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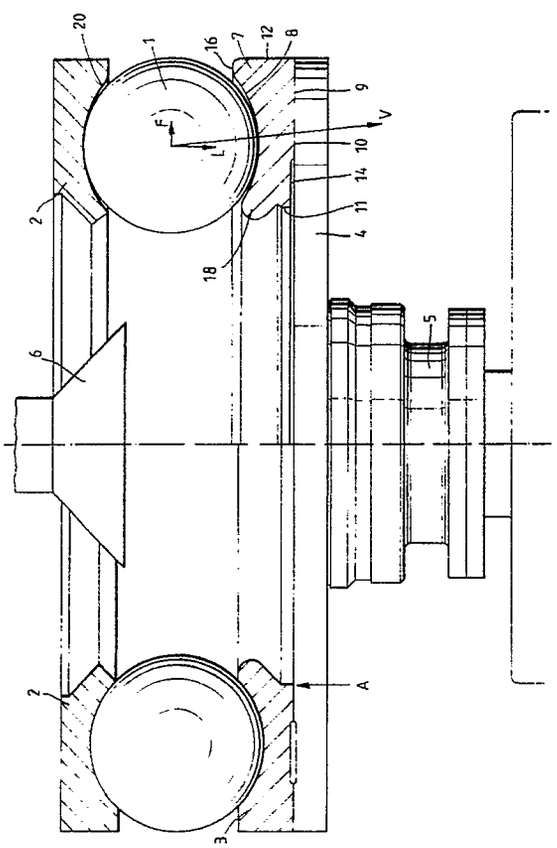
(54) **A method of manufacturing a lower grinding ring for a pulverised mill and a mill incorporating same.**

(57) A pulverising or grinding mill in which steel balls 1 roll on a circular path intermediate a rotating lower annular track 7 and a fixed upper track 2, the lower track 7 resting on a support table 4 having a drive 5. As shown on the right hand side of the drawing, an underface 10 of the lower ring 7 is formed with a relieved portion 14 and an annular landing face 9. The annular landing face is machined with a slight bias toward removing metal from a radially inner portion so that the face 9 is of slightly frusto-conical form. In an unloaded condition, the lower ring is supported at a radially outer edge portion on the support table 4. On applying a load and driving the table, the table deflects slightly and support of the ring 7 is effected at a radially inner annular face of contact substantially coincident with the loading vector. This substantially avoids the generation of a radial bending moment across the lower ring 7 due to the avoidance of an offset reaction to the loading. Edge portions 13, 18 of the lower ring 7 are of rounded, merging, form to avoid localised stress concentrations from any residual radial bending moments. The tracks 20, 8 in the upper and lower rings 2, 7 are of a slightly larger effective radius of curvature than the steel balls 1 to permit a slight oscial-lation in the path of the balls 1 without the force vector moving outside the annular face of contact.



EP 0 435 537 A1

A METHOD OF MANUFACTURING A LOWER GRINDING RING FOR A PULVERISING MILL AND A MILL INCORPORATING SAME.

This invention relates to pulverising or grinding mills and, more particularly, to a method of manufacturing a lower grinding ring for a pulverising mill and a mill incorporating same.

EP-A-161943 describes pulverising or grinding mills having grinding elements rolling on a circular path intermediate a rotating lower annular track or ring and a fixed upper annular track or ring, the lower annular track or ring seating on a rotating support table or platform having a planar upper face and having loading means arranged to act on the upper annular track or ring to urge the upper annular track or ring toward the lower track or ring, and hence the tracks or rings into contact with the grinding elements, and an underface of the lower track or ring formed with a landing face arranged to seat on the planar upper face of the support table or platform.

EP-A-161943 describes the problem arising from the development of such mills to increased size and loading in which there was found an increasing tendency for the lower grinding ring to fracture in configurations where the ring rests flat on the support table when the mill is at rest and unloaded. EP-A-161943 describes configurations in which the underface of the lower grinding ring is formed with a hump concentric with the ring such that the moment exerted on the lower grinding ring as a result of the loading on the grinding elements and the reactive support of the table is maintained at a low optimum. However, whilst this is a satisfactory solution, forming of the hump requires a machining operation to shape the hump - which can be expensive and cause difficulties to maintaining accuracy at the relatively large diameters involved.

According to the present invention, the underface of the lower track or ring is formed with a landing face of slightly frusto-conical form, extending across the width of the underface such that, prior to applying loading, the landing face contacts the support table or platform at a radially outer edge and that, upon loading, the landing face makes contact with the support table or platform over an annular area inwardly from the radially outer edge.

The invention also includes a method of manufacturing a lower grinding ring for a pulverising or grinding mill including producing a hard iron casting and machining the casting to predetermined dimensions and tolerances, the machining including forming a landing face on the underface of the lower grinding ring by removal of metal from the casting with a slight bias toward metal removal from a radially inner portion such that the landing face is ofslightly frusto-conical form.

Preferably, the underface is relieved over a radially inner portion thereof such that the annular area of contact is positioned such that the resultant line of action of the vector of the loading force and centrifugal force arising from movement of the grinding elements around the circular path passes through the annular area of contact.

The invention will now be described, by way of example, with reference to the accompanying, partly diagrammatic cross-section of a portion of a pulverising mill utilising steel balls as grinding elements and indicating on the left hand side a standard arrangement and on the right hand side a modification introduced by the invention.

As shown, steel balls 1 are positioned between a fixed upper grinding ring 2 and a rotating lower, grinding ring 3 supported upon a support table 4 connected to drive means 5 by which the table is rotated about the 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 ground 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 the drawing) 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 with the result that the moment acting there on the ring is increased since it is dependent upon the distance between A and the vector V of the resultant forces acting on the ring.

The essential difference between the standard arrangement and the modified arrangement illustrated on the right of the drawing is that in the latter configuration the underface of a modified lower grinding ring 7 is of slightly frusto-conical form.

The lower grinding ring is produced as a hard iron casting and is cast such as to form an arcuate track 8 on an upper face and an annular landing face 9 on a relieved underface 10 also having a relieved portion 14 together with inner and outer cylindrical edge faces 11, 12.

The casting is then machined on the cylindrical edge faces 11, 12 to centre the arcuate track 8 with the central axis of the mill and on the annular landing face 9 in order to seat on the support platform or table 4. A minimum of metal is re-

moved from the underface sufficient to produce a clean, full-width landing face 9 across the underface and any excess thickness removed at an annular shoulder 16 on the upper face intermediate the arcuate track 8 and the outer cylindrical edge 12, which outer shoulder region 16 is merged smoothly with the arcuate track 8 to avoid localised stress concentration in the associated region. Similarly, an inner nose region 18 is also of smoothly rounded form to avoid localised stress concentration in the associated region, since normally this will be the region of greatest stress concentration in the grinding ring 7, particularly from any residual bending moments.

In machining the annular landing face 9 on the underface 10, a slight bias is made toward removing metal from a radially inner portion such that the landing face 9 has a slightly frusto-conical form. By way of example, on a grinding ring 7 of approximately 3 metres diameter the inner portion of the landing face 9 is displaced by a distance of approximately 0.1 millimetre toward the arcuate track from a plane containing the intercept of the outer cylindrical edge face 12 and the radially outer portion of the landing face 9.

The displacement is such that upon applying loading L to the mill, a corresponding deflection arises in a radially outer portion of the support platform or table 4 and accordingly, by virtue of the relieved portion 14 of the face, annular face contact between the lower grinding ring 7 and the support platform or table 4 is achieved in the loaded state over an annular region displaced somewhat outwardly of the imaginary cylinder containing the centes of the balls 1 in order to accommodate the effect of centrifugal force F on the balls giving rise to a resultant force acting on a vector V at a slight outward angle to the vertical.

As a result of the annular face contact under loading, stress arising from the loading and the grinding operation tends to be distributed more evenly in the grinding ring as opposed to a mill in which the underface of the lower grinding ring is initially planar, since in such an arrangement, as an outer portion of the support platform or table deflects, reduced contact between the lower grinding ring and the support platform or table occurs, thereby adversely affecting the stress distribution pattern.

In addition, it will be appreciated that, by making the relieved portion 14 of appropriate radial dimension, the intercept of the resultant force vector arising from the loading of the steel balls 1 and the centrifugal force arising from rotation of the balls about the central axis of the mill with the underface 10 of the lower grinding ring 7 may be arranged to co-incide with the annular face of contact between the lower grinding ring 7 and the support table 4. Thus, if the vector V and the annular face of contact coincide or substantially coincide, no or little resultant radial bending moment is imposed on the lower grinding ring since there is no or little displacement of the support for the ring from the vector V and hence no or little bending moment is generated.

The arcuate tracks 20 and 8 in the upper and lower rings 2 and 7 have a slightly greater radius of curvature than the radius of the balls 1 or, alternatively, are formed with an annular flat at a central portion flanked by arcuate portions, to permit a slight oscillation in the movement of the balls around the track. However, as indicated in the foregoing, since an annular face of contact exists, whilst the position of the force vector V will oscillate with the oscillation of the balls, no undue bending moment will be imposed on the lower grinding ring by virtue of the oscillation on the location of the support of the ring.

Claims

1. A pulverising or grinding mill having grinding elements (1) rolling on a circular path intermediate a rotating lower annular track or ring (7) and a fixed upper annular track or ring (2), the lower annular track or ring (7) seating on a rotating support table or platform (4) having a planar upper face and having loading means arranged to act on the upper annular track or ring (2) to urge the upper annular track or ring (2) toward the lower track or ring (7), and hence the tracks or rings (2, 7) into contact with the grinding elements (1), an underface (10) of the lower track or ring being formed with a landing face arranged to seat on the planar upper face of the support table or platform (4), characterised in that the underface (10) of the lower track or ring (2) is formed with a landing face (9) of slightly frusto-conical form, extending across the width of the underface (10) such that, prior to applying loading, the landing face (9) contacts the support table or platform (14) at a radially outer edge (12) and that, upon loading, the landing face makes contact with the support table or platform over an annular area inwardly from the radially outer edge.

2. A pulverising or grinding mill as claimed in Claim 1, characterised in that the underface (10) is relieved over a radially inner portion thereof such that the annular area of contact at operational loading is positioned with the resultant line of action of the vector of the loading force and centrifugal force arising from movement of the grinding elements around the cir-

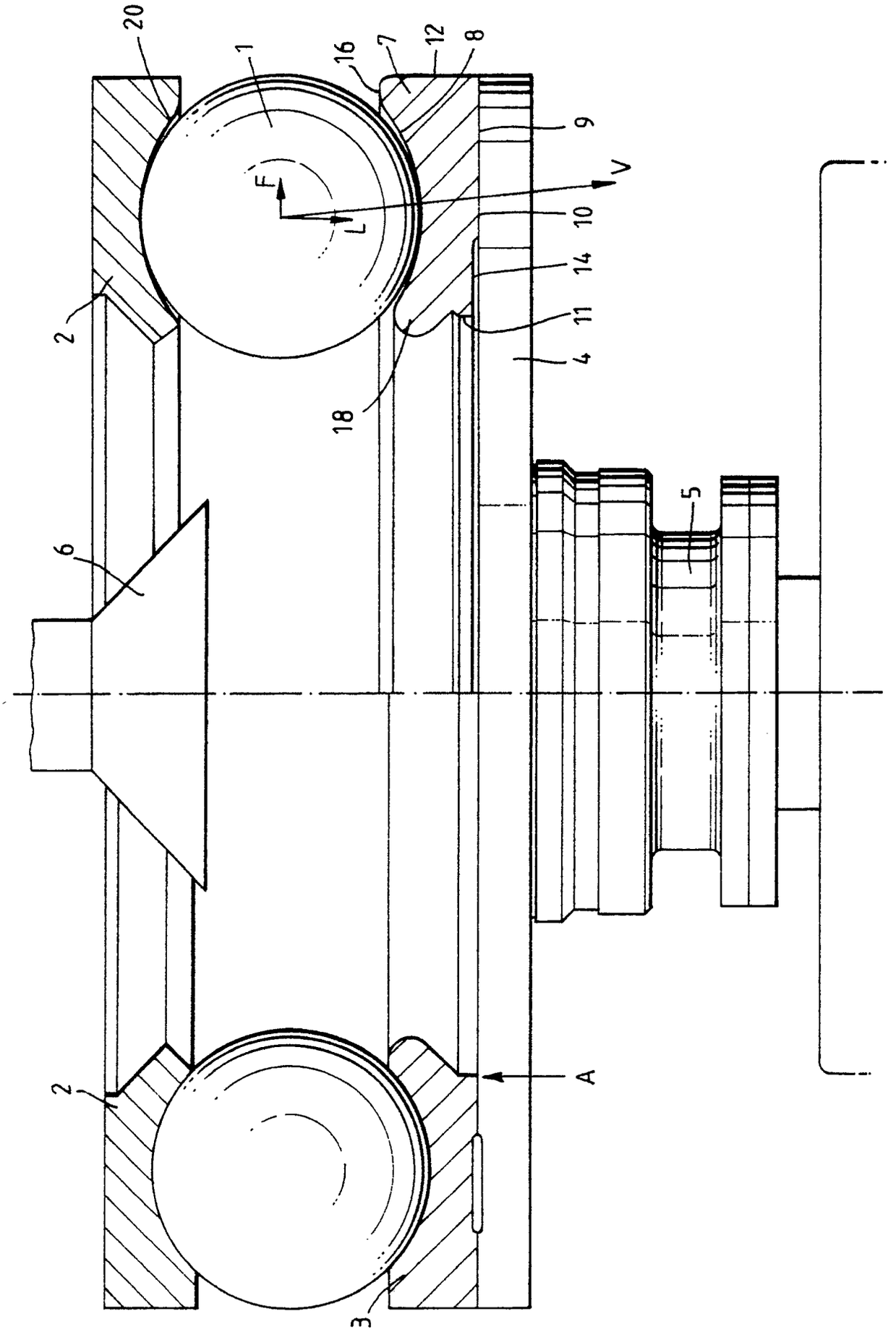
cular path passing through the annular area of contact.

3. A pulverising or grinding mill as claimed in Claim 1 or Claim 2, characterised in that an inner nose region (18) and an outer shoulder region (16) of the lower grinding ring (7) respectively merge smoothly with the arcuate track (8) such as to avoid localised stress concentrations in the associated regions.

4. A pulverising or grinding mill as claimed in any preceding claim, characterised in that the grinding elements are steel balls (1) and arcuate tracks (20, 8) in the upper and lower rings (2,7) have a slightly greater radius of curvature than the radius of the steel balls (1).

5. A pulverising or grinding mill as claimed in any one of Claims 1 to 4, characterised in that the grinding elements are steel balls (1) and arcuate tracks (20, 8) in the upper and lower grinding rings (2, 7) are formed as flat annuli at central portions thereof flanked by arcuate portions.

6. A method of manufacturing a lower grinding ring (7) for a pulverising or grinding mill including producing a hard iron casting and machining the casting to predetermined dimensions and tolerances, characterised in that the machining includes forming a landing face (9) on the underface (10) of the lower grinding ring (7) by removal of metal from the casting with a slight bias toward metal removal from a radially inner portion such that the landing face (9) is of slightly frusto-conical form.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EUROPEAN SEARCH REPORT

Application Number

EP 90 31 3728

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A,D	EP-A-0 161 943 (BABCOCK POWER LTD) * Page 1, abstract; pages 7,8; figures 1-5 *	1-3,6	B 02 C 15/12
A	GB-A-2 194 177 (CHARLES W. TAYLOR & SON LTD) * Page 1, abstract; figure 3 *	1,6	
A	US-A-1 483 932 (ELLIS) * Page 3, lines 66-76 *	4,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 02 C

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	28 March 91	VERDONCK J.C.M.J.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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