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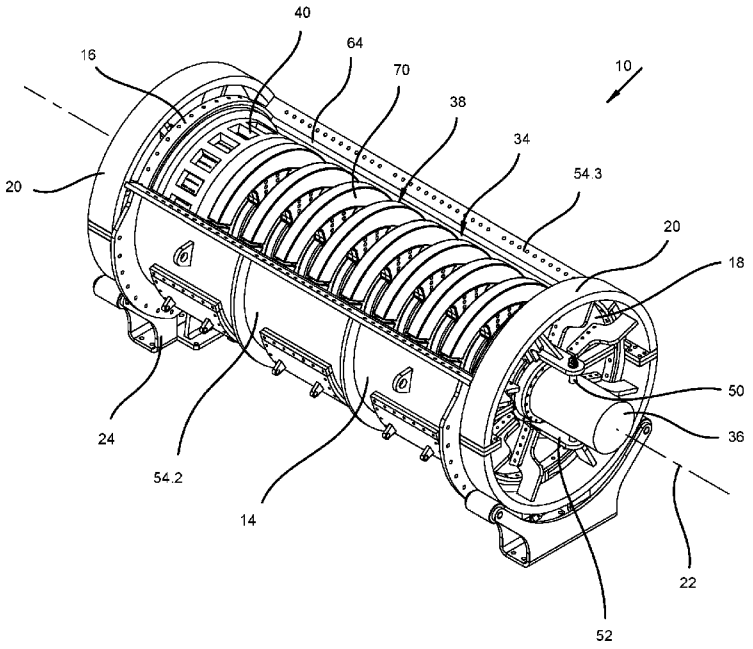
(54) Title: GRINDING MILL

Figure 5



(57) Abstract: There is disclosed a grinding mill for grinding mineral ore particles or other particulate material. The grinding mill includes a shell enclosing a grinding chamber that is configured to contain a slurry of the ore particles, grinding media and water. A drive shaft extends into the grinding chamber, with the drive shaft supporting a plurality of rotors located within the grinding chamber so that, during use, rotation of the rotors causes motion and circulation of the slurry. The shell is substantially cylindrical having a horizontally orientated central axis, with the shell comprising two or more annular side wall shell segments being joined together, whereby each of the shell segments is selectively removable from the side wall to allow maintenance access to the grinding chamber and the rotors without requiring exhaustion or dumping of the slurry from the grinding chamber.

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Grinding mill

TECHNICAL FIELD

The present disclosure relates to a grinding mill.

More particularly, the present disclosure relates to a grinding mill used to grind mineral ore particles or other particulate material, which are typically mixed with grinding media and water to form a slurry.

BACKGROUND

A grinding mill (also known as an attrition mill) is an apparatus used to pulverise or comminute particulate material. There are a large variety of grinding mills each being aimed at grinding different types of materials and being configured to yield resultant particles having a desired particulate size. One type of grinding mill, such as the commercially known IsaMill, is a fine grinding mill which is configured to receive a feed of ore particles that are in the range of about 30 µm to 4000 µm in diameter and to grind these down to produce particles with a target product size in the range of about 5 µm to 60 µm in diameter.

The grinding mill uses an inert grinding media, such as silica sand, waste smelter slag, or ceramic or steel balls, which is mixed in and stirred together with the ore particles being ground. The grinding mill includes a housing/shell defining a grinding chamber in which is provided several rotors/stirrers mounted on a rotating shaft. The grinding chamber is filled with a slurry of the grinding media, the ore particles and water. The rotors are configured to cause motion in the slurry resulting in collisions between the ore particles and the grinding media and also between the ore particles and other ore particles, thereby breaking down the ore particles by attrition and abrasion.

The grinding mill can be provided as either a vertical shaft mill or a horizontal shaft mill. Prior art examples of vertical shaft mills are described in US 8,205,817 and WO 2020/053419. Similarly, prior art examples of horizontal shaft mills are described in US 5,797,550 (being an example of the commercially known IsaMill), US 8,002,213 and US 10,173,222.

In such horizontal shaft mills, the shaft is typically provided in a cantilevered manner with one end thereof being joined to a drive motor and supported in a machine frame, and the opposed end thereof being unsupported.

As will be appreciated, the highly abrasive conditions within the grinding mill results in wear to the shaft and the rotors mounted thereon. The shell is provided with an internal lining to protect the shell from excessive wearing, but also this lining must be replaced from time-to-time after it becomes damaged or worn through use.

When conducting maintenance, the shaft and shell are separated, e.g. in an IsaMill or other horizontal mills the shaft and rotors are pulled axially out from the shell. This same separation process can also be used in vertical mills. However, some larger vertical mills, such as the mill described in WO 2020/053419, the shell is separated laterally to allow access to the rotor. Inevitably, for the removal of the rotor or the separation of the shell to occur, any slurry contained or remaining within the grinding chamber needs to be dumped.

Dumping of the slurry is considered disadvantageous and dangerous for numerous reasons, namely (i) it leads to a waste of slurry that cannot be easily recycled or reprocessed, (ii) it creates an environmental hazard requiring clean-up, (iii) it increases the required infrastructure as a bund or other containment vessel must be provided to capture any dumped slurry, and/or (iv) especially when the grinding media comprises heavy steel balls, there is a risk of these balls causing injury by sliding into or onto operators as the slurry is dumped.

One or more of the above disadvantages may be overcome if the required maintenance to the grinding mill can be conducted without always needing to dump the slurry.

The above references to the background art and any prior art citations do not constitute an admission that the art forms part of the common general knowledge of a person of ordinary skill in the art.

SUMMARY OF THE DISCLOSURE

According to a first aspect of the disclosure, there is provided a grinding mill comprising

a shell enclosing a grinding chamber that is configured to contain a slurry of a liquid, ore particles and grinding media;

a drive shaft extending into the grinding chamber, the drive shaft supporting a plurality of rotors located within the grinding chamber whereby, during use, rotation of the rotors is configured to cause motion of the slurry;

the shell comprising an annular side wall and opposed end walls, wherein the side wall comprises two or more shell segments being joined together, each of the shell segments being selectively removable from the side wall to provide an opening in the shell to allow maintenance access to the grinding chamber and the rotors; and

wherein the grinding media is retained within the grinding chamber while each shell segment is selectively removed from the side wall.

In one embodiment the grinding media and some residual ore particles are retained within the grinding chamber while each shell segment is selectively removed from the shell.

The shell may be substantially cylindrical having a horizontally orientated central axis.

The grinding mill may comprise rolling rings being co-axially joined to the shell, the rolling rings being rotatably seated within complementary support frames and being configured to permit rotation of the shell around the central axis. The support frames may carry rollers abutting the rolling rings. In some embodiments the rollers are drive rollers that are operatively joined to motors for rolling the shell around the central axis. The rolling rings may be joined to an outer side of the end walls and located remote from the shell thereby to avoid hindering selective removal of the shell segments.

The end walls and the rolling rings may be diametrically split into hemispheres.

The shell may comprise locking collars enabling the shell to be locked in selected positions around the central axis and thereby prevent rotation of the shell relative to the support frames.

The grinding mill may comprise a locking formation being configured to permit the drive shaft to be locked to the shell to thereby retain the drive shaft in a fixed angular orientation relative to the shell. In one embodiment the locking formation comprises locking brackets extending from the shell adjacent to the drive shaft, with the locking brackets and the drive shaft both having slots that are configured to removably receive a pin for locking the drive shaft to the locking brackets.

Each of the shell segments may be similarly shaped and dimensioned arc-shaped shell segments. In one embodiment the shell comprises three shell segments each extending through an arc of about 120°.

Each shell segment may comprise an inspection hatch that is normally closed by a cover, each inspection hatch being configured to permit inspection of the grinding chamber when such inspection hatch is operatively positioned above a surface of slurry contained within the grinding chamber, and each inspection hatch further being configured to permit dumping of slurry from the grinding chamber when such inspection hatch is operatively positioned beneath the surface of the slurry.

One or more of the rotors may be a multi-component part comprising a hub configured to be supported on the drive shaft, and the hub removably carrying multiple grinding disc segments. Each grinding disc segment may be removably joined to a splice plate, and the splice plate is removably joined to the hub. In one embodiment each grinding disc segment is in abutting contact with each of its neighbouring grinding disc segments while each splice plate is spaced away from its neighbouring splice plate, thereby to define openings extending axially through the rotor.

In one embodiment each rotor comprises three grinding disc segments each extending through an arc of about 120°. In another embodiment each shell segment and each grinding disc segment extends through a similar arc.

According to a second aspect of the disclosure, there is provided a method of conducting maintenance on a grinding mill as described in the first aspect of the disclosure, the method comprising the steps of:

a) removing one or more of the shell segments that are positioned above a surface of slurry contained within the grinding chamber;

b) inspecting and conducting any requisite maintenance on the removed shell

segment;

c) inspecting and conducting any requisite maintenance on a part of a rotor that is rotationally aligned with the removed shell segment;

d) reattaching the removed shell segment to close the grinding chamber; and

e) repeating steps (a) to (d) until each shell segment has been removed and inspected.

The maintenance may be conducted without exhausting or dumping the slurry and/or grinding media from the grinding chamber.

One or more of the shell segments may be simultaneously removable to permit replacement of the drive shaft. In such case it may be necessary to exhaust or dump some or all of the slurry.

BRIEF DESCRIPTION OF DRAWINGS

The above and other features will become more apparent from the following description with reference to the accompanying schematic drawings. In the drawings, which are given for purpose of illustration only and are not intended to be in any way limiting:

Figure 1 shows a perspective view of a grinding mill according to the present disclosure;

Figure 2 shows an end view of the grinding mill of Figure 1;

Figure 3 shows a side view of the grinding mill of Figure 1;

Figure 4 shows a sectional side view of the grinding mill of Figure 1;

Figure 5 shows a perspective view of the grinding mill having part of its shell removed to allow access to its grinding chamber allowing removal of or maintenance to its rotors;

Figure 6 shows an end view of a single rotor; and

Figure 7 shows a perspective view of the grinding mill having a major part of its shell removed to allow access to its grinding chamber allowing removal of or maintenance to its drive shaft.

DETAILED DESCRIPTION

Referring to the Figures, there is shown a grinding mill 10 according to the present disclosure for use in grinding mineral ore particles or other particulate materials, which are typically mixed with grinding media and a liquid, e.g. water, to form a slurry.

The grinding mill 10 includes a substantially cylindrical housing or shell 12 comprising an annular side wall 14 that is closed at its opposed ends by end walls 16,18. Although the end walls 16,18 are shown having a planar configuration in the exemplary embodiment, other embodiments of the end walls may be dome shaped. The grinding mill 10 is configured to be substantially horizontally orientated in use. The end walls 16,18 are respectively attached to outer rolling rings 20 that are arranged co-axially with a central axis 22 of the shell 12. The rolling rings 20 are joined to the end walls 16,18 on their outer sides and located remote from the shell 12. The rolling rings 20 are seated in cradles or support frames 24 that are typically secured to a base platform or foundation (not shown). The support frames 24 are generally concave when seen in end view and have opposed arms 26 that each carry one or more rollers 28 being configured to abut against the rolling rings 20 and thereby enable the shell 12 to be rotated around the central axis 22. The rollers 28 can be idler rollers or drive rollers. The rolling rings 20 include spokes 30 that are bolted onto flanges 32 projecting outwardly from the end walls 16,18.

The rolling rings 20 and the end walls 16,18 each are diametrically split into two similar hemispheres.

As shown in Figures 4 to 6, the shell 12 encloses a grinding chamber 34. A drive shaft 36 extends axially through the shell 12, with the drive shaft 36 carrying a plurality of rotors 38 that are located within the grinding chamber 34. The drive shaft 36 also carries a classifier 40 and various other parts, the details of which are not required for purposes of this disclosure, but the function and working of which will be understood by the skilled addressee. The drive shaft 36 is mounted on bearings 42 at each end wall 16,18 permitting the drive shaft 36 to rotate with respect to the shell 12 and thereby permit the rotors 38 to be rotated within the grinding chamber 34. Typically, the bearings 42 will include various seals and glands being configured, during use, to prevent leakage of any slurry from the grinding chamber 34.

At various times during operation and maintenance of the grinding mill 10 it may become necessary to lock either or both the shell 12 and the drive shaft 36 to prevent rotation thereof. For this reason, the shell 12 includes locking collars 44 that can be selectively secured to locking brackets 46, e.g. by temporarily bolting the locking collars 44 to the locking brackets 46. The locking collars 44 have bolt holes at various discrete locations allowing the shell 12 to be locked in place at various angular orientations around the central axis 22. It will be appreciated that various other locking means can be provided, such as by using latches or levers to secure the locking collars 44 to the locking brackets 46. In some embodiments, the locking brackets 46 are mounted on the base platform while in other embodiments the locking brackets 46 can be mounted on the support frames 24. Alternatively, the locking brackets 46 can form part of the support frames 24 whereby the locking collars 44 are secured directly to the support frames 24 to prevent rotation of the shell 12.

The grinding mill 10 includes a further locking formation being configured to permit the drive shaft 36 to be locked to the shell 12 to thereby retain the drive shaft 36 in a fixed angular orientation relative to the shell 12. In the opposed ends of the drive shaft 36 that protrude beyond the shell 12, the drive shaft 36 has transverse through-holes 48 that extend diametrically therethrough and which are configured to receive locking pins 50 extending between two brackets 52. During normal operation, the locking pins 50 are removed and the drive shaft 36 can rotate within the shell 12. When maintenance is required, the locking pins 50 are inserted to lock the drive shaft 36 to the brackets 52 and thereby prevent rotation of the drive shaft 36 relative to the shell 12. In some embodiments the drive shaft 36 may have multiple through-holes 48 arranged at various angular orientations with respect to each other, e.g. at 60° angles, thereby to enable the drive shaft 36 to be locked in place at various angular orientations around the central axis 22.

As can be more clearly seen in Figure 1, the side wall 14 comprises multiple similarly shaped and dimensioned arc-shaped shell segments 54 that are bolted together and to the end walls 16,18 to define the shell 12. The exemplary embodiment shows the side wall 12 comprising three shell segments 54 wherein each shell segment 54 extends through about 120° of the side wall circumference. It should be understood that other embodiments of the side wall 14 can comprise a different number of shell segments, wherein the shell segments can also extend through a different arc, e.g. comprising four 90°-arc segments or five 72°-arc segments or other geometrical variations.

Each shell segment 54 is provided with circumferential strengthening ribs 56 spaced at discrete intervals along the axial length of the shell segment 54. Each segment also has one or more inspection hatches 58 that are normally closed by covers 60. Each inspection hatch 58 is configured to permit inspection of the grinding chamber 34 when such inspection hatch 58 is operatively positioned above a surface of slurry contained within the grinding chamber 34, and each inspection hatch 58 is further configured to permit dumping of slurry from the grinding chamber 34 when such inspection hatch 58 is operatively positioned beneath the surface of the slurry. The shell segments 54 and covers 60 are provided with various suitable anchor points 62 that allow connection of a crane hook or the like when the shell segment 54 or cover 60 is to be lifted away from the shell 12.

Each of the shell segments 54 is provided with an internal lining 64 being configured to withstand damage during use by abrasion of the ore particles and grinding media against the lining.

Figures 4 and 5 show the rotors 38 being spaced at discrete intervals along the drive shaft 36. The desired spacing between the rotors 38 is maintained by providing spacers 66 (see Figures 4 and 7) between each of the rotors 38.

As can be seen more clearly in Figure 6, each rotor 38 is a multi-component part comprising a central hub 68 that is keyed to the drive shaft 36. Each rotor 38 further comprises discrete grinding disc segments 70 that are arranged to form a ring concentrically surrounding the hub 68 and with the grinding disc segments 70 being joined to the hub 68 by splice plates 72. Each grinding disc segment 70 ends near or in abutting contact with each of its neighbouring grinding disc segments 70 while each splice plate 72 is spaced away from its neighbouring splice plate 72, thereby to define openings 74 extending axially through the rotor 38. The exemplary embodiment shows three grinding disc segments 70 each extending through an arc of about 120°. The grinding disc segments 70 and splice plates 72 are removably attached to the hub 68, e.g. being bolted thereto, so that they can be individually removed or replaced as needed.

In use, during normal operation, the grinding chamber 34 is loaded with grinding media, while a feed of ore particles and water is introduced into the grinding chamber 34 through an inlet in the end wall 18, thereby resulting in the formation of a slurry of the

ore particles, grinding media and water being present within the grinding chamber 34. In normal operating conditions the grinding chamber 34 will be filled with slurry to a maximum volume of about 65% vol/vol. Typically, the shell 12 will be anchored to the locking brackets 46 to be stationary while the drive shaft 36 is rotated to cause rotation of the rotors 38. As will be understood by the skilled addressee, this rotation will cause movement in and mixing of the slurry within the grinding chamber 34 resulting in collisions between the ore particles and the grinding media and also between the ore particles and other ore particles, thereby breaking down the ore particles by attrition and abrasion. Coarse ore particles in the slurry move to the radially outer side of the grinding chamber 34 under centrifugal forces where they undergo further grinding, while fine or finished ground ore particles are able to flow axially through the rotors 38 (through the openings 74 between the splice plates 72) towards the classifier 40. Once the ore particles are sufficiently fine, they are able to pass through the classifier 40 and exit the grinding chamber 34 through an outlet in the end wall 16.

From time-to-time it will become necessary to conduct maintenance on the grinding mill 10. In most instances, the maintenance work will normally require repair or replacement of the rotors 38 and also repair or replacement of the lining 64 on the shell segments 54. In such case, operation of the grinding mill is stopped, the drive shaft 36 brought to standstill, and the drive shaft 36 is locked in place relative to the shell 12 by inserting the locking pins 50 – in this position the grinding disc segments 70 are rotationally aligned with the shell segments 54.

In a first maintenance step, the shell 12 is then unlocked from the locking brackets 46 so that the shell 12 can be rotated on the support frames 24 until a desired shell segment 54.1 is positioned above the slurry surface at or near the top of the shell 12, whereafter the shell 12 is again locked to the locking brackets 46. The top positioned shell segment 54.1 can then be removed from the shell 12 to permit access to the grinding chamber 34 – this is shown in Figure 5 – during which time the lining of the removed shell segment 54.1 can be inspected and repaired. Similarly, the rotors 38 can also be inspected and, if necessary, the top positioned grinding disc segments 70 be removed from their splice plates 72 for repair or replacement.

Once the first maintenance step is complete, the shell segment 54.1 is reattached to the shell 12, whereafter the shell 12 is then again unlocked from the locking brackets 46 and rotated on the support frames 24 until a further shell segment 54.2 is

positioned above the slurry surface at or near the top of the shell 12 and relocked to the locking brackets 46. This permits removal of the shell segment 54.2, inspection and repair thereto and to the grinding disc segments 70 that are aligned therewith, and subsequent replacement of the shell segment 54.2. These steps can be repeated for maintenance to the final shell segment 54.3. Obviously, the above steps can be repeated as often as necessary if the shell comprises more than three shell segments until each of the shell segments has been removed for inspection and repair.

It should be appreciated that during the above described maintenance steps, it is not necessary to exhaust or dump any of the slurry from the grinding chamber 34. Rather, by rotating the shell 12 so that only the upper shell segment 54 is removed, it is possible to conduct all the requisite maintenance while the slurry remains contained within the grinding chamber 34.

However, on some occasions it may become necessary to conduct maintenance on the spacers 66 or to replace the drive shaft 36 or bearings 42. In such cases, it may be necessary to dump a majority or all of the slurry. This is achieved by opening the inspection hatches 58 in a top positioned shell segment 54 and then rotating the shell 12 so that the open inspection hatches 58 are positioned on a bottom of the shell 12 so that the slurry can exhaust through the open inspection hatches 58. Thereafter the two upper positioned shell segments 54 are removed together with the upper halves of the rolling rings 20 and end walls 16,18 – as is shown in Figure 7. The entire drive shaft 36 and all the rotors 38 and classifier 40 can then be lifted away from the shell 12 for inspection and repair. It will be appreciated that opening the inspection hatches 58 in this manner is relatively free from operator risk as there is no sudden exhaustion of slurry on opening, i.e. the inspection hatches 58 are manually opened by the operator, the operator can move beyond a retaining bund positioned under the shell 12 and only then is the shell 12 rotated to dump the media in a relatively orderly manner during which the rate of discharge can be controlled by adjusting the degree of rotation of the shell 12.

Due thereto that the grinding mill 10 does not require axial removal of the drive shaft 36 from the shell 12 (as is the position in the prior art), it is possible to support the drive shaft at both its opposed ends and it is not necessary to provide a cantilevered drive shaft. Accordingly, it is likely that the grinding mill 10 will require less structural

strength and will have smaller footprint than conventional horizontally orientated grinding mills.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the grinding mill as shown in the specific embodiments without departing from the spirit or scope of the disclosure as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

It is known that in some embodiments of horizontal grinding mills the axial shaft carrying the rotors is held stationary while the shell is rotated around the axial shaft. The current disclosure will be able function in the same manner envisaged in such a grinding mill, whereby the rolling rings 20 are seated on drive rollers 28.

As mentioned above, the shell 12 can be partitioned into two or more shell segments 54, whereby the rotors 38 will be equivalently partitioned into two or more grinding disc segments 70.

In the claims which follow and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in a non-limiting and an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in the various embodiments of the crusher. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the elements is present, unless the context clearly requires that there be one and only one of the elements.

Reference numerals

10	grinding mill
12	shell
14	side wall
16	end wall (outlet)
18	end wall (inlet)
20	rolling rings
22	central axis
24	support frames
26	arms
28	rollers
30	spokes
32	flanges
34	grinding chamber
36	drive shaft
38	rotors
40	classifier
42	bearings
44	locking collars
46	locking brackets
48	through-holes
50	locking pins
52	brackets
54	shell segments
56	ribs
58	inspection hatches
60	covers
62	anchor points
64	lining
66	spacers
68	hub
70	grinding disc segments
72	splice plates
74	openings

CLAIMS

1. A grinding mill, comprising

a shell enclosing a grinding chamber that is configured to contain a slurry of a liquid, ore particles and grinding media;

a drive shaft extending into the grinding chamber, the drive shaft supporting a plurality of rotors located within the grinding chamber whereby, during use, rotation of the rotors is configured to cause motion of the slurry;

the shell comprising an annular side wall and opposed end walls, wherein the side wall comprises two or more shell segments being joined together, each of the shell segments being selectively removable from the side wall to provide an opening in the shell to allow maintenance access to the grinding chamber and the rotors; and

wherein the grinding media is retained within the grinding chamber while each shell segment is selectively removed from the side wall.

2. A grinding mill as claimed in claim 1, wherein the shell is substantially cylindrical having a horizontally orientated central axis.

3. A grinding mill as claimed in claim 2, which further comprises rolling rings being co-axially joined to the shell, the rolling rings being rotatably seated within complementary support frames and being configured to permit rotation of the shell around the central axis.

4. A grinding mill as claimed in claim 3, wherein the support frames carry rollers abutting the rolling rings.

5. A grinding mill as claimed in claim 4, wherein the rollers are drive rollers.

6. A grinding mill as claimed in any one of claims 3 to 5, wherein the rolling rings are joined to an outer side of the end walls and located remote from the shell thereby to avoid hindering selective removal of the shell segments.

7. A grinding mill as claimed in claim 6, wherein the end walls and the rolling rings are diametrically split into hemispheres.

8. A grinding mill as claimed in any one of claims 3 to 7, wherein the shell comprises locking collars enabling the shell to be locked in selected positions around the central axis and thereby prevent rotation of the shell relative to the support frames.

9. A grinding mill as claimed in any one of claims 1 to 8, further comprising a locking formation being configured to permit the drive shaft to be locked to the shell to thereby retain the drive shaft in a fixed angular orientation relative to the shell.

10. A grinding mill as claimed in claim 9, wherein the locking formation comprises locking brackets extending from the shell adjacent to the drive shaft, with the locking brackets and the drive shaft both having slots that are configured to removably receive a pin for locking the drive shaft to the locking brackets.

11. A grinding mill as claimed in any one of claims 1 to 10, wherein each of the shell segments are similarly shaped and dimensioned arc-shaped shell segments.

12. A grinding mill as claimed in claim 11, wherein the shell comprises three shell segments each extending through an arc of about 120°.

13. A grinding mill as claimed in claim 11 or 12, wherein each shell segment comprises an inspection hatch that is normally closed by a cover, each inspection hatch being configured to permit inspection of the grinding chamber when such inspection hatch is operatively positioned above a surface of slurry contained within the grinding chamber, and each inspection hatch further being configured to permit dumping of slurry from the grinding chamber when such inspection hatch is operatively positioned beneath the surface of the slurry.

14. A grinding mill as claimed in any one of claims 1 to 13, wherein one or more of the rotors is a multi-component part comprising a hub configured to be supported on the drive shaft, and the hub removably carrying multiple grinding disc segments.

15. A grinding mill as claimed in claim 14, wherein each grinding disc segment is removably joined to a splice plate, and the splice plate is removably joined to the hub.

16. A grinding mill as claimed in claim 15, wherein each grinding disc segment is in abutting contact with each of its neighbouring grinding disc segments and wherein each splice plate is spaced away from its neighbouring splice plate, thereby to define openings extending axially through the rotor.

17. A grinding mill as claimed in claim 16, wherein each rotor comprises three grinding disc segments each extending through an arc of about 120°.

18. A method of conducting maintenance on a grinding mill as claimed in any one of claims 1 to 17, the method comprising the steps of:

a) removing one or more of the shell segments that are positioned above a surface of slurry contained within the grinding chamber;

b) inspecting and conducting any requisite maintenance on the removed shell segment;

c) inspecting and conducting any requisite maintenance on a part of a rotor that is rotationally aligned with the removed shell segment;

d) reattaching the removed shell segment to close the grinding chamber; and

e) repeating steps (a) to (d) until each shell segment has been removed and inspected.

19. A method as claimed in claim 18, wherein the maintenance is conducted without exhausting or dumping the slurry and/or grinding media from the grinding chamber.

20. A method as claimed in claim 18, wherein one or more of the shell segments are simultaneously removable to permit replacement of the drive shaft.

Figure 1

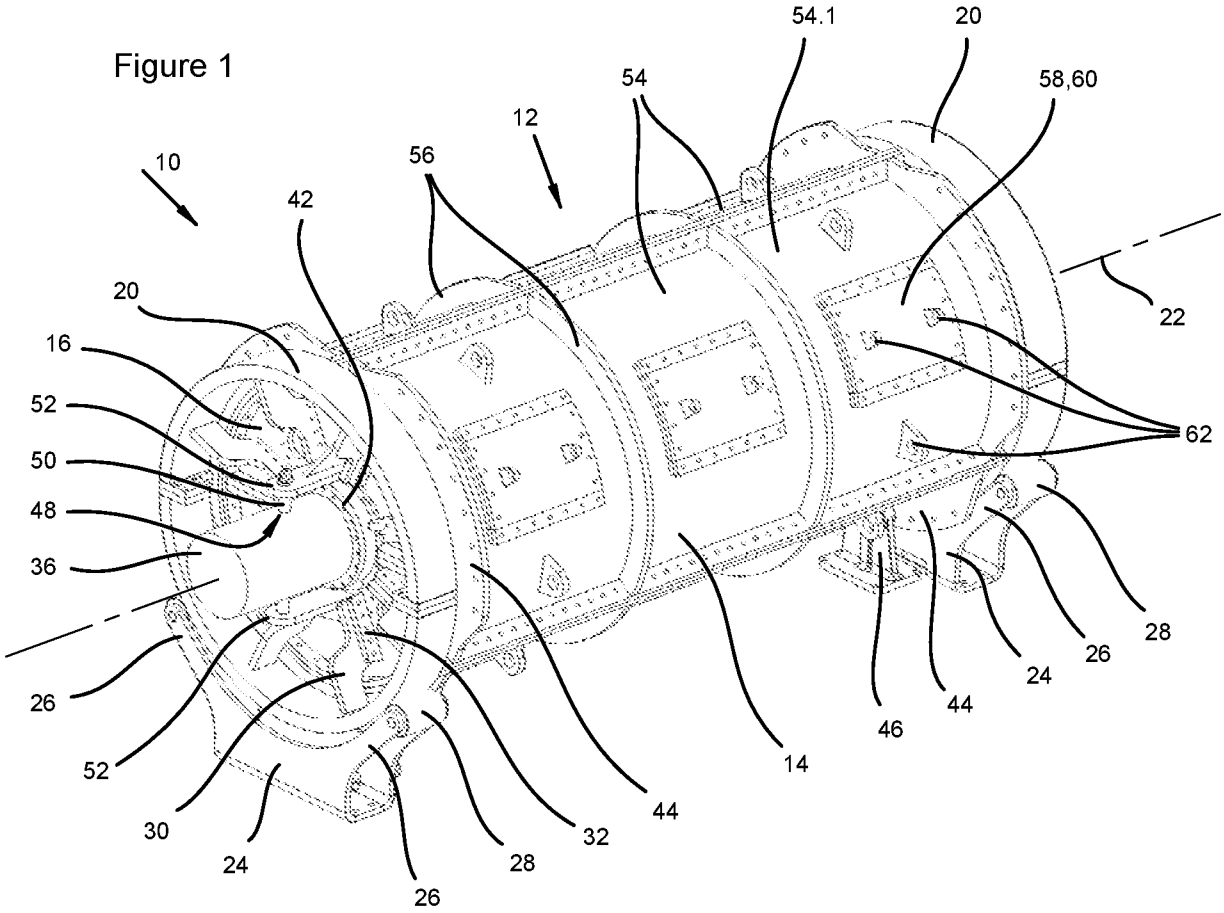


Figure 2

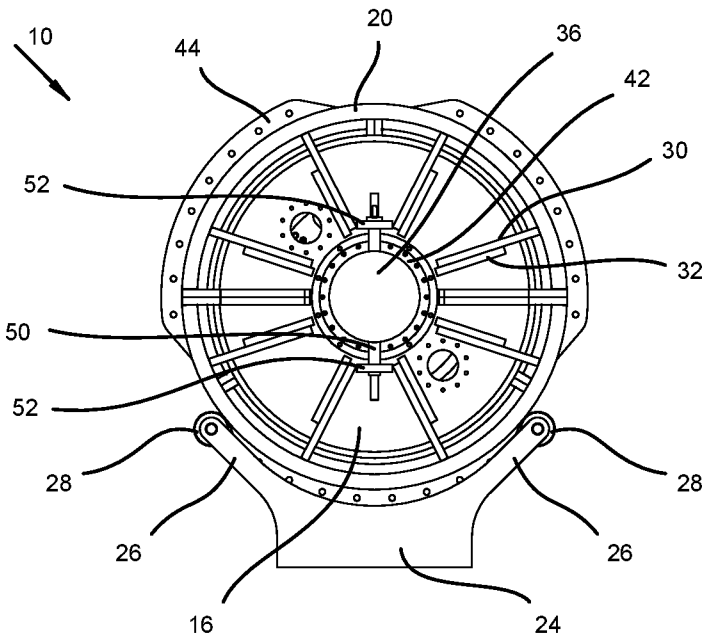


Figure 3

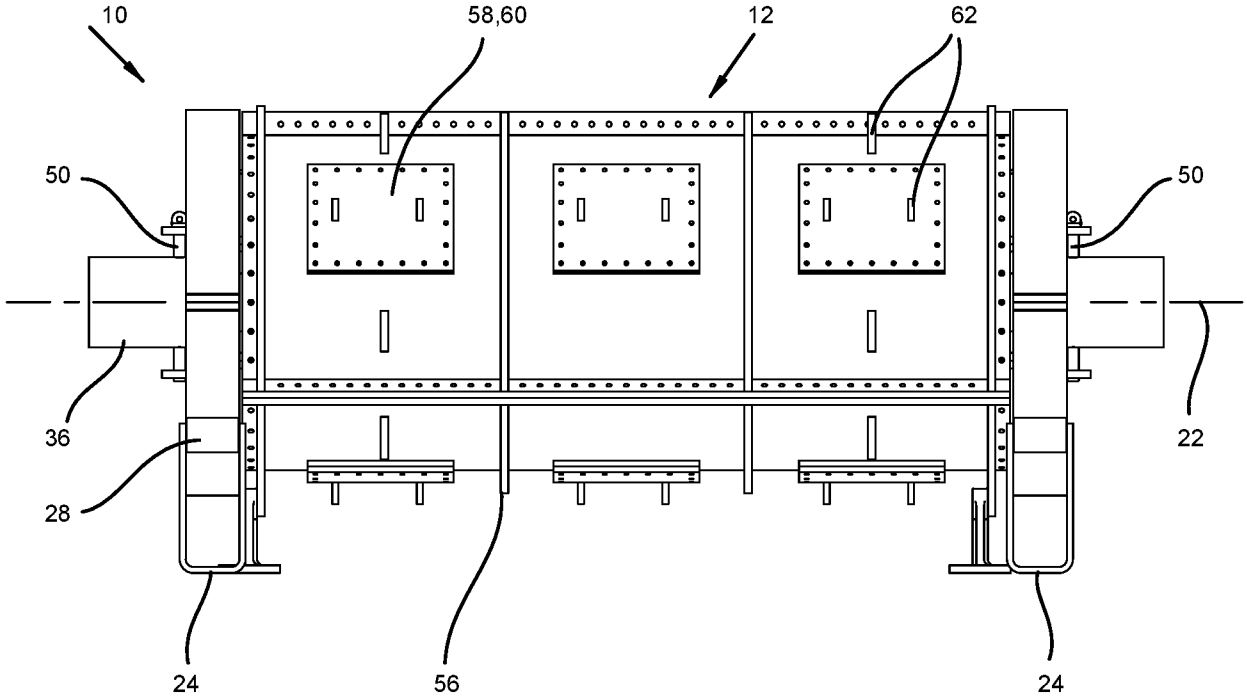


Figure 4

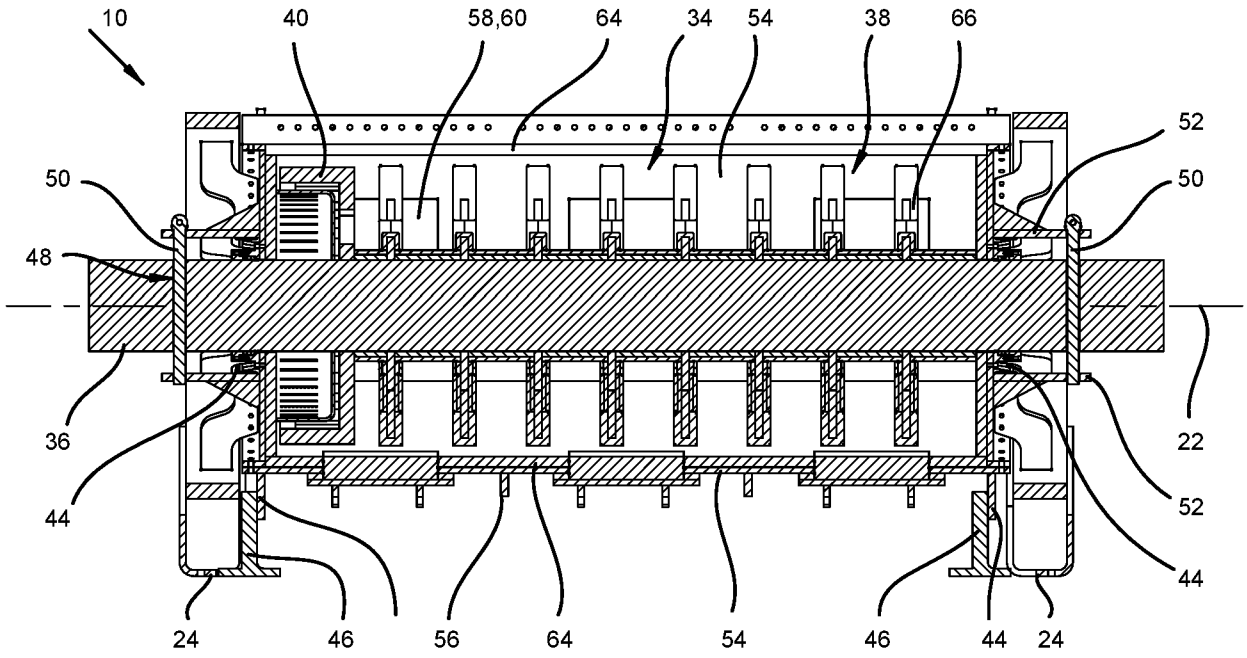


Figure 5

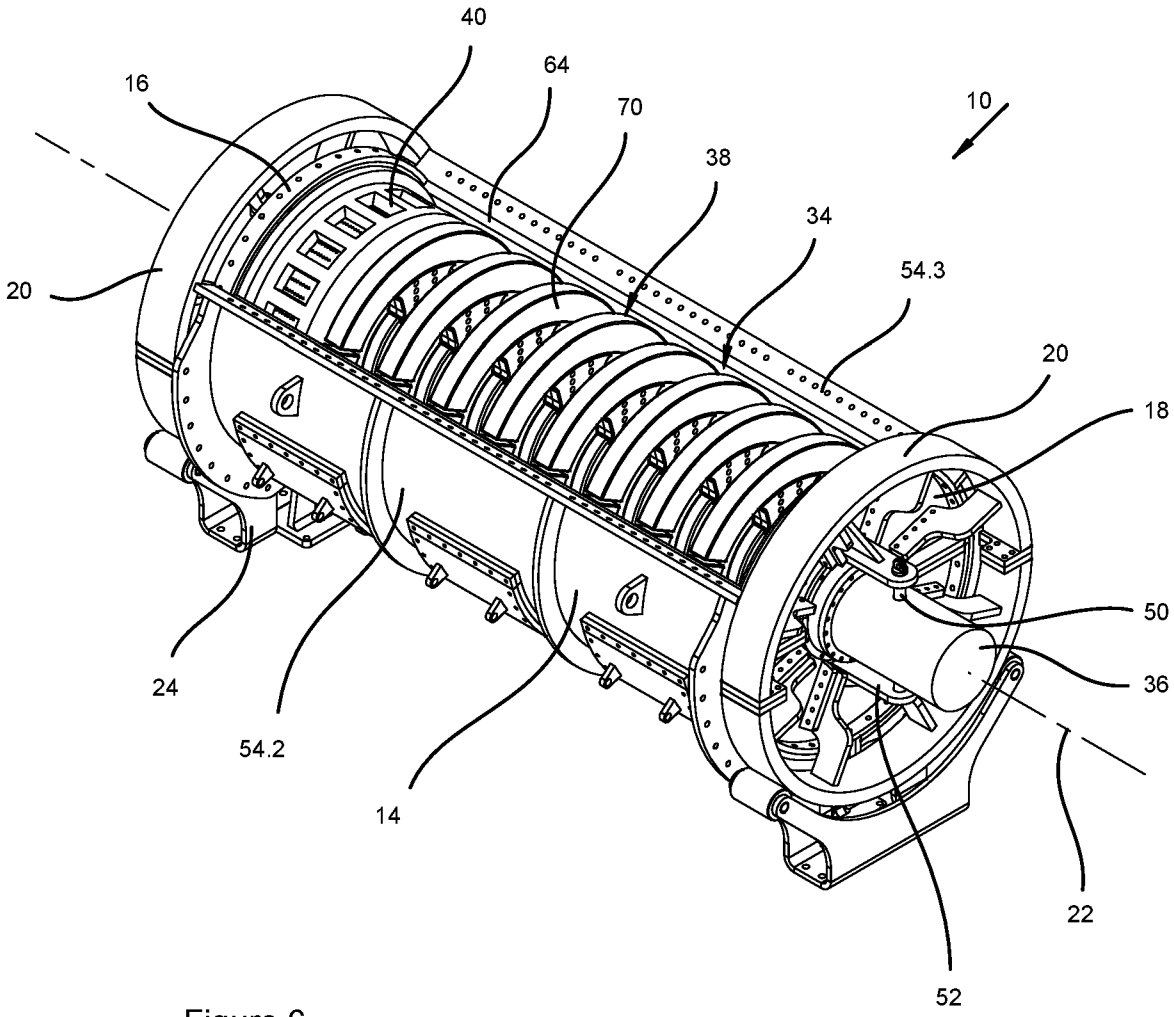


Figure 6

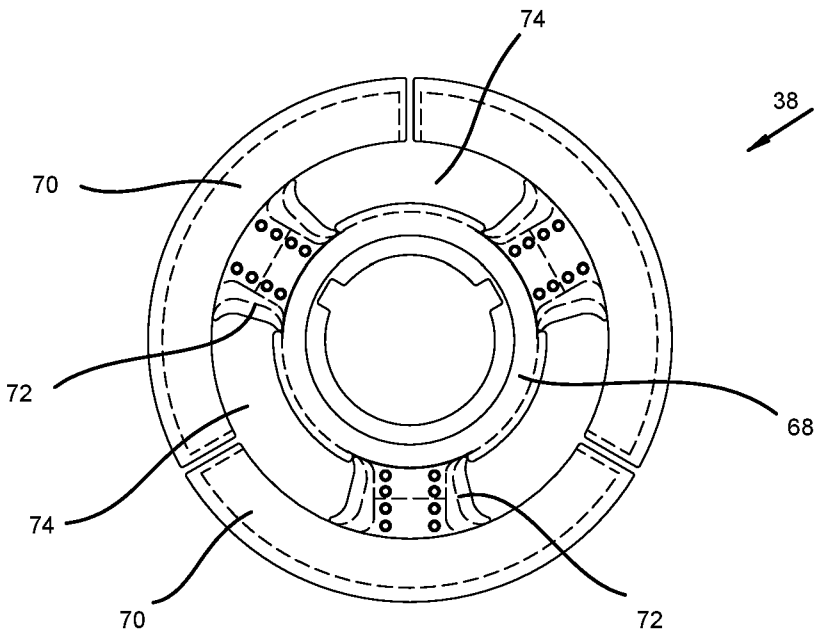
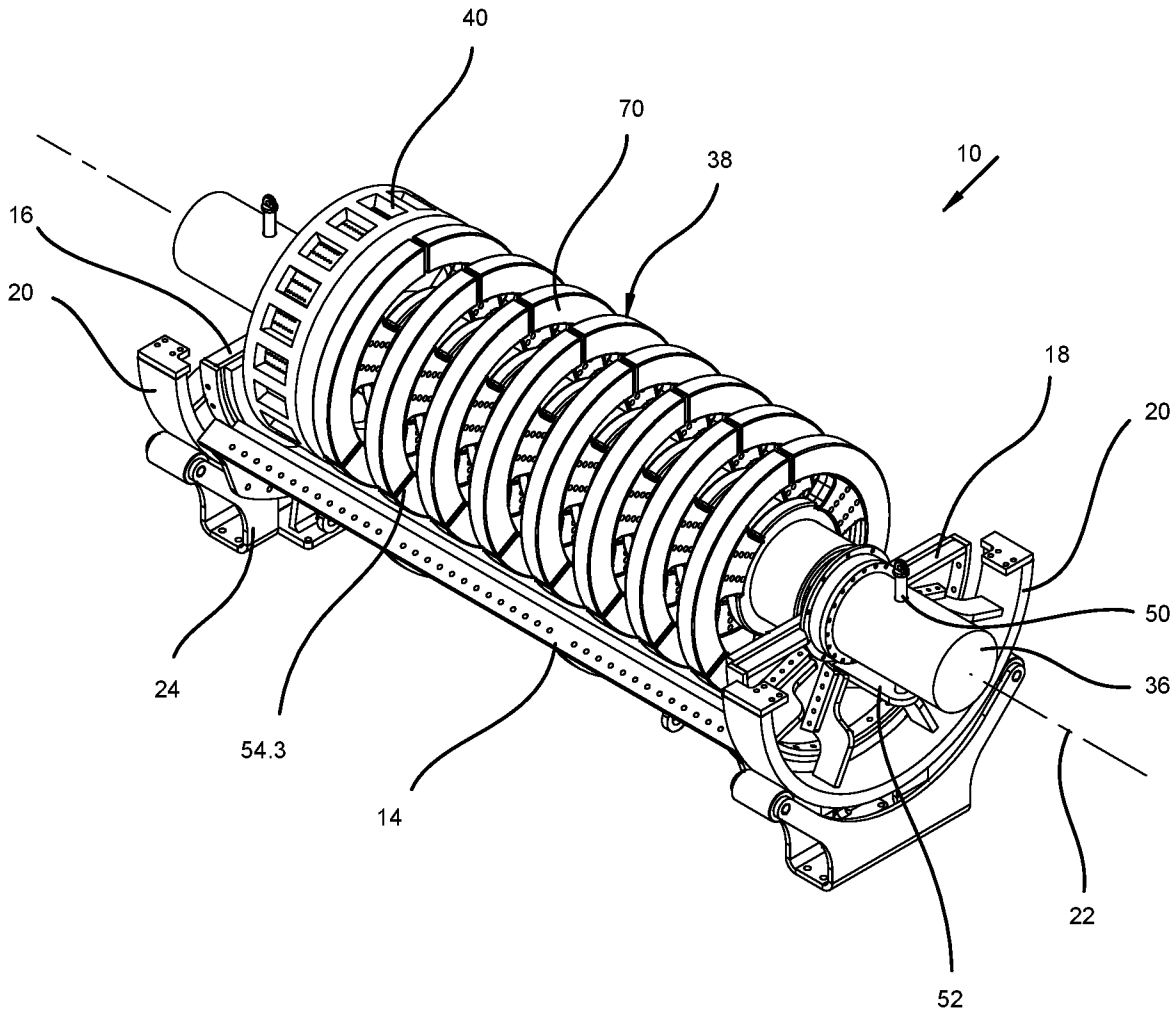


Figure 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2021/050751

A. CLASSIFICATION OF SUBJECT MATTER

B02C 17/04 (2006.01) B02C 17/18 (2006.01) B02C 17/20 (2006.01) B02C 17/24 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIAP & EPODOC: IPC & CPC; (B02C17/[--, 00, 04, 18]): KEYWORDS;(CHAMBER, SHELL, CONTAINER, SEGMENT, SECTION, PORTION, INSPECT, MAINTENANCE, SERVICE, ROLLER, BEARING, IDLER, SUPPORT, RIM, END, FRONT, BACK, PERIMETER, OUTSIDE, REMOVE, REPLACE, EXCHANGE, HATCH, COVER, MANHOLE) and like terms in various combinations. GOOGLE INTERNET; KEYWORDS (VECTIS PTY LTD, ISA, XSTRATA, OUTOTEC, NETZSCH, AGITATOR, MILL, GRINDER, ROTOR, AGITATOR, SHAFT, DRIVE, SHELL, DRUM BARREL, MAINTENANCE, REPAIR, ACCESS) and like terms in various combinations and AUSPAT & EspaceNet Applicant and Inventor Names. and AUSPAT, EspaceNet and internal databases provided by IP Australia Applicant and Inventor Names.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 September 2021	21 September 2021

Name and mailing address of the ISA/AU	**Authorised officer**
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INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2021/050751**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	WO 2015000457 A1 (NETZSCH-FEINMAHL TECHNIK GMBH) 08 January 2015 ABSTRACT and Figures 1-3 & 15, Items 1-3, 5-6, 10-13, 15-17, 20 & 60 ABSTRACT, TITLE and Figures 1-3 & 15, Items 1-3, 5-6, 10-13, 15-17, 20 & 60 Whole Document	1-4 & 8-11 5-7 & 12-17 18-20
Y	WO 2020079323 A1 (OUTOTEC (FINLAND) OY) 03 April 2020 Figures 1, 3 & 6, Items 1, 8-9, 14 Page 5 Lines 6-11 and Page 3 Line 25 - Page 6 Line 12	6-7 & 12
Y	US 2014096705 A1 (PIKE SR.) 10 April 2014 Figures 2-3 Items 12-14, 40 & 48	5 & 13
Y	WO 2003092897 A1 (NETZSCH-FEINMAHLTECHNIK GMBH) 13 November 2003 Figure 1-2 Items 12, 14-22, 28-30, 46-48 & 54-60 and Claim 4	14-17
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A	US 3614002 A (DORE) 19 October 1971 Whole Document	1-20

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/050751**

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INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/050751**

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End of Annex

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