241/69; 241/186 R
[51] **Int. Cl.** **B02c 13/09**
[58] **Field of Search** .... 241/52, 55, 80, 68, 69, 241/186 R, 189 R

[56] **References Cited**

UNITED STATES PATENTS

335,827	2/1886	Mead	241/52 X
1,699,849	1/1929	Lykken	241/80 X
1,702,248	2/1929	Crites	241/52
2,486,421	11/1949	Kessler	241/69 UX
2,546,286	3/1951	Zakel	241/55 X

FOREIGN PATENTS OR APPLICATIONS

316,922	8/1929	United Kingdom	241/52

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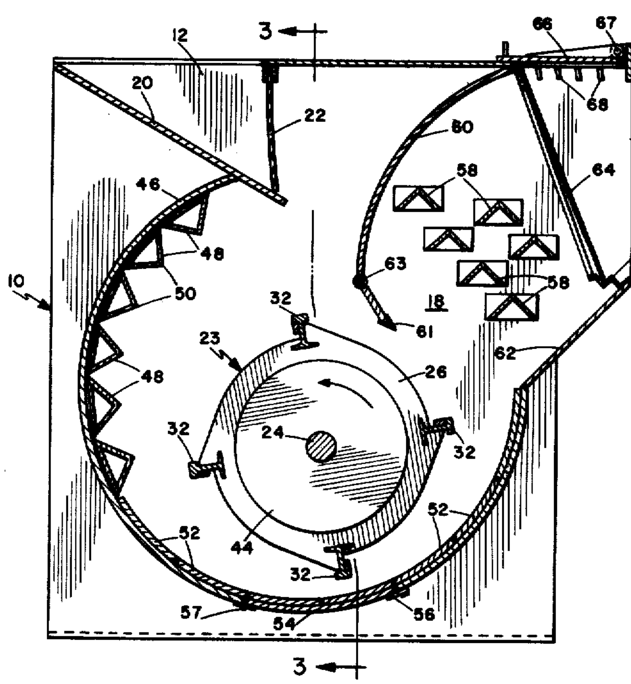
[57] **ABSTRACT**

A mill for the reduction and classification of ore utilizing an impact rotor to obtain the initial reduction of large ore chunks and particles by impaction against hammer bars mounted on the rotor and shatter bars. The shatter bars are mounted on walls of a primary reduction chamber in a position to be impacted by the ore thrown from the impact rotor. After primary reduction a secondary reduction is obtained when the heavy particles are carried by the air flow into contact with breaker bars in a fine reduction chamber. Gravity return of the heavier of these particles causes a secondary impact with the impact rotor producing a continuous interchange of particles and resulting in the autogenous attrition of the particles between the rotor and breaker bars.

8 Claims, 6 Drawing Figures



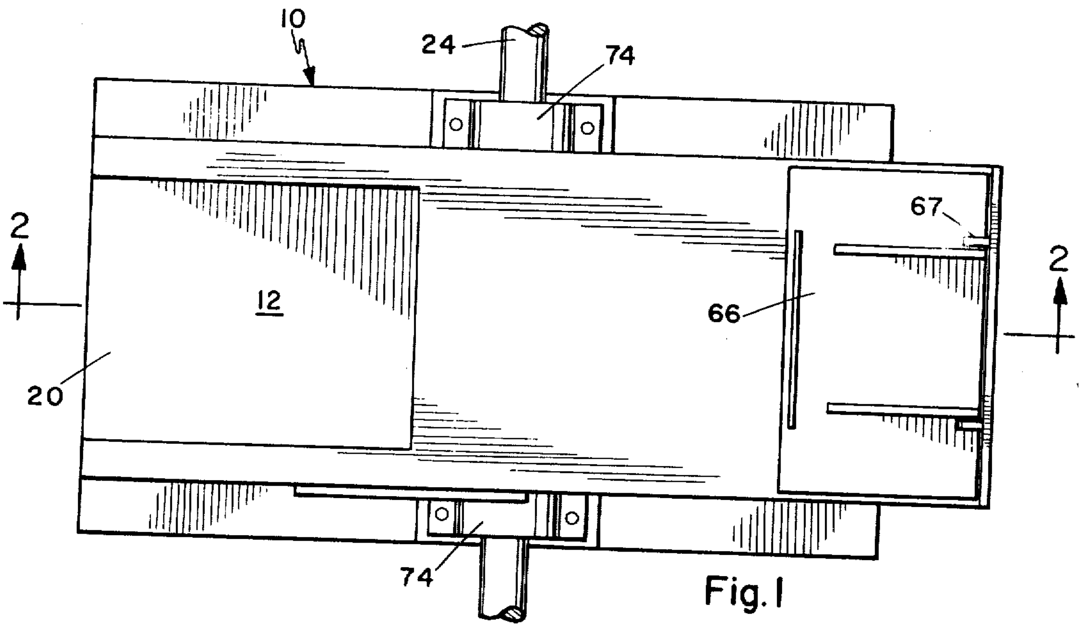

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Fig. 1

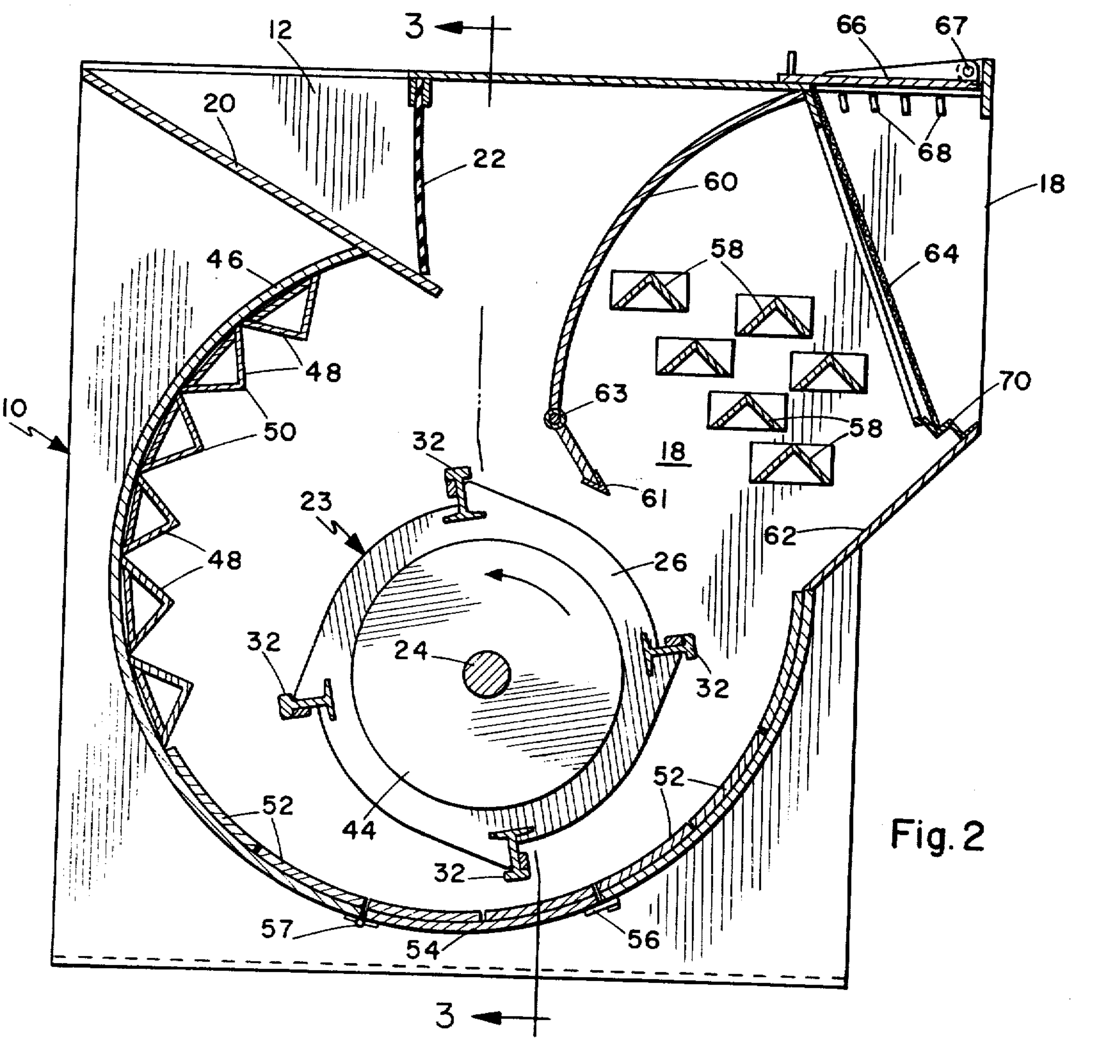
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Fig. 2

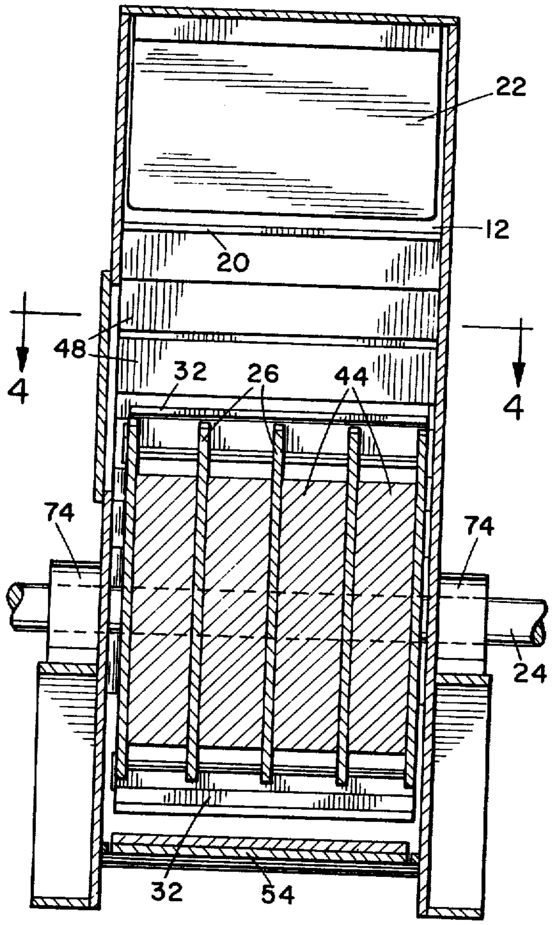

Fig. 3

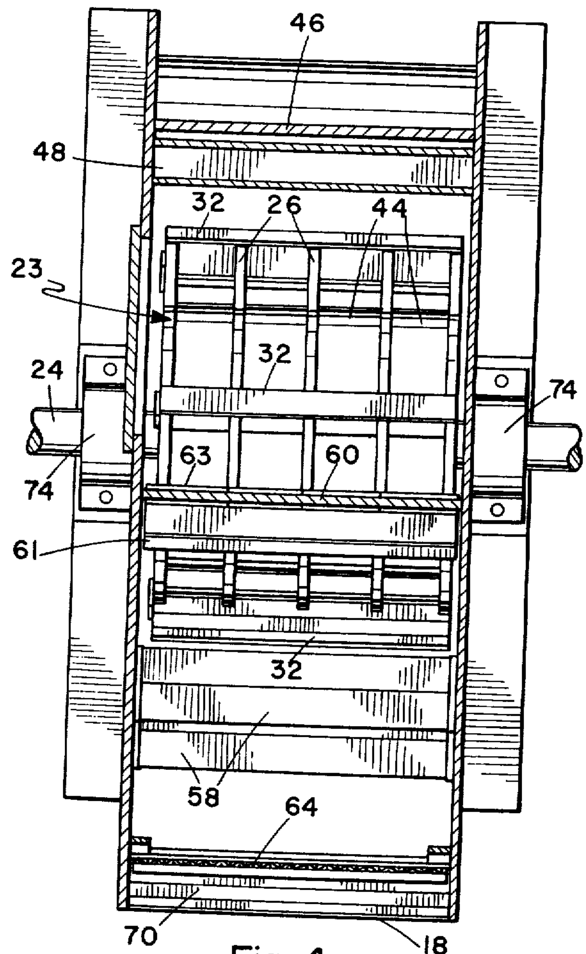

Fig. 4

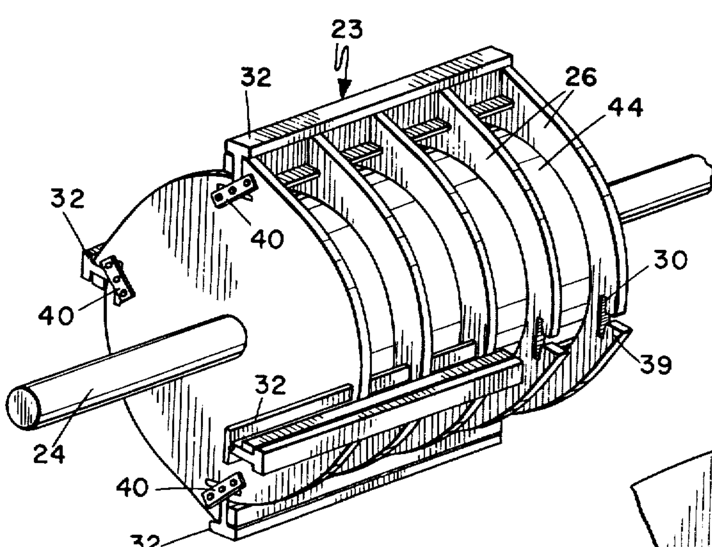

Fig. 5

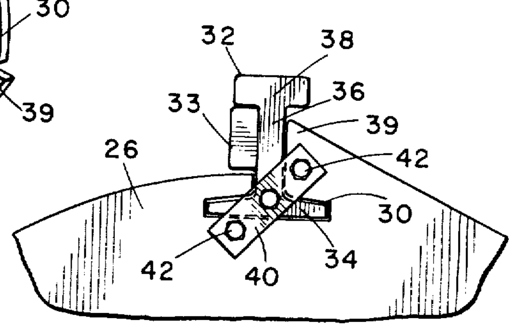

Fig. 6

IMPACT-ATTRITION MILL UTILIZING AIR FLOW

BACKGROUND OF THE INVENTION

In the removal of desirable minerals from waste materials in a given ore it is frequently necessary to reduce the raw size of the ore chunks by a multistep reduction process. Furthermore it is frequently necessary to obtain a relatively uniform final particle size for various concentration processes whereby the desirable materials are separated. The processes associated with the crushing, milling, discharge, and classification of ore are labor intensive, resulting in the expenses associated with supporting a substantial labor force at the location of the ore deposit. Also each of the processes is relatively power intensive resulting in a high power expenditure. Furthermore, for each step in the process the abrasive and impacting forces associated with the reduction of the ore produces a high wear condition, resulting in considerable down time for the machinery, and the expensive replacement parts.

Because of the deficiencies of prior art reduction processes various approaches have been proposed, whereby the process of crushing, milling, and classification can be accomplished in a single machine. However, previous prior art devices have failed to provide for sufficient reducing force in conjunction with a device that provides adequate control over the finally reduced product, so that a uniform classified size may be consistently produced.

It is therefore desirable to have an ore reduction mill which combines the functions of crushing, milling, and classification in a single housing and with a single drive motor. Such a mill is particularly desirable if the wearing parts of the mechanism are inexpensive, and easily replaced, and if positive control over the final particle size is available.

SUMMARY OF THE INVENTION

An exemplary embodiment of the invention comprises a mill in a single housing. A primary reduction chamber is fed the raw ore with variable particle sizes up to and including chunks on the order of 1 foot in diameter. An impact rotor is positioned within the primary reduction chamber and secured to the output shaft of a drive motor. The impact rotor mounts a plurality of elongated hammer bars around its periphery. These hammer bars are oriented parallel to the rotational axis of the impact rotor. The rotor is positioned so that the ore, falling under the influence of gravity, is directed against the hammer bars, and repelled therefrom with great force against the sides of the primary reduction chamber. In the initial impact zone, within the primary reduction chamber, the wall are lined with a plurality of shatter bars. The shatter bars contain projecting edges which reduce the already impacted ore to a finer particle size. The reduced ore particles fall to the bottom of the chamber and are swept, as they reach a predetermined depth, by the continuous rotation of the impact rotor toward a fine particle outlet. Interposed between the impact rotor and the fine particle outlet is the secondary reduction chamber. A plurality of breaker bars comprising inverted V-shaped channel sections mounted with their longitudinal axes in alignment and parallel to the rotational axis of the impact rotor. The breaker bars are staggered across the width of the secondary reduction chamber so that there is no straight line path from the discharge of the impact rotor to the fine particle outlet. Particles driven against the breaker bars are returned to the impact rotor under the influence of gravity. The interchange between the impact rotor and breaker bars produces an autogenous attrition of the particles with the impacted larger particles being reduced by the finer particles contacted en route to the breaker bars, until the particles have reached a size that permits them to follow the circuitous path through the breaker bars under the influence of the air stream.

An air control blade determines the amount of air which recirculates to the primary reduction chamber and thereby controls the particle size. Generally speaking the more air which is returned to the primary reduction chamber the finer the particle size necessary before a particle can follow the circuitous path to the fine particle outlet.

A final classification screen is positioned transversely of the fine particle outlet to prevent the exit of particles not yet finally reduced. The orientation of this fine particle outlet screen is adjustable to maintain the screen perpendicular to the actual air flow experienced at a selected adjustment of the air control blade.

All of the shatter bars and other lining plates in the primary reduction chamber are removable by removing generally cylindrical end wall of the chamber and sliding the shatter bars and lining plates out of the chamber. The breaker bars in the secondary reducing chamber may be removed in a similar manner.

It is therefore an object of the invention to provide a new and improved impact-attrition mill utilizing air flow.

It is another object of the invention to provide a new and improved impact-attrition mill which crushes, mills, and classifies ore within a single housing.

It is another object of the invention to provide a new and improved impact-attrition mill which makes it practical to produce previously uneconomical ore deposits.

It is another object of the invention to provide a new and improved impact-attrition mill with a high power efficiency.

It is another object of the invention to provide a new and improved impact-attrition mill with adjustment of the discharged fine particle size.

It is another object of the invention to provide a new and improved impact-attrition mill which is relatively low in intial cost.

It is another object of the invention to provide a new and improved impact-attrition mill which is relatively simple in construction.

It is another object of the invention to provide a new and improved impact-attrition mill which may be used for concentration of gold ore.

It is another object of the invention to provide a new and improved impact-attrition mill utilizing control over the air flow as a means of controlling final particle size.

It is another object of the invention to provide a new and improved impact-attrition mill wherein the impact rotor acts as an air blower.

Other objects and many attendant advantages of the invention will become more apparent upon a reading of the following detailed description together with the drawings in which like reference numerals refer to like parts throughout and in which:

FIG. 1 is a top plan view of the complete mill.

FIG. **2** is a sectional view taken on line **2—2** of FIG. **1.**

FIG. **3** is a sectional view taken on line **3—3** of FIG. **2.**

FIG. **4** is a sectional view taken on line **4—4** of FIG. **3.**

FIG. **5** is a perspective view of the rotor assembly illustrating the replacement of a hammer bar.

FIG. **6** is an enlarged end view of a portion of the impact rotor, illustrating the hammer bar mounting.

Referring now to the drawings and particularly to FIG. **2,** there is illustrated the impact-attrition mill **10.** An ore chute **12** comprises a downwardly sloping wall **20** which terminates in a flexible curtain **22** secured at its upper edge. Mounted interiorly of the housing **10** is an impact rotor **23.** The rotor is carried on a shaft **24** which extends transversely across housing **10** and penetrates the housing to be carried on bearings **74.** The impact rotor **23** comprises of a plurality of discs **26** separated by spacers **44.** The discs and spacers are welded to shaft **24** to increase the strength and rigidity of the unit. Discs **26** are penetrated at their periphery by slots **30.** The slots **30** in adjacent discs are in alignment to receive a plurality of hammer bars **32.** The hammer bars **32** are comprised of a rail section including a flange portion **34,** web portion **36** and head portion **38.** The striking face of the hammer bar is reinforced by a section 33 welded to the web **36** and head **38.** The hammer bars are secured in the slots **30** by passing the flange section **34** through the slots **30,** with the face opposite the striking face engaging a radially extended portion **39** of the discs **26.** The rails are secured in axial extent on the impact rotor **23** by a plate **40** secured by a plurality of bolts **42.** The impact rotor **23** is turned by a motor (not shown) in the direction of the arrow to propel ore chunks and particles falling from the chute **12** under the influence of gravity against the walls **46** of the primary reduction chamber **14.** In the zone of impact for the heavier ore particles there is mounted a plurality of shatter bars **48.** The shatter bars **48** comprise V-shaped channel sections extending transversely of the housing **10** with their elongated longitudinal axes in parallelism with the rotational axis of the impact rotor **23.** So positioned, the shatter bars **48** present a plurality of apex portions **50** to shatter the ore chunks and reduce the particle size. Particles passing the shatter bars and impacting the remainder of the chamber wall **46** contact a plurality of lining plates **52.** The lining plates **52,** as well as the shatter bars **48,** may be easily removed by access from the ends of the generally cylindrical housing **10** and replaced by sliding new bars and plates in their place.

Particles of ore collect on the trap door **54** until they build up to a sufficient extent that they are swept, by contact with the hammer bars **32,** and are therefore directed into the fine reduction chamber **18.** The access door **54** may be utilized for certain ore types, such as gold bearing ore to remove the concentrated ore. Removal is accomplished by swinging the latch portion **56** out of interference with the door, thereby permitting it to swing free on the hinge **57.**

Ore particles which are propelled by the impact rotor into the fine reduction chamber are driven into contact with a plurality of breaker bars **58.** These breaker bars **58** comprise inverted V-shped channel section extending across the secondary reduction chamber between an exterior wall **62** and a deflector wall **60** and are in a spaced and staggered relationship so that there is no straight line path to the fine particle outlet **18.** Therefore, larger particles, after impacting the breaker bars **58,** are returned under the influence of gravity to the vicinity of the impact rotor. The interchange of heavier particles propelled at a high velocity against the breaker bars and the finer particles falling back from the breaker bars produces a plurality of secondary impacts and results in an autogenous attrition of the particles, whereby both the finer particles and larger particles are reduced. When a particle has been reduced to a fineness that permits it to be carried over a sufficiently curvilinear path, by the influence of the airflow out of the fine particle outlet **18,** that the particle is able to thread its way through the staggered array of breaker bars **58,** it will be permitted to discharge through a screen **64.** The screen size is selected to pass only particles that have been reduced to a predetermined particle size thereby excluding from emission any particle which have become projected through the breaker bars prior to proper reduction.

The lower terminus of the deflector wall **60** mounts an air control blade **61** on a hinge shaft **63.** The rotational orientation of the air control blade **61** may be varied so that the blade may be moved toward and away of the effective periphery of the impact rotor **23.** On the closest approach to the impact rotor **23** substantially all of the air, carried generally in the direction of arrow by the rotor **23,** is caused to pass from the primary reduction chamber **14** into the secondary reduction chamber **18** and into the fine particle outlet **18.** With adjustment of the air control blade **61** to position the blade away from the effective outer periphery of the impact hammer **23** it is possible to produce a recirculation of the air, with some of the air and particles being redirected into the primary reduction chamber. The resultant reduction in exhaust air results in a lesser ability of the exhaust air to carry heavy particles into the fine particle outlet **18,** therefore such adjustment would be utilized to produce a smaller fine particle discharge size. The screen **64** is selected to be compatible with the particle size generally being produced through the use of the air control blade **61.** The screen is found to be most effective when it is positioned precisely transverse to the airflow from the secondary reduction chamber and therefore a plurality of adjustment stops **68** are provided together with a lower screen rest **70** with a plurality of positions. By selecting between the positions on the screen rest **70** and adjustment stops **68** it is possible to position a screen **64** for maximum transversity to the then occurring airflow. A screen access door **66** is hinged on pivot **67** so that the screen may be removed and replaced readily.

Having described my invention, I now claim:

1. The improvement in a mill for the crushing, milling and classification of dry ore and other friable materials comprising the combination with a housing and a drive motor of the following:

an ore intake chute;

a fine particle outlet means;

a primary reduction chamber within said housing;

an impact rotor connected to the said motor noncentrically mounted within said primary reduction chamber such that upon rotation of said rotor an air flow is produced directionally from said intake chute through said primary reduction chamber to said fine particle outlet means;

a plurality of impact bars mounted upon said rotor, extending outward from the periphery of said rotor;

a secondary reduction chamber intermediate said primary reduction chamber and said fine particle outlet, and separated from the primary reduction chamber and the ore intake chute by a deflector wall terminating in a movable flap structure;

attrition means within said secondary reduction chamber, obstructing a straight line passage of particles from said primary reduction chamber to said outlet means;

a plurality of elongated angular members depending inwardly from the walls of the primary reduction chamber, said members being so positioned as to provide impingement surfaces for particles driven by the said impact rotor, the longitudinal axes of said members being parallel with the axis of the said impact rotor.

2. The impact attrition mill of claim 1 wherein:

the flap structure is an air control vane adjustable to vary the amounts of air which flow into the secondary reduction chamber and back into the primary reduction chamber.

3. The apparatus of claim 1 wherein the said rotor is provided with a plurality of discs extending radially outwardly and perpendicular from the axis of said impact rotor; and wherein said impact bars are mounted within slots in said discs.

4. The apparatus of claim 3 wherein each of said impact bars comprises a flat bar mounted in said slots; A perpendicular webbing depending outwardly from each of said bars and affixed thereto; And a rolled impact member affixed upon each of said webbins extending the length webbings

5. The apparatus of claim 4 wherein the secondary reduction chamber has mounted therein a classification screen.

6. An impact attrition mill comprising:

a housing;

a frame mounted upon said housing;

a shaft mounted upon said frame;

a plurality of spaced apart discs mounted upon said shaft perpendicular thereto;

a plurality of impact member holding means located upon the periphery of each of said discs;

impact member means fastened to each of said impact member holding means;

the shaft, discs, impact member holding means and impact member means constituting a rotor;

an arcuate first chamber mounted within said housing and about said rotor at a distance therefrom and nonconcentric thereto;

impact means mounted upon a portion of the interior of said arcuate first chamber;

chute means communicating through said housing to the space between said arcuate first chamber and said rotor;

a second chamber mounted upon the interior of said housing and intercommunicating with said first chamber;

dividing means separating the second chamber from the first chamber and the chute means, terminating in an air flow regulating flap means;

grid means located within said second chamber;

screen means fastened adjacent the outlet of said second chamber, which outlet does not intercommunicate with the said first chamber;

adjustment means for said screen means suitable to adjust the angular relationship of said screen to said second chamber;

and outlet means intercommunicating between the exterior of said housing and the said screen means.

7. An impact attrition mill, comprising:

a closed horizontally disposed cylindrically-shaped primary reduction chamber having a motor driven impact rotor nonconcentrically mounted to provide an enlarged ore intake space at one side and adjacent the top of the chamber, the rotor having radially extending vanes and rotating toward and down through the ore intake space;

a gravity feed intake chute disposed above the primary reduction chamber and communicating therewith to supply ore directly onto the top of the rotor and to the ore intake space;

a plurality of shatter bars disposed within the primary reduction chamber opposite the rotor adjacent the ore receiving space and positioned so that ore will be flung by the rotor against the shatter bars;

a secondary reduction chamber disposed adjacent the primary reduction chamber on the side opposite the ore receiving space and communicating with the primary reduction chamber to receive the flow of broken ore from the shatter bars and having impact attrition means obstructing a straight line passage of broken ore through the secondary reduction chamber to an outlet means;

a passage between the secondary reduction chamber and the intake chute for providing diversion of a portion of the broken ore stream to the ore intake space and including adjustable deflector means for varying the amount of ore diverted from the secondary reduction chamber.

8. The impact attrition mill of claim 7, wherein:

the adjustable deflector means includes a hinged air control blade which may be set in a variety of positions.

* * * * *