(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 161 943**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **85303491.6**

(22) Date of filing: **17.05.85**

(51) Int. Cl.⁴: **B 02 C 15/12**

(30) Priority: **17.05.84 GB 8412543**

(43) Date of publication of application: **21.11.85 Bulletin 85/47**

(84) Designated Contracting States: **AT BE CH DE FR GB IT LI LU NL SE**

(71) Applicant: **Babcock Power Limited, Maypole House 128-132, Borough High Street, London SE1 1LB (GB)**

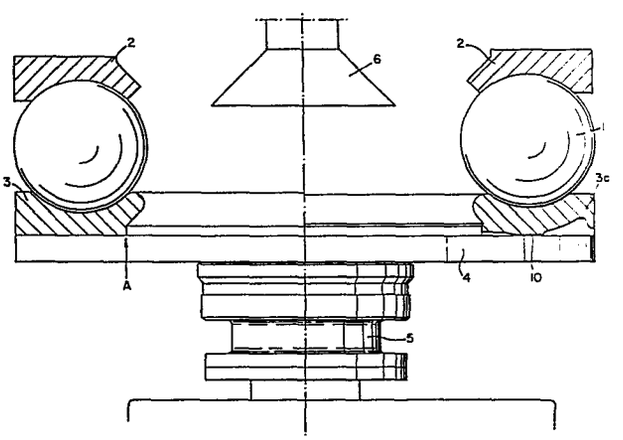
(72) Inventor: **Templeton, John, 1, Colinslee Cresent Lochfield, Paisley Renfrew PA2 6SD Scotland (GB)**
Inventor: **Taylor, John Welsh, 17, Cedarwood Avenue, Newton Mealns Glasgow G77 5QB (GB)**

(74) Representative: **Sinnett, Richard Albert Edward, Babcock International plc Cleveland House 19 St. James's Square, London SW1Y 4LN (GB)**

(54) Improvements in or relating to grinding mills.

(57) The invention concerns grinding mills of the kind that comprises a circle of grinding rings (1) held between a fixed upper grinding ring (2) and a lower rotatable grinding ring (3a). The lower ring (3a) rests on a support table (4) through a hump (10) projecting from the lower surface of the ring (3a). If the edge of the table should tilt, due to load, say, then the point of contact of the hump (10) and the table (4) will move along the hump (10), so that the moment acting on the ring (3a) will remain approximately constant. The centre of the hump (10) may lie on the vertical passing through the centre of the balls (1) or just radially outwardly of this, to take account of the centrifugal action in operation on the balls.

An alternative form of hump is in the form of a flat bottom and two sides that incline gradually away from the plane containing the bottom.



EP 0 161 943 A2

"Improvements in or relating to Grinding Mills"

DESCRIPTION

This invention relates to grinding mills. A form of grinding mill that has been progressively and successfully developed in recent times includes a circle of grinding balls held between an upper and a lower grinding ring, both being concentric with the circle. The upper ring is fixed and the lower ring is rotated about its axis. To enable the lower ring to be rotated, in a widely used design it initially rests flat on a support table that is connected to a central means by which the table can be rotated.

The development of such mills has progressed towards design that would entail the use of very large grinding rings (in order of 3.8m.in diameter) and grinding balls that are in the order of 98 cms. in diameter. A concomitant of this is that the loads applied on the grinding balls are greatly increased so that the loads that must be supported by the support table are also greatly increased.

It was found that the increase in loads tended to result in an increasing tendency for the lower grinding ring to break. An investigation of this phenomenon led to the present invention.

It was observed that as the load on the support table increased, there was a tendency for the table to be deflected to an extent that increased with the distance from the means by which it can be rotated. With the lower grinding ring initially resting flat

on the support table, then deflection of the table would result in support for the ring being provided only at the internal periphery of the ring and this resulted in strains that rendered the ring liable to fracture. Now it is not good technical logic to have recourse to the obvious remedy of increasing the thickness of the support table since this does not allow the dynamic energy to be absorbed easily. Further, the resultantly heavier support table would induce heavier dynamic loads on the grinding ring and this, in itself, might occasion breakages, What is more, assemblies of heavier masses possess greater rotational energy than lighter assemblies and can lead to increased wear and greater impact at guides with a possible consequence of cracking of the main mill housing and the mill housing support. In addition to such operational problems, first costs would be increased.

What the present invention provides is a grinding mill comprising a circle of grinding balls held between a fixed upper grinding ring and a lower rotatable grinding ring that rests on a support table that is connected to, and rotatable from, a central support, contact between the lower grinding ring and the support table being through a hump, concentric with the circle, on the ring or the table and a surface on the other such that variation in the angle of the part of the surface of the support table on which the ring rests results in movement, seen in a vertical axial section, of the point of contact from one point on the hump to another.

By way of example, embodiments of the invention will now be described with reference to the accompanying somewhat diagrammatic drawings in which:

Figure 1 shows a section through the balls-and-rings combination of a grinding mill, the left hand side indicating the standard arrangement and the right hand side indicating a modification introduced by the invention;

Figure 2 illustrates an alternative to this modification;

Figure 3 illustrates that modification in relation to the support table in one of the positions that the support table may achieve;

Figure 4 illustrates that modification in relation to the support table in another position that the support table may achieve; and

Figure 5 illustrates yet another modification that may be introduced by the invention.

Figure 1 illustrates a ring of grinding balls 1 acting between a fixed upper grinding ring 2 and a lower, rotatable, grinding ring 3. The ring 3 rests on a support table 4, integrally connected to means 5 by which the table can be rotated about its vertical axis. When the mill is unloaded and at rest, the upper surface of the support table 4 is horizontal. Material to be ground is discharged through the chute 6. A seal (not shown) is provided around the inner edge of the ring 3 to prevent the ingress of pulverulent material to the space between the ring 3 and the table 4.

In the standard arrangement (i.e. the arrangement that is illustrated in the left of Figure 1) the ring 3 rests flat on the support table 4 when the mill is at rest and unloaded. When the mill is operating, the

support table will tilt downwardly at its outer edge so that support for the lower ring 3 is provided only at the edge A of the ring and the moment acting there on the ring is dependent upon all of the distance between A and the direction of the forces acting on the ring.

The essential difference between the standard arrangement and the modified arrangement illustrated on the right of Figure 1 is that in the latter contact between the ring 3a and the support table 4 is made only through the hump 10. This extends continuously around, concentrically with, the ring 3a and has for cross section an arc of which the centre lies at the circle that contains the centres of the balls 1. When the mill is unloaded, the arc extends by equal amounts to both sides of the vertical that passes through the circle that contains the centre of the balls. If, then, the surface of the support table 4 tilts, the point of contact between the ring 3a and the support table 4 will (seen in the vertical axial section illustrated) roll along the hump 10, remaining, throughout a certain angle of tilt, on the vertical that passes through the circle that contains the centres of the balls. As a result there is, ideally, constantly, no moment exerted on the ring.

In operation of the mill, the centrifugal forces on the balls will tend to mean that the resultant force acting downwardly on the support table acts at a small angle outwardly from the vertical. To take account of this, the centre of the bump 10 may lie slightly outwardly of the circle that contains the centres of the balls.

This consideration is embodied in the modification shown in Figures 2,3 and 4. Here the hump 20 is not continuously curved but, in section, provides a flat bottom 21 and two flat sides 22 and 23 that slope upwardly at a small inclination upwardly from the edges of the bottom surface 21.

When the mill is at rest and unloaded, the bottom surface 21 is horizontal and rests flat on the top of the support table 4. Should a temperature differential occur, due to the heat of the primary air, say, that would tend to cause the outer edge of the support table 4 to tilt upwardly, then contact between the hump 20 and the support table 4 will occur only at the corner X unless the tilt of the table 4 were so excessive as to bring the table 4 into contact with the outer edge of the surface 23

Should the table 4 tilt downwardly, due to the loading of the ring 3a and the table 4, say, then contact between the hump 20 and the support table 4 will occur only at the corner Y unless the tilt of the table 4 were so excessive as to bring the table 4 into contact with the inner edge of the surface 22.

As is apparent from Figures 2 to 4, the centre of the hump 20 is slightly displaced outwardly from the circle that contains the centres of the balls 1 to maintain, during the life of the mill, at a low optimum the moment exerted by the resultant force acting on the ring 3a.

An advantage of the use of a hump in the form as shown at 20 is that the lower surface 21 can be

ground slightly to ensure contact between the hump and the support table 4 throughout its extent.

In the modification illustrated in Figure 5 there are two concentric humps 30 and 31, which may be in either of the forms shown to the right of Figure 1 or in Figures 2 to 4. The hump 30 is normally operative, with a small gap between the hump 31 and the support table 4. Should the support 4 become slightly deflected, then the hump 31 will become operative to share the load with the hump 30.

As an alternative to a support table in the form that has been described, the use of a yoke on which the ring 3a rests, and connected to the rotating means 5 by a spider, is envisaged.

Whilst convenience may dicate that the hump should be provided on the lower surface of the lower ring, it is envisaged that it might be provided on the upper surface of the support table.

CLAIMS

1. A grinding mill comprising a circle of grinding balls held between a fixed upper grinding ring and a lower rotatable grinding ring that rests on a support table that is connected to, and rotatable from, a central support, contact between the lower grinding ring and the support table being through a hump, concentric with the circle, on the ring or the table and a surface on the other such that variation in the angle of the part of the surface of the support table on which the ring rests results in movement, seen in a vertical axial section, of the point of contact from one point on the hump to another.

2 A grinding mill as claimed in claim 1 in which the hump is formed on the lower surface of the lower grinding ring and the part of the upper surface of the support table with which the grinding ring co-operates is flat.

3. A grinding mill as claimed in claim 2 in which said part of the upper surface of the support table is horizontal when the mill is unloaded.

4. A grinding mill as claimed in either of claims 2 and 3 in which the hump, in axial cross section of the mill, is in the form of an arc of a circle of which the centre lies on the circle that contains the centres of the balls.

5. A grinding mill as claimed in claim 3 in which the hump, in axial cross section of the mill, comprises a surface that is horizontal when the mill is unloaded and two further surfaces sloping upwardly and outwardly from the edges of that surface.

6. A grinding mill as claimed in either of claims 4 and 5 in which the centre of the hump lies outwardly of the circle on which the centres of the balls lie so that the resultant force acting on the ring when the mill is operating acts more nearly on the centre of the hump then would be the case if the centre of the hump lay vertically below the circle on which the centres of the balls lie.

7. A grinding mill as claimed in any of the preceding claims in which a further hump lies outwardly of, and concentric with, the hump specified in any of the preceding claims, the further hump being, when the mill is unloaded, out of contact with the surface with which it makes contact only after the variation in the angle has reached a predetermined value.

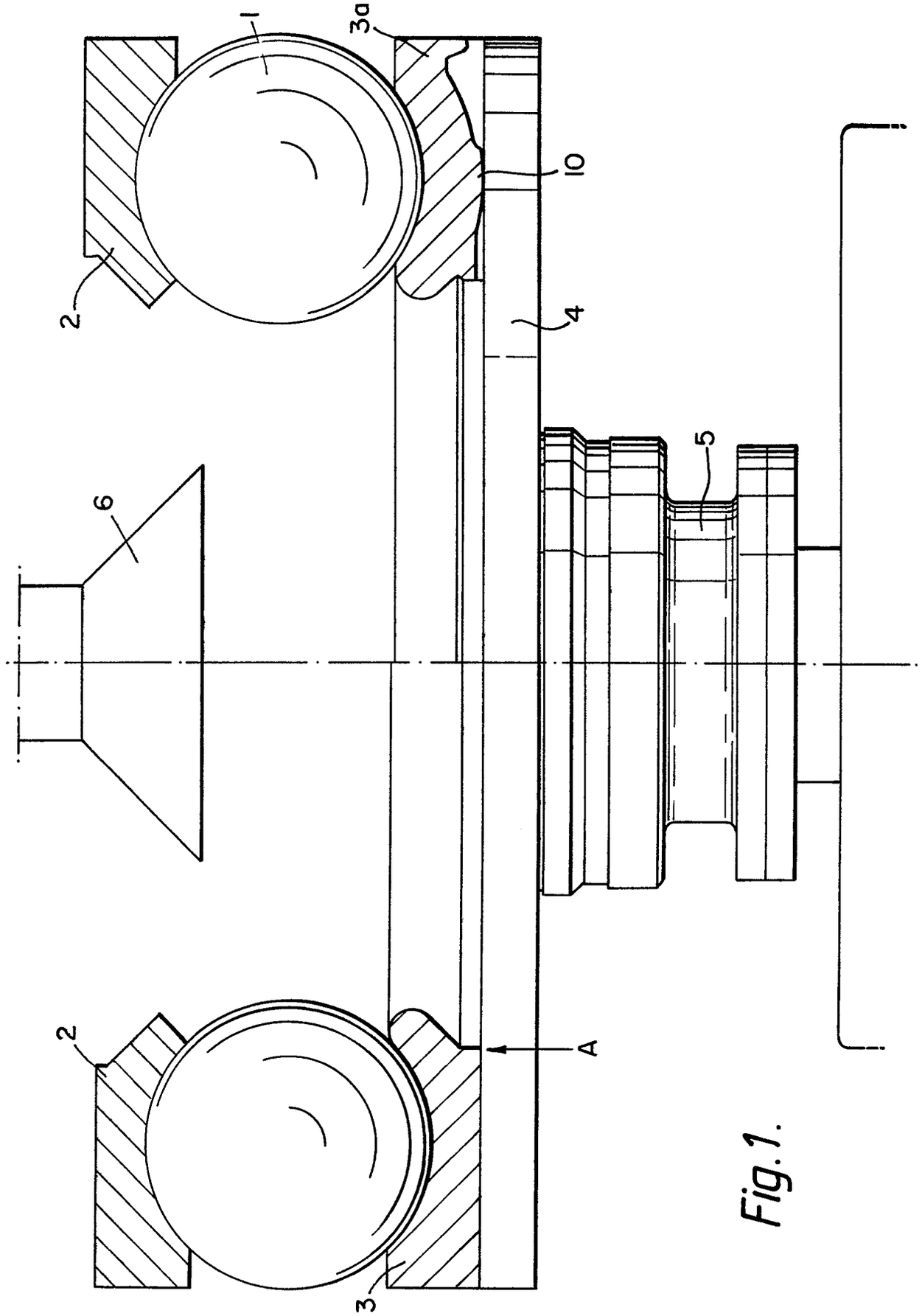


Fig.1.

Fig.2.

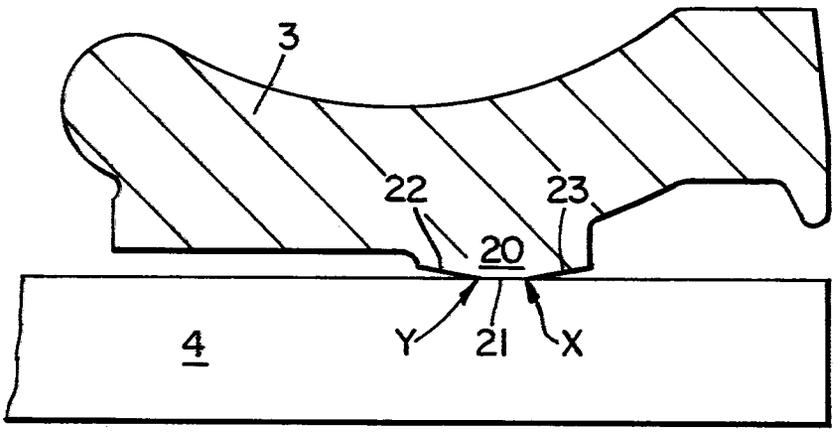


Fig.3.

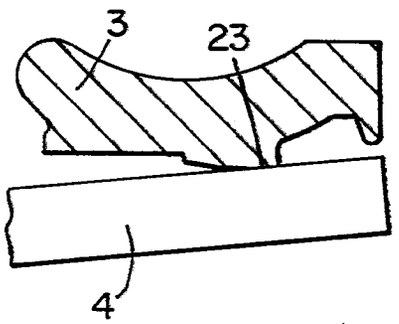


Fig.4.

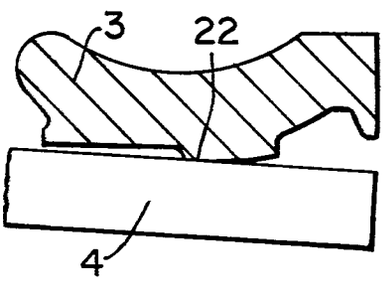


Fig.5.