United States Patent [19]

Dockstader

[11] **3,834,632**

[45] **Sept. 10, 1974**

[54] **IMPACT ORE MILL**

[76] Inventor: **Wesley E. Docksteader,** P. O. Box 758, Grand Forks, Canada

[22] Filed: **Jan. 8, 1973**

[21] Appl. No.: **321,723**

[30] **Foreign Application Priority Data**

Jan. 18, 1972 Canada 132802

[52] **U.S. Cl.** .... **241/187,** 241/189 R, 241/231, 241/286

[51] **Int. Cl.** **B02c 13/06,** B02c 13/30

[58] **Field of Search** .... 241/73–74, 241/79.2, 79.3, 87, 178, 187, 188 R, 189 R, 191, 195, 230–231, 286

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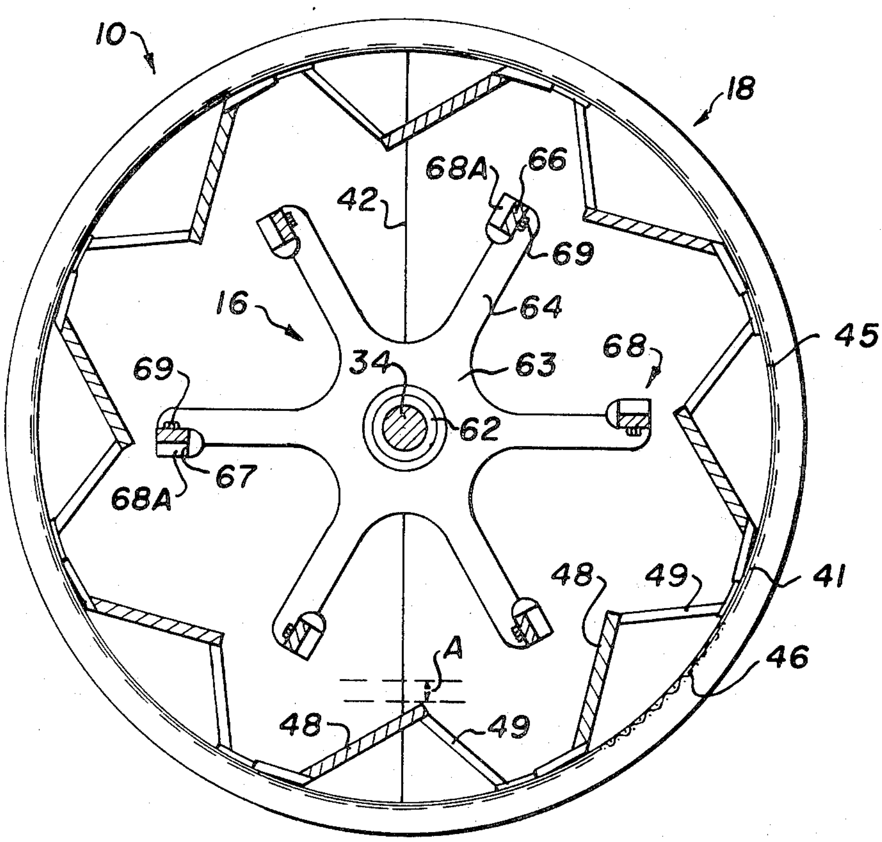
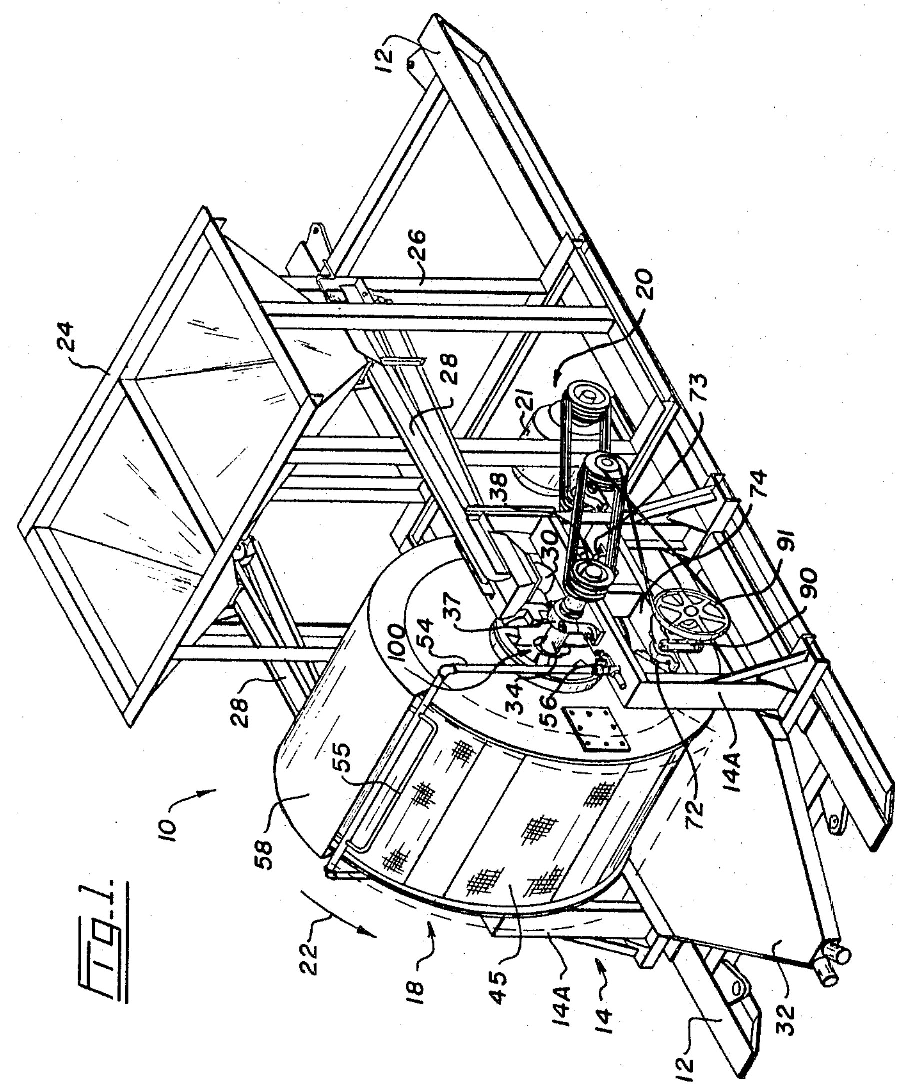
Primary Examiner—Roy Lake
Assistant Examiner—Howard N. Goldberg
Attorney, Agent, or Firm—Fetherstonhaugh & Co.

[57] **ABSTRACT**

A mill is provided for crushing ore by impaction which has a rotor and a drum driven in the same direction at varying speeds. The axis of rotation of the drum can be shifted relative to the axis of rotation of the rotor to selectively adjust the spacing between beater blades on the rotor and impact plates carried by the drum. Seals are provided between the rotor shaft and the side walls of the drum to allow this relative movement to take place. The beater blades are each made up of identical parts which can be rearranged on the rotor to compensate for wear.

10 Claims, 6 Drawing Figures

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14A
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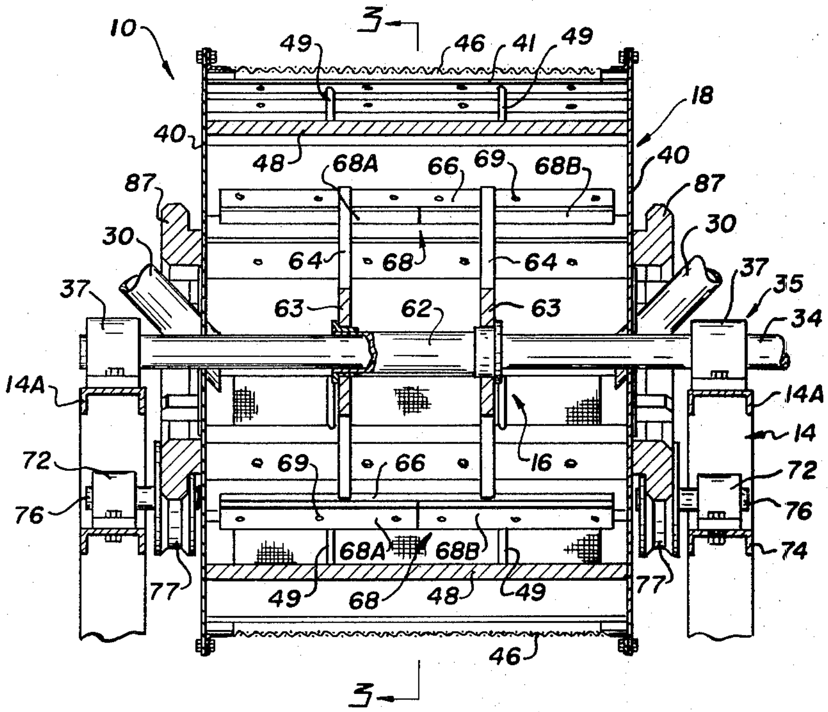
56
58
72
73
74
90
91
100

Fig. 1.

FIG. 2.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10
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46
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18
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68A
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68B
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30
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68
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37
37
35
63
62
63
34
14A
14A
14
16
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66
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68A
68B
74
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68
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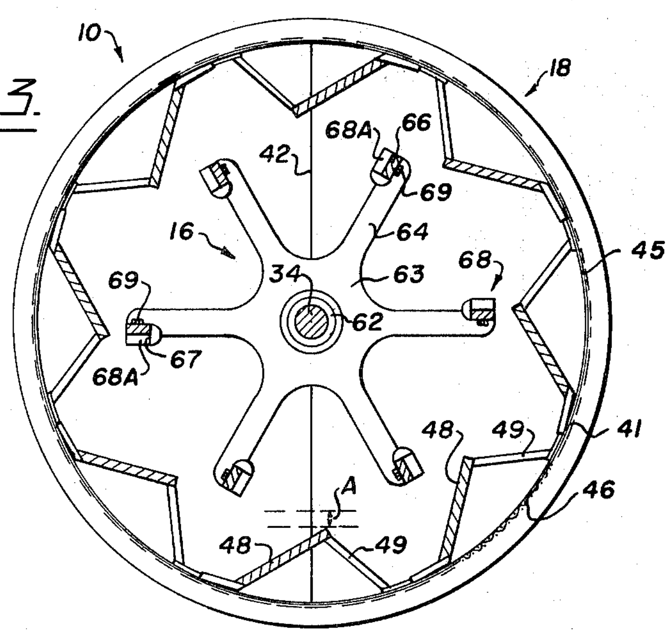
46
3

FIG. 3.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68A
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42
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68A
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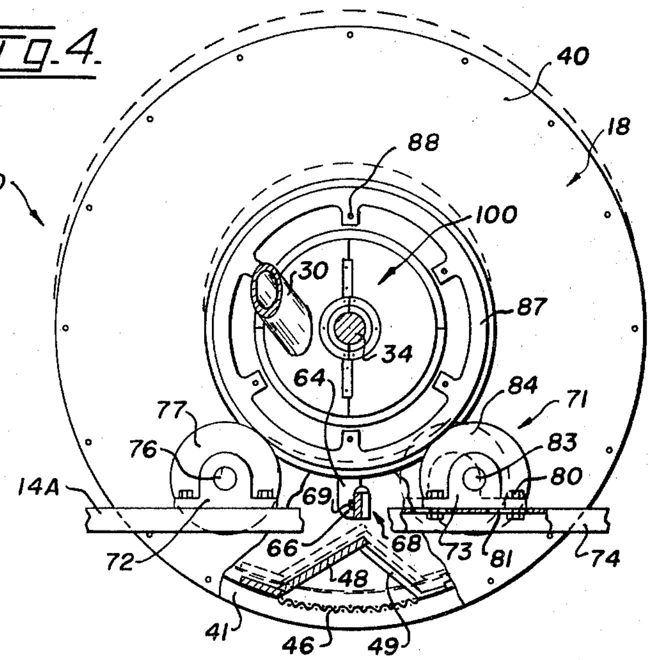
46
48
49

Fig. 4.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64
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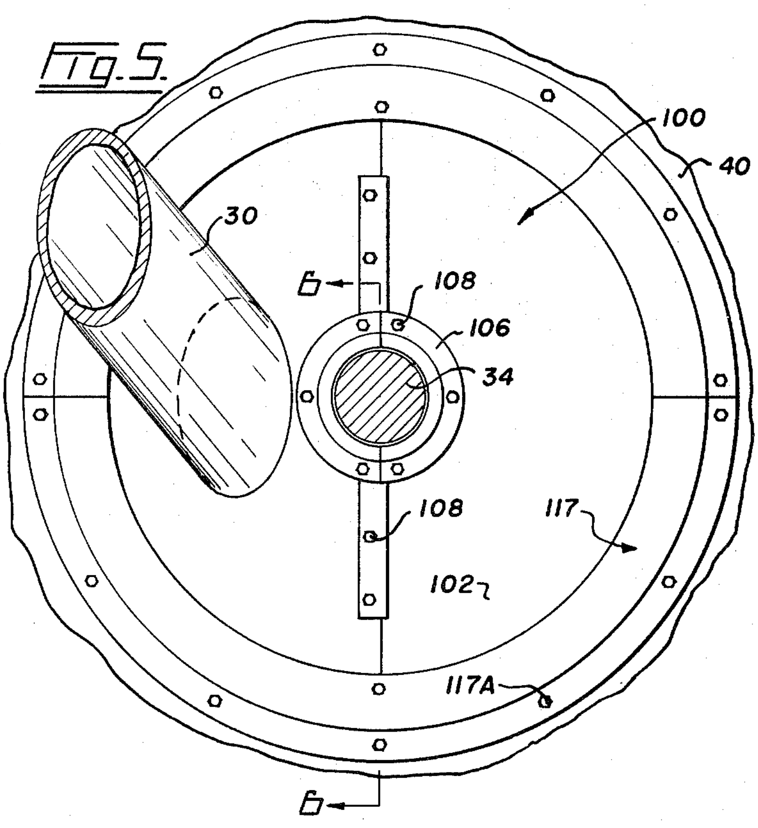
74
72
48
41
46
49

Fig. 5.


100
40
30
6
108
106
34
108
117
102
117A
6

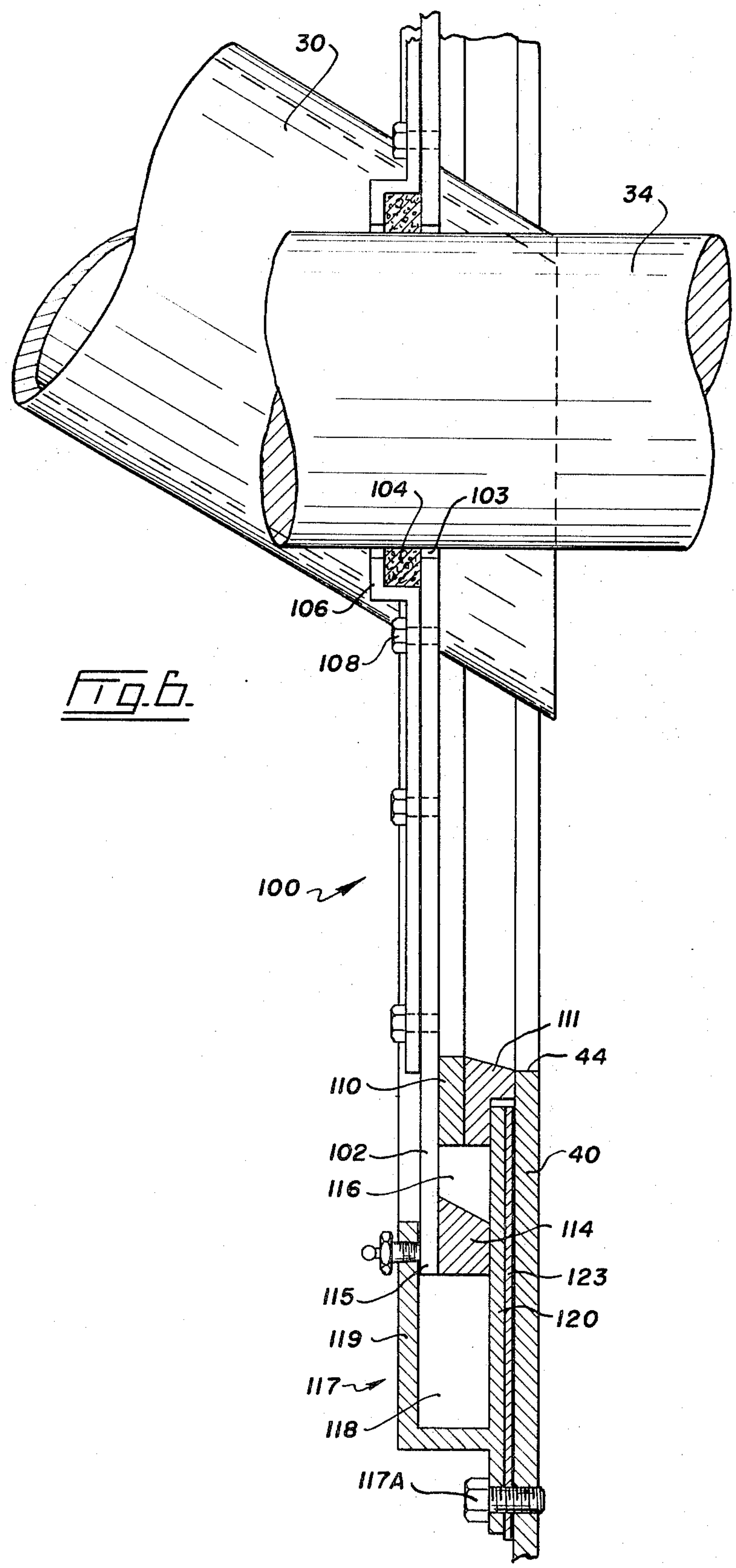

30
34
104
103
106
108
100
111
44
110
102
40
116
114
123
115
120
119
117
118
117A

Fig. 6.

IMPACT ORE MILL

My invention relates to machines for crushing ore and more particularly to a machine for milling batches of ores which vary in size.

The operators of small mines are particularly interested in milling machines which are versatile enough to handle a variety of free milling ores. It is important that the mill be readily adjustable to reduce one type of ore after a run of crushing ore of another type otherwise lengthy and therefore costly shut-down periods are required. Desirably, bearings as well as other operating parts of the mill should be protected from the highly abrasive effects of the milled ore and those parts which actually engage the ore during the crushing operation and which inevitably become worn, should be interchangeable in order to reduce operating costs. Most lightweight ore mills, currently in use in small mines, lack some or all of these basic requirements.

The ore mill I have designed can be adjusted quickly and easily to vary the spacing between the ore impacting parts and this allows the machine to be set to handle ore of a particular size which considerably improves production. In order to achieve this adjustment, the ore-impacting rotor and drum of the present mill are made radially movable with respect to one another and a simple and effective seal is provided therebetween to allow this relative movement to take place. The rotor has beater blades which are divided and secured in such a way that whenever a blade part becomes worn to a degree where it is no longer effective, it can be exchanged for an unworn part of the same type or another blade.

In drawings which illustrate a preferred embodiment of the invention,

FIG. 1 is a perspective view of my impact ore mill,

FIG. 2 is a vertical section with parts purposely omitted for the sake of clarity,

FIG. 3 is a transverse section taken on the line 3—3 of FIG. 2,

FIG. 4 is a side elevation, partly broken away, and again with some parts omitted,

FIG. 5 is an enlarged side elevation showing the sealing means, and

FIG. 6 is a further enlarged section taken on the line 6—6 of FIG. 5.

Referring to the drawings, the numeral **10** in FIG. **1** indicates generally an impact ore mill embodying the improvements of the present invention. Preferably, the mill **10** is mounted on a skid frame **12** so that it can be readily towed over rough terrain if necessary. The skid frame **12** supports a base **14** formed by a pair of transversely spaced pedestals **14A** on which a beater-type rotor **16** (FIG. **2**, for example) and an enclosing drum **18** are rotatably mounted. Drive means generally indicated at **20**, and including an electric motor **21**, is provided to rotate both the rotor **16** and the drum **18** in the direction of arrow **22**, see FIG. **1**, and during this rotation the drum and rotor co-operate to reduce ore to the desired degree of fineness.

The ore which is to be processed by the mill **10** is dumped into twin hoppers each designated by the numeral **24**, these hoppers being supported on a framework **26** carried by the skid frame **12**. The hoppers **24** are adapted to feed ore into twin conveyors **28** disposed one on each side of the drum **18**, and these conveyors deliver the ore into the revolving drum **18** through infeed spouts **30**. Eventually, the divided ore is discharged from the drum **18** on to a launder **32** which delivers the milled ore to a separation table (not shown) for further processing.

The rotor **16** has a horizontal driven shaft **34** and means generally indicated at **35** is provided for mounting said rotor shaft on the pedestal base **14**. As shown in FIGS. **1** and **2**, the mounting means **35** comprises a pair of bearings **37** in which the shaft **34** is journalled, there being one such bearing carried on top of each pedestal **14A**. The drive means **20** includes a belt-driven pully **38** (FIG. **1** only) which is secured to one end of the shaft **34** and the drive train from the motor **21** to said shaft is such that the rotor **16** can be rotated at quite a high rate of speed.

The drum generally indicated at **18** is shown to comprise side walls **40** and a connecting peripheral wall **41**, the three walls being suitably bolted together. Preferably, the drum **18** is constructed in two separatable halves as indicated by line **42** in FIG. **3** whereby one half can be removed from the other if necessary to provide access to the interior of the drum. Side walls **40** are each provided with an concentric opening **44** (FIG. **6**) through which the shaft **34** projects. The peripheral wall **41** has a plurality of rectangular openings **45**, see FIG. **3**, which are circumferentially spaced around the drum to extend between the side walls **40**. Each opening **45** is covered by a classifier screen **46** of a suitable mesh. On the inner surface of the wall **41**, the adjacent each opening **45**, a transversely extending impact plate **48** is secured to extend inwardly and project partly across said opening as shown best in FIG. **3**. The inner end of the plates **48** are braced against the drum wall **41** by means of transversely spaced rods **49**.

Ore deposited in the drum **18** through the infeed spouts **30** is thrown against the impact plates **48** by the action of the rotor **16** as will be described later and is reduced or disintegrated to a degree of fineness which will allow the material to pass through the screens **46** and be discharged on to the launder **32**.

In order to prevent clogging of the screens **46**, a high pressure spray of water is directed against the outer periphery of the drum **18**. This is done by means of a pipe **54** fitted with a spray head **55**, see FIG. **1**. The U-shaped pipe **54** is mounted on the pedestals **14A** so as to connect with a suitable source of pressurized water (not shown) and said pipe is fitted with a control valve **56**. By adjustment of the valve **56**, the water spray can be controlled to keep the screens **46** clear of the reduced ore and also to provide a properly proportioned mixture of fines and water for discharge as a slurry from the mill **10**. A water guard **58** (FIG. **1**) is mounted over the drum **18** and the spray head **55** to prevent water from discharging outwardly of the mill. Preferably, the guard **58** encloses a major portion of the circumference of the drum and is a two-part structure with one part being shown by dotted lines only in FIG. **1**.

As shown in FIGS. **2** and **3**, the rotor **16** is provided with an elongated hub **62** which is non-rotatably mounted on the shaft **34**. A pair of transversely spaced spiders **63** are secured to opposite ends of the hub **62** and these spiders each have a suitable number of radial spokes **64**. The outer ends of the spokes **64** are connected by cross bars **66** and each bar is provided with a recess **67** on the leading edge thereof. Seated in each recess **67**, is a beater blade **68** which is secured to the bar **66** by means of bolts **69**. Each beater blade **68** is made of a good quality, hard wearing steel, which will stand up to hard use for lengthy periods.

The ore which is reduced by the mill **10** is screened before it is fed into the drum **18** and the material processed during a particular run of the machine may have a maximum diameter of, say, one inch with the usual quantity of smaller ore. Another batch of a different type of ore processed during a later run may be three quarter inch and less. If the mill **10** is to run smoothly and efficiently to ensure a high rate of production, it is extremely important that proper clearance be provided between the impact plates **48** and the beater blades **68** for each batch of ore. For example, it has been found that with 1 inch minus ore, the plate to blade clearance should be approximately one and one quarter inches while the three quarter minus ore requires a clearance of about 1 inch. In this ore mill, provision is made for adjusting the axis of rotation of the rotor **16** radially relative to the axis of rotation of the drum **18** to provide the necessary clearance and preferably this adjustment is incorporated into mounting means **71** for the drum **18.** However, it should be noted that the adjustment almost as readily be part of the mounting means **35** for the rotor since the bearings **37** might conveniently be made vertically adjustable on the pedestal base **14.**

Referring now particularly to FIGS. **2** and **4**, the drum mounting means **71** is shown to comprise a pair of bearings **72** and a second pair of bearings **73** which are secured to pedestal members **74** spaced below the top of the base **14.** The two bearings **72,** which are located one on each side of the drum **18**, are suitably bolted to the members **74** and each bearing journals a stub shaft **76** on which a circumferentially grooved wheel **77** is mounted. Both the bearings **73** are secured to their members **74** by bolts **80** which project through longitudinally extending slots **81** (FIG. **4**) formed in said pedestal members. Thus, the pair of bearings **73** are adjustable towards and away from the pair of bearings **72.** A stub shaft **83** is journalled in each bearing **73** and is fitted with a wheel **84.** The wheels **84** are similar to and aligned with the wheels **77.**

Trunnion rings **87** are mounted in the wheels **77** and **84** on opposite sides of the drum **18** so as to rotate freely in the wheels. The rings **87** are suitably bolted as at **88** or otherwise fastened to the side walls **40** in a position concentric to the openings **44** therein. Thus, the rings **87** sit in the pulley-like wheels **77** and **84** and are held against jumping out by the considerable weight of the drum **18.** The shaft **76** on the right side of the mill, see FIG. **1,** is the output shaft of a reduction gear **90** which has an input shaft fitted with a pulley **91** and this pulley is belt connected into the drive means **20.** Drum **18** is rotated by the means **20** in the same direction as the rotor **16** but at a much slower speed, the preferred ratio being 1 to 100.

Whenever it is necessary to adjust the spacing between the blades **68** and the innermost edges of the plates **48,** it is a simple matter to do so by virtue of the adjustable mounting means **71.** This adjustment is accomplished by temporarily slacking off the bolts **80** which hold down the bearings **73** and moving the wheels **84** towards or away from the wheels **77** according to whether the spacing is to be increased or decreased. This adjustment raises or lowers the drum **18** and it is the blade-to-plate spacing at the bottom of the drum (indicated by letter A in FIG. 3) which is set at 1 inch for three quarter minus ore and at one and one quarter inches for 1 inch minus ore. The ore deposited in the drum through the spouts **30** naturally falls to the bottom of the drum and the necessary clearance must be provided for the largest pieces before reduction begins, hence the need for clearance at this point.

Since the rotor **16** and drum **18** are adapted to be moved vertically relative to one another, a special seal is required for the shaft **34** where it projects through the drum wall opening **44.** A particularly effective sealing means **100** is provided for each opening **44** and one such means is shown best in FIGS. **5** and **6.** In FIG. **6** it will be seen that the opening **44** is much larger than the shaft **34** and a cover plate **102** is provided to form a closure for said opening. The circular cover plate **102** has a hole **103** for the shaft **34** and a packing gland **104** encloses the shaft alongside this hole, the gland being held in place by a divided collar **106** which is secured to the plate **102** by means of bolts **108.**

Surrounding the opening **44** is an annular seal **110** which is secured to the wall **40** by a ring **111.** A relatively large annular seal **114** is secured to the inner face of the cover plate **102** near rim **115** thereof and this seal is spaced from the small seal **110** to provide an annular mud channel **116.** The seal **114** is received in a two-part or divided annular collar **117** which is secured to the wall **40** by bolts **117**A. Collar **117** is substantially U-shaped in cross section as shown in FIG. **6** and an annular mud channel **118** is provided between flanges **119** and **120** of said collar. A gasket **123** separates the collar **117** from the wall **40** and the flange **120** has sliding engagement with the cover plate **102.** An identical sealing means **100,** which is not illustrated in the drawings, is provided on the opposite side wall **40** to seal the opening **44** thereof.

This particular construction for the two sealing means **100** allows the rotor **16** and drum **18** to rotate in the same direction but at different speeds but, more importantly, it allows the drum to move vertically with respect to the rotor by adjustment of the mounting means **71** as previously described. In addition, the means **100** will serve to trap any of the slurry which might escape past the seals **110** and **114.** Some of this watery or mud-like fluid will be trapped in the channel **116** but a greater amount will be contained in the channel **118.** The mixture reaching the channel **118** dries out and settles in the form of mud which conveniently can be cleared away periodically by removal of the two-part collar **117** from the wall **40.**

It has been found that the maximum amount of blade wear occurs near the side walls **40** of the drum since it is in this region where most of the ore is struck by the blades and hurled against the impact plates **48.** Eventually, the ends of the beater blades **68** nearest the walls **40** become worn and when this occurs, the mill **10** is less effective in disintegrating the ore. To overcome this, the blades **68** are each formed into two equal and oblong portions **68A** and **68B** (FIG. **2**) which are separately secured to the bars **66** by means of the bolts **69.**

When excessive wear is noted on the opposite ends of the blades **68,** the blade portions **68A** and **68B** are rearranged to avoid the necessity of replacing the entire blade as normally would be the case. To rearrange the blades **68,** the milling operation need only be halted long enough to allow one of the classifier screens **46** to be removed from the peripheral wall **41** of the drum whereupon said blades are accessible. The portions 68A and 68B which make up each blade are unbolted and turned end for end so as to place the worn ends thereof at the center of the rotor 16 whereupon the portions are rebolted to the bars 66. This rearrangement doubles the operating life of the blade 68 and, when both ends of the blade portions are worn on opposite faces, the portions still have two unworn corner faces which are usable to further extend the period before the blades must be replaced with new ones.

From the foregoing it will be apparent that I have provided a lightweight and simply constructed ore mill which is most economical to operate. Adjustment of the drum 18 relative to the rotor 16 can be done without the need to shut down for lengthy periods and the arrangement is such that these two rotating members can be kept properly aligned as wear takes place on the wheels 77 and 84 or on the rings 87 which engage these wheels. Any slurry which might escape from the drum is effectively trapped by the sealing means 100 before it can reach and harm bearings or the like and this makes the present mill a particularly easy one to maintain and operate.

I claim:

1. An ore mill comprising a rotor having a shaft on which beater blades are mounted, a revolvable drum enclosing the rotor and having side walls and a peripheral wall, said side walls having openings through which the rotor shaft projects, said peripheral wall having circumferentially spaced screened openings and inwardly projecting impact plates, means for rotating the rotor and the drum to sweep the beater blades passed the impact plates in a cooperative, ore disintegrating motion, and mounting means for the drum, said mounting means including means for adjusting the axes of rotation of the rotor and drum radially relative to one another to vary the clearance between the beater blades and the impact plates.

2. An ore mill as claimed in claim 1 and including sealing means mounted on each side wall to seal the rotor shaft within an adjacent opening.

3. An ore mill as claimed in claim 1, in which said rotor comprises circumferentially spaced bars extending parallel to the rotor shaft, said beater blades each being formed of at least two similar and interchangeable parts removably secured to a bar.

4. An ore mill as claimed in claim 1, in which said mounting means supports the drum on a base and comprises two pairs of wheels mounted on said base, a trunnion ring secured to each side wall concentric to the axis of rotation of the drum, said trunnion rings being rotatably supported on the pairs of wheels and means for adjusting one pair of wheels towards and away from the other pair of wheels.

5. An ore mill as claimed in claim 2, in which each of said sealing means comprises a cover plate slidably and non-rotatably supported against an end wall to cover the opening therein, and a small and a large annular seal interposed between each cover plate and end wall to define a mud channel for containment of seepage escaping through the end wall opening.

6. An ore mill as claimed in claim 5, and including an annular collar secured to each side wall to enclose a large annular seal and a rim of a cover plate, said annular collars each being shaped to define a second mud channel encircling one of the first mentioned mud channels.

7. An ore mill comprising a base, a rotor having a shaft rotatably mounted on the base and beater blades extending parallel to said shaft, a revolvable drum enclosing the rotor and having side walls and a peripheral wall, said side walls having openings through which the rotor shaft projects, said peripheral wall having inwardly projecting impact plates, two pairs of wheels mounted on the base, a trunnion ring secured to each side wall around the opening therein, said trunnion rings being rotatably supported on the pairs of wheels, means for rotating the rotor and the drum to sweep the beater blades passed the impact plates, and means for adjusting one pair of wheels towards and away from the other pair of wheels whereby to move the axes of rotation of the rotor and drum radially relative to one another and thereby vary the clearance between the beater blades and the impact plates.

8. An ore mill as claimed in claim 7 and including sealing means mounted on each side wall to seal the rotor shaft within an adjacent opening.

9. An ore mill as claimed in claim 8, in which each of said sealing means comprises a cover plate slidably and non-rotatably supported against an end wall to cover the opening therein, and a small and a large annular seal interposed between each cover plate and end wall to define a mud channel for containment of seepage escaping through the end wall opening.

10. An ore mill as claimed in claim 9, and including an annular collar secured to each side wall to enclose a large annular seal and a rim of a cover plate, said annular collars each being shaped to define a second mud channel encircling one of the first mentioned mud channels.

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