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(54) **Pulverising mill.**

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Description

This invention relates to pulverising or grinding mills as referred to in the preamble of claim 1. Such mills are known from e.g. EP-A-161943.

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 and having a portion of slightly frusto-conical form.

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 from a radially outer edge of the lower track or ring radially inwardly across the width of the underface such that, prior to applying loading, the landing face contacts the support table or platform at the 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.

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 removed 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 (9) arranged to seat on the planar upper face of the support table or platform (4) and having a portion of slightly frusto-conical form, characterised in that the underface (10) of the lower track or ring (7) is formed with a landing face (9) of slightly frusto-conical form, extending from a radially outer edge (12) of the lower track or ring (7) radially inwardly 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 the 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 (12).

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 circular 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 3, 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.

Patentansprüche

1. Pulverisier- oder Feinmühle mit folgenden Merkmalen:
   Mahlelemente (1) rollen auf einer kreisförmigen Bahn zwischen einer sich drehenden unteren Spur oder einem Ring (7) und einer feststehenden oberen Spur oder einem Ring (2);
   die untere ringförmige Spur oder der Ring (7) sitzen auf einem sich drehenden Trägertisch oder einer Plattform (4), die eine ebene Oberseite und eine Belastungseinrichtung aufweist, die zur Einwirkung auf der oberen ringförmigen Spur oder dem Ring (2) angeordnet ist, um die obere ringförmige Spur oder den Ring (2) zu der unteren Spur oder dem Ring (7) zu drängen und daher die Spuren oder Ringe (2, 7) in Kontakt mit den Mahlelementen (1) zu bringen; eine Unterseite (10) der unteren Spur oder des Ringes ist mit einer Feldfläche (9) versehen, die zur Lagerung auf der ebenen Oberseite des Trägertisches oder der Plattform (4) angeordnet ist und einen Teil mit leicht kegelstumpfförmiger Form aufweist,
   dadurch gekennzeichnet,
   daß die Unterseite (10) der unteren Spur oder des Ringes (7) mit einer Feldfläche (9) von leicht kegelstumpfförmiger Gestalt ausgebildet ist, sich von einer radial äußeren Kante (12) der unteren Spur oder des Ringes (7) radial nach innen über die Breite der Unterseite (10) erstreckt, so daß vor dem Aufbringen der Belastung die Feldfläche (9) den Trägertisch oder die Plattform (14) an der radial äußeren Kante (12) berührt, und
   daß bei Belastung die Feldfläche den Trägertisch oder die Plattform über einen radial von der äußeren Kante (12) innenliegenden ringförmigen Bereich berührt.

2. Pulverisier- oder Feinmühle nach Anspruch 1,
   dadurch gekennzeichnet,
   daß die Unterseite (10) über einen radial inneren Teil ausgespart ist, so daß die ringförmige Berührungsfläche bei Betriebsbelastung so gelegen ist, daß die resultierende Wirkungslinie des Vektors der Belastungskraft und der Zentrifugalkraft aus der Bewegung der Mahlkörper um die kreisförmige Bahn durch die ringförmige Berührungsfläche hindurchgeht.

3. Pulverisier- oder Feinmühle nach Anspruch 1 oder 2,
   dadurch gekennzeichnet,
   daß ein innerer Vorsprungsbereich (18) und ein äußerer Schulterbereich (16) des unteren Mahlringes (7) glatt in die bogenförmige Spur oder Laufbahn (8) übergehen, um örtliche Spannungskonzentrationen in den zugeordneten Bereichen zu vermeiden.

4. Pulverisier- oder Feinmühle nach einem der vorhergehenden Ansprüche,
   dadurch gekennzeichnet,
   daß die Mahlelemente aus Stahlkugeln (1) bestehen und daß die bogenförmigen Spuren oder Führungsbahnen (20, 8) in dem oberen und unteren Ring (2, 7) einen etwas größeren Krümmungsradius als der Radius der Stahlkugeln (1) aufweisen.

5. Pulverisier- oder Feinmühle nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet,
   daß die Mahlelemente Stahlkugeln (1) sind und daß die bogenförmigen Spuren oder Führungsbahnen (20, 8) in den oberen und unteren Mahlringen (2, 7) als ebene Ringflächen in den zentralen Teilen und als bogenförmige Teilflächen an den Flanken ausgebildet sind.

Revendications

1. Broyeur pulvérisateur ou concasseur comportant des éléments concasseurs (1) roulant sur une voie circulaire entre une piste ou couronne annulaire inférieure rotative (7) et une piste ou couronne annulaire supérieure fixe (2), la piste ou couronne annulaire inférieure (7) reposant sur une plate-forme ou table de support rotative (4) comportant une face supérieure plane et comportant un moyen de charge agencé pour agir sur la piste ou couronne annulaire supérieure (2) afin d'amener la piste ou couronne annulaire supérieure (2) vers la piste ou couronne inférieure (7), et donc les pistes ou couronnes (2, 7) en contact avec les éléments concasseurs (1), une face inférieure (10) de la piste ou couronne inférieure dotée d'une face d'appui (9) agencée pour reposer sur la face supérieure plane de la plate-forme ou table de support (4) et comportant une portion de forme légèrement tronconique, caractérisé en ce que la face inférieure (10) de la piste ou couronne inférieure (7) est dotée d'une face d'appui (9) de forme légèrement tronconique, s'étendant depuis un bord externe radialement (12) de la piste ou couronne inférieure (7) radialement vers l'intérieur sur la largeur de la face inférieure (10) de manière que, avant d'appliquer la charge, la face d'appui (9) contacte la plate-forme ou table de support (14) au bord externe radialement (12) et que, lors de la charge, la face d'appui fasse contact avec la plate-forme ou table de support sur une zone annulaire vers l'intérieur depuis le bord externe radialement (12).

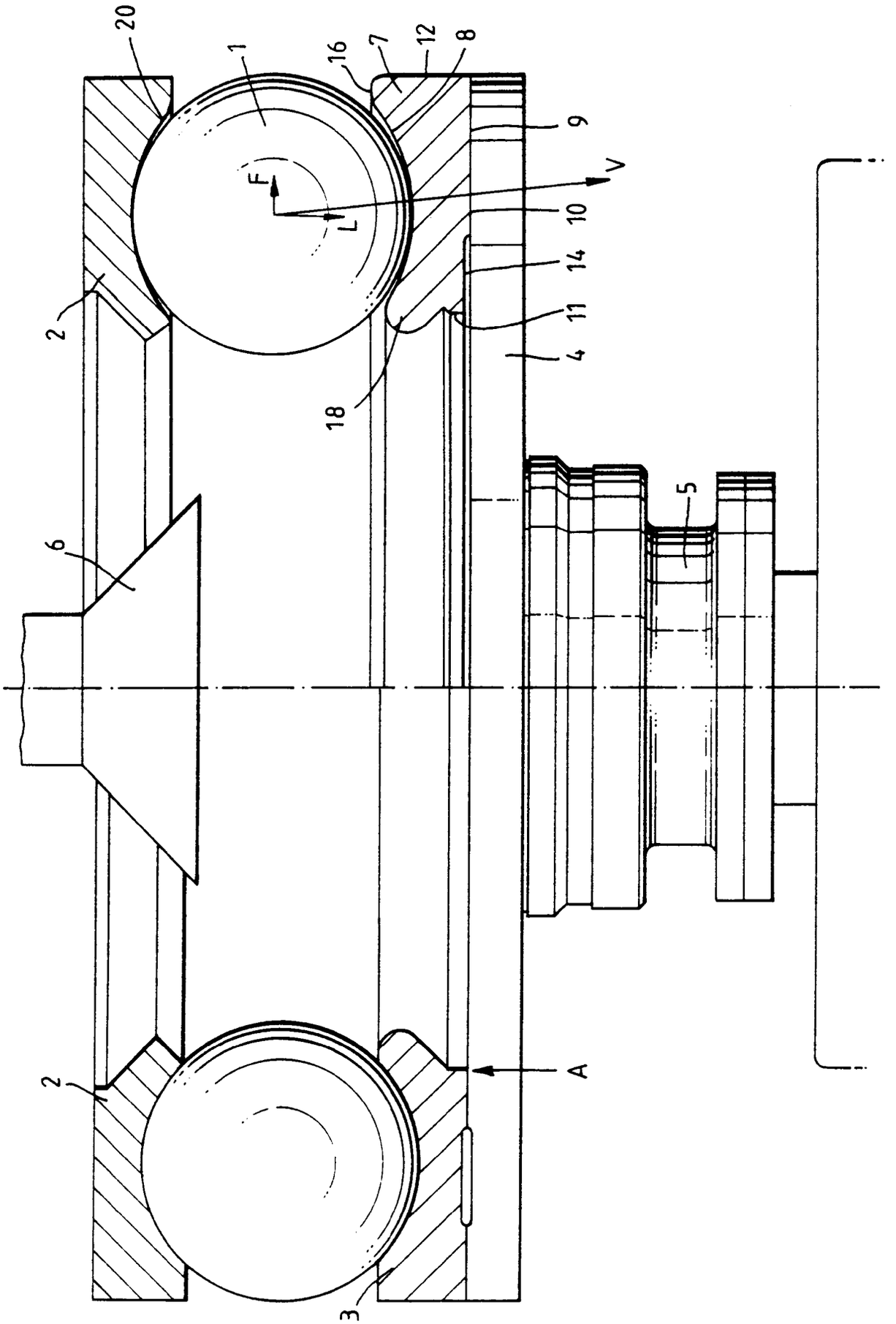
2. Broyeur pulvérisateur ou concasseur selon la revendication 1, caractérisé en ce que la face inférieure (10) est dégagée sur une portion interne

radialement de manière que la zone annulaire de contact lors d'une charge durant le fonctionnement soit positionnée avec la ligne résultante d'action du vecteur de la force de charge et la force centrifuge provenant du mouvement des éléments concasseurs autour de la voie circulaire passant par la zone annulaire de contact.

3. Broyeur pulvérisateur ou concasseur selon la revendication 1 ou 2, caractérisé en ce qu'une région de bec interne (18) et une région d'épaulement externe (16) de la couronne de concassage inférieure (7) fusionnent, respectivement, doucement avec la voie arquée (8) pour éviter des concentrations de contrainte localisées dans les régions associées.

4. Broyeur pulvérisateur ou concasseur selon l'une quelconque des revendications précédentes, caractérisé en ce que les éléments concasseurs sont des boulets d'acier (1) et les voies arquées (20, 8) dans les couronnes supérieure et inférieure (2, 7) ont un rayon de courbure légèrement plus grand que le rayon des boulets d'acier (1).

5. Broyeur pulvérisateur ou concasseur selon l'une quelconque des revendications 1 à 3, caractérisé en ce que les éléments concasseurs sont des boulets d'acier (1) et les voies arquées (20, 8) dans les couronnes supérieure et inférieure (2, 7) sont dotées d'un plat annulaire en une portion centrale flanquée de portions arquées.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