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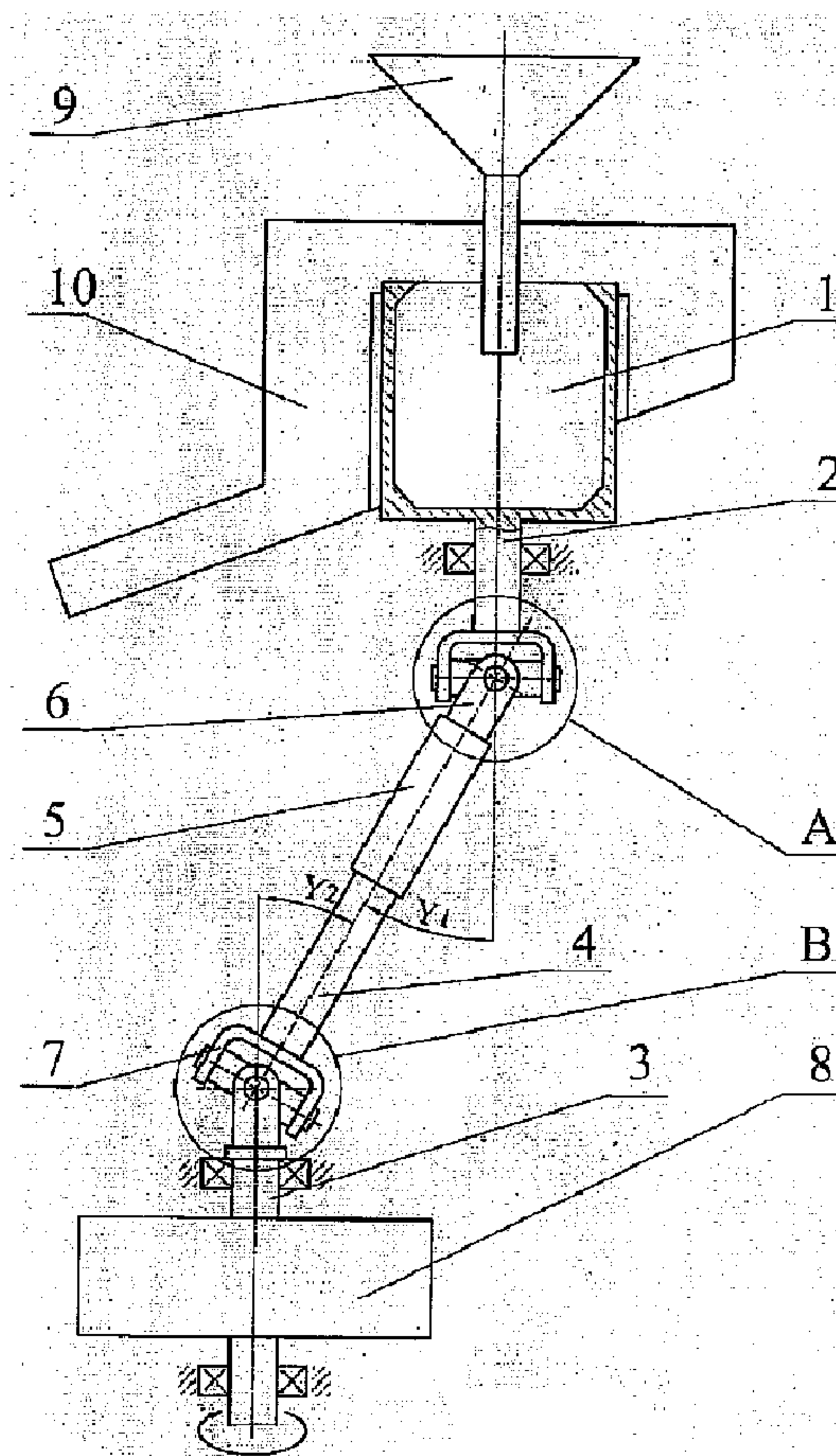
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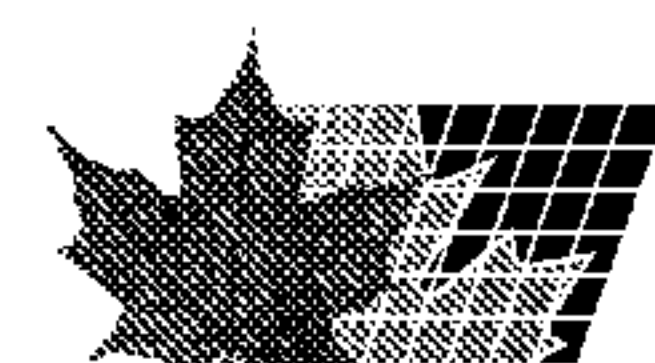
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(54) Title: CENTRIFUGAL CONCENTRATOR



(57) Abrégé/Abstract:

The centrifugal concentrator is designed for gravity separation of mineral raw materials and can be used for processing of gold ore and fine size class sands. The concentrator comprises a bowl installed on a shaft, a rotation drive, a device for feeding raw material,



(57) **Abrégé(suite)/Abstract(continued):**

and a device for removing tailings and unloading the concentrate. The bowl shaft and the rotation drive shaft are connected by means of a transmission comprising two universal joints connected by means of a universal joint shaft with a sliding spline joint. Herein, adjoining yokes of adjacent universal joints are installed perpendicularly to each other, and the shaft axes are installed at an angle to each other. In the operating mode, raw material in pulp form is fed to the bottom of the bowl. Due to centrifugal forces the raw material flow is pressed to the inside surface of the bowl. Due to the action of torsional vibrations of the bowl, the wall layer of raw material loosens up. The flow of raw material separates. Heavy fraction particles in the enriched material penetrate pores of the loosened layer, and due to the action of centrifugal forces they concentrate in the bowl in the area adjacent to its inside surface. Light fraction particles together with water flow are discharged over the bowl upper edge. As heavy fraction particles accumulate in the bowl, the concentrator is stopped, and heavy fraction is removed.

ABSTRACT

The centrifugal concentrator is designed for gravity separation of mineral raw materials and can be used for processing of gold ore and fine size class sands.

The concentrator comprises a bowl installed on a shaft, a rotation drive, a device for feeding raw material, and a device for removing tailings and unloading the concentrate. The bowl shaft and the rotation drive shaft are connected by means of a transmission comprising two universal joints connected by means of a universal joint shaft with a sliding spline joint. Herein, adjoining yokes of adjacent universal joints are installed perpendicularly to each other, and the shaft axes are installed at an angle to each other.

In the operating mode, raw material in pulp form is fed to the bottom of the bowl. Due to centrifugal forces the raw material flow is pressed to the inside surface of the bowl. Due to the action of torsional vibrations of the bowl, the wall layer of raw material loosens up. The flow of raw material separates. Heavy fraction particles in the enriched material penetrate pores of the loosened layer, and due to the action of centrifugal forces they concentrate in the bowl in the area adjacent to its inside surface. Light fraction particles together with water flow are discharged over the bowl upper edge. As heavy fraction particles accumulate in the bowl, the concentrator is stopped, and heavy fraction is removed.

CENTRIFUGAL CONCENTRATOR

FIELD OF INVENTION

The invention relates to the field of enrichment of mineral resources and can be used for gravity separation of particles, for instance, for processing of gold ore and fine size class sands.

BACKGROUND ART

Known are centrifugal concentrators wherein material particles are acted upon by centrifugal forces many times their weight. Such concentrators comprise a rotating bowl raw material in pulp form is fed to. When raw material particles move along the bowl walls, they are acted upon by centrifugal forces and segregated by gravity.

The general objective of ensuring serviceability of such centrifugal unit is to eliminate unacceptable compaction of mineral bed in the concentrator rotating bowl that impedes particle segregation.

For instance, known is the Bragin centrifugal vibratory concentrator [1]. The concentrator comprises a bowl installed on a shaft in a cam that is connected to a drive via a pulley. The shaft lower section is connected to the drive by means of the second pulley and attached to the pulley by means of an elastic toroidal shell. The drive, via the toroidal shell and the cam, induces the shaft rotation and radial beats. Said beats are aimed at loosening up raw material particles in the rotating bowl.

The unit shortcoming is the complexity and insufficient reliability of its design, especially at high rotational speeds.

Also known is the Knelson concentrator [2]. The concentrator comprises a bowl in the shape of a truncated cone with double walls. The concentrator is fed through the central pipe. The cone inside surface has annular grooves; on the grooves bottom there are holes for feeding water from

the space between the cone walls in order to loosen up raw material particles in the rotating bowl. In such concentrator, particles are acted upon by centrifugal forces on the one hand and by ascending water currents on the other. The concentrate is unloaded as it accumulates in the bowl.

The unit shortcoming is the design complexity, high sensitivity to fluctuations of flow of loosening water, and strict requirements to water purity. Besides, feeding loosening water through holes on the grooves bottom creates streams that wash out concentrate particles smaller than 50 microns. But it is exactly at the grooves bottom where the heavy fraction is concentrated.

The closest to the proposed invention is the centrifugal inertial concentrator [3] comprising a bowl connected to the rotation drive by means of an uneven angular velocity joint. Herein, the motor axis of rotation and the bowl axis of rotation are installed at an angle to each other.

A universal joint is an uneven angular velocity joint wherein the ratio is determined by periodic change of angular velocity of the driven yoke from maximum to minimum - twice each joint revolution – with respect to constant angular velocity of the drive yoke. This causes onset of torsional vibrations.

The larger the angle between the motor and bowl axes of rotation the larger is the amplitude of torsional vibrations. Beginning at a certain angle the bowl torsional vibrations become such that they provide loosening up of the raw material processed in the bowl.

Such action provides a simpler method for loosening up and separation of raw material particles in the bowl. The unit set-up consists of just setting the angle between the motor and bowl axes of rotation. Besides, because this eliminates feeding of loosening water and washing out of raw material particles, the loss of fine size class of the concentrate heavy fraction is considerably lower.

The unit shortcoming is low reliability. Even small deviations from the specified precision of attaching the bowl rotation assembly and motor attachment assembly lead to high mechanical loads on the universal joint bearings and to fast failure of the unit. Besides, to ensure high

variable tangential accelerations of the bowl it is necessary to set a large angle between the bowl and motor axes. For instance, when concentrating heavy ore this angle can be as high as 45° . But increasing the angle shortens operation life of the universal joint.

SUMMARY

The technical result of the proposed device is increasing the reliability and operational life of the concentrator.

In accordance with one aspect of the present application, there is provided a centrifugal concentrator comprising:

- a) a bowl with a shaft;
- b) a rotation drive;
- c) a universal (uneven angular velocity) joint connecting the bowl shaft with the rotation drive shaft;
- d) a raw material feeder; and
- e) a device for removing tailings and unloading the concentrate.

The concentrator is distinct in that the bowl shaft and the rotation drive shaft are connected by means of a transmission comprising:

- a) at least two universal (uneven angular velocity) joints; and
- b) a compensating joint.

Adjoining yokes of two adjacent universal joints are installed perpendicularly to each other. The axes of adjoining shafts are installed at an angle to each other. The compensating joint can be made spline and telescopic.

The installation of two or more universal joints in the centrifugal concentrator with adjoining yokes of the joints installed perpendicularly to each other ensures gradual increase of the amplitude of torsional vibrations of the concentrator bowl.

The installation of not one but two or more universal joints in the centrifugal concentrator makes it possible to reduce the operating angle of each joint, which increases the operational life of each joint and of the device as a whole.

The installation of two universal joints and the compensating device, for instance, in the form of a spline telescopic joint, in the centrifugal concentrator provides simple installation and reliable connection between the bearings housing of the bowl and the drive attachment.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows the general view of the concentrator.

DETAILED DESCRIPTION

The concentrator comprises bowl 1 with an annular edge in the upper section. The bowl is installed on driven shaft 2. Driven shaft 2 is connected to drive shaft 3 by means of universal joints A, B and universal joint shaft 4 with spline telescopic joint 5. Shafts 2, 3 and 4 are located in the same plane.

Yoke 6 (the drive yoke) of universal joint A is installed perpendicularly to adjoining yoke 7 (the driven yoke) of universal joint B.

The axis of universal joint shaft 4 is installed at angle Y_1 to the shaft axis of the bowl and at angle Y_2 to the shaft axis of drive 3. Flywheel 8 is installed on the drive shaft. The concentrator has hopper 9 to feed raw material, and collector 10 to discharge tailings.

When assembling the concentrator, the universal joints and the telescopic joint provide relative independence of installation of the bowl attachment assembly and the motor attachment assembly.

The concentrator works as follows. Draft shaft 3 with flywheel 8 rotates at constant velocity. Herein, the angular velocity of shaft 2 with bowl 1 changes periodically, twice each revolution, from maximum to minimum. Raw material in pulp form is fed through hopper 9 to the bowl bottom. Due to centrifugal forces the flow of raw material is pressed to the inside surface of the bowl and moves up. Due to torsional vibrations of the bowl, raw material particles undergo tangential shift with frequency twice as high as the bowl rotational speed. Due to the tangential shift, the raw material moving along the inside surface of the bowl is loosening up. Heavy fraction particles in the enriched material penetrate pores of the loosened layer, and due to the action of centrifugal forces they concentrate in the bowl close to its inside surface. Light fraction particles together with water flow are discharged over the annular edge in the upper section of the bowl and drained through collector 10. As heavy fraction particles accumulate in the bowl, the concentrator is stopped, and heavy fraction is removed.

It is preferable for angles Y_1 and Y_2 to be equal in order to ensure equal operational life of both universal joints. The angles value is determined experimentally, depending on parameters of the processed raw material: as the angles increase, the amplitude of torsional vibrations increases, as do alternating tangential acceleration and the degree of loosening up.

Any shifts or skewing of bowl attachment and drive attachment assemblies are compensated by the telescopic joint and the universal joints. In the process there are no additional loads on the universal joint bearings.

In setting up the concentrator, when raw material changes it may be necessary to change angles Y_1 and Y_2 . Changing angles Y_1 and Y_2 is done, for instance, by parallel shifting of the bowl attachment assembly or the drive attachment assembly. It is easily done because the spline

telescopic joint compensates for the change of the relative position while maintaining the mechanical link between the bowl and the drive.

An example of the embodiment is a concentrator with the capacity of 250 kg/hour and average bowl diameter of 120 mm. Experiments of concentrating heavy gold dust less than 0.074 mm in size produced about 92% gold recovery with a 700-900 reduction factor. The shaft speed was 900 rpm, angle Y_1 was equal to angle $Y_2 - 37^\circ$.

In a concentrator with two universal joints, angles Y_1 and Y_2 equal to 37° ensure torsional vibrations of the bowl with about the same amplitude as the 50° angle in a concentrator with one universal joint. Reducing the angle increases operational life of the concentrator.

It is obvious for persons skilled in the art that the design of the device described above can be changed and amended without going beyond the essence of the invention the scope of which is defined in the claims.

Information sources

Certificate of Authorship No. 1651955, cl. B 03 B 5/32, published in 1991.

US No. 4846781 A, cl. B 04 B 11/00, 07.11.89.

Republic of Kazakhstan provisional patent No. 15584, cl. B 03 B 5/32, 09.16.2003

CLAIMS

1. A centrifugal concentrator comprising a bowl installed on a shaft connected to a rotation drive shaft by means of a universal joint, a device for feeding raw material, and a device for removing tailings and unloading the concentrate, distinctive in that the bowl shaft and rotation drive shaft are connected by means of a transmission comprising at least two universal (uneven angular velocity) joints and a compensating joint wherein adjoining yokes of adjacent universal joints are installed perpendicularly to each other, and the axes of adjoining shafts are installed at an angle to each other.
2. A centrifugal concentrator comprising:
 - a bowl with a shaft;
 - a rotation drive;
 - a universal (uneven angular velocity) joint connecting the bowl shaft with the rotation drive shaft;
 - a raw material feeder; and
 - a device for removing tailings and unloading the concentrate.
3. The concentrator as defined in claim 2, wherein the bowl shaft and the rotation drive shaft are connected by means of a transmission comprising:
 - at least two universal (uneven angular velocity) joints; and
 - a compensating joint.
4. The concentrator as defined in claim 3, wherein adjoining yokes of two adjacent universal joints are installed perpendicularly to each other, the axes of adjoining shafts being installed at an angle to each other.

