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(54) Method and device for crushing in a conical eccentric-drive crusher

(57) The invention relates to a method for crushing and reducing material by at least one fine crushing step and at least one first reducing step, comprising; charging a crushing chamber of a conical eccentric-drive crusher with raw material; rotating an eccentric (8) of the conical eccentric-drive crusher to develop a centrifugal force to obtain a crushing force between an inner cone (3), to a shaft (4) to which the eccentric (8) is rotary mounted, and an outer cone (2) of the conical eccentric-drive crusher; performing, in an integrated manner, under the influence of said crushing force generated by said centrifugal force, said crushing step and said reducing step in said conical eccentric-drive crusher; crushing and reducing the raw material; and discharging reduced material from said conical eccentric-drive crusher. The invention also relates to a system for performing the method and a use of a conical eccentric-drive crusher.

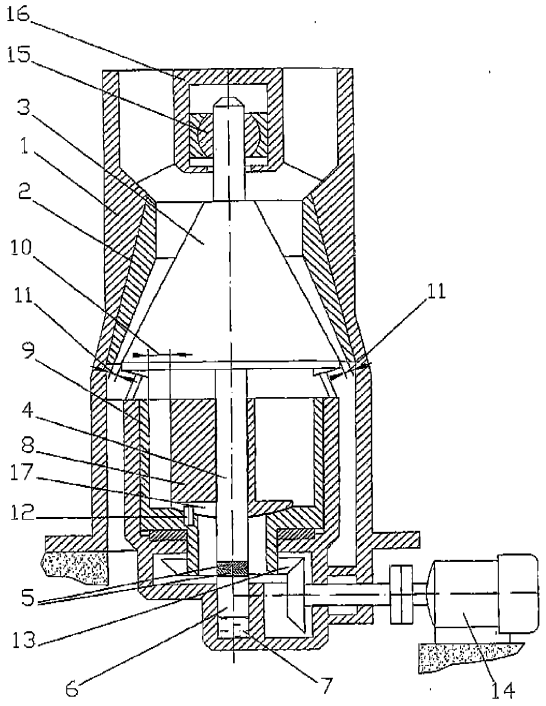

FIG 1

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Description

[0001] The invention relates to methods for medium and fine crushing in conical eccentric-drive crushers and can find the widest use in the building and mining-and-metallurgical industries.

[0002] To prepare metal concentrate from ore, it is necessary to crush and reduce a piece that is more than 1 meter to particles that are less then 0.1 mm. Mostly, 3 or 4 reducing steps are used where conical eccentric-drive crushers are employed, followed by three stages of reducing in rod and ball mills.

[0003] Eventually, the crushing and reducing divisions of ore-mining enterprises take up almost 60 % of all types of costs. Further, inevitable over-reduction to less then 20 μm results in metal losses of near 15 %.

[0004] With this, transfer of the bulk of the disintegration process to the crushing division allows essential decrease of said costs and losses.

[0005] The crushing methods in the existing eccentric-drive crushers had no changes from the moment of their development in 1878. The compression ratio of a material layer at a crushing plane is limited by a drive excenter; therefore, an inner movable cone cannot have amplitude of vibrations different from a drive eccentricity. Hence, the crushing ratio is not higher than 6÷7.

[0006] It is impossible to increase the number of eccentric revolutions in traditional eccentric-drive crushers because this would result in going the system out of balance and sliding the cone from the spherical support.

[0007] Thus, technological capabilities of eccentric-drive crushers are practically exhausted, and the efforts of designers are focused mainly at improvement in the reliability of crusher assemblies and enhancement of the automatic control in the system.

[0008] Known is a method for intensifying the operation of an eccentric-type crusher, as implemented in an apparatus (the USSR Inventor's Certificate № 589895 of July 9, 1974) wherein a driving member is embodied as a lever whose ends are in an eccentric and in a cone body while a support is in a crusher housing. This gives double increase of a crushing force, which increases the crushing ratio up to 7÷8, but still does not provide a controllable ratio of compressing a material layer and limits further improvement in technological process parameters.

[0009] Known is also a method of improving process parameters of an eccentric-drive crusher (the USSR Inventor's Certificate № 625770 of April 25, 1977), comprising: idle starting the crusher; decreasing a size of a discharging slot down to a first touch with an inner cone; fixing the achieved slot size; and charging the crusher with a mineral. The method allows achievement of a minimum tolerable size of the discharging slot due to taking all radial clearances (about 4 mm total) up in an eccentric assembly because of pressing a cone shaft by a centrifugal force to an eccentric surface and pressing an eccentric to a cylindrical sleeve.. Such a method gives rise to the crushing ratio already up to 7÷8. However, it is already impossible to gain the large effect in the known eccentric-drive crushers at preservation of the operation principle of the eccentric assembly.

[0010] Known is a method - taken as a prototype - for crushing a mineral, implemented in a conical eccentric-drive crusher wherein hydraulic regulation of an inner cone position (throughout a height) and of a discharging clearance value is provided (US Patent № 3,456,889 of April 10, 1967, IPC B02C).

[0011] The method comprises: setting a discharging slot between crushing cones; charging a crushing chamber with a raw mineral; crushing the raw mineral; determining a grain-size of a crushing product; and correcting a size of said slot to obtain a required grain-size of the product.

[0012] Similar to the previous analogue, the prior art method is associated with difficulties in setting an accurate and - possibly - small slot in order to obtain a maximum crushing ratio.

[0013] The present method as well as the previous one gives no chance to make the crushing ratio higher that 7÷8.

[0014] It is an object of the inventive method to cut down the crushing and reducing steps by integrating at least two steps in one plant due to enhancement of the crushing ratio.

[0015] A problem to be solved by the method is to organize such a sequence of operations that provide a high crushing ratio at the enhanced productivity and the reduced specific energy consumption.

[0016] Said problem is solved by that, in the inventive method comprising setting a size of a discharging slot between crushing cones, starting a crusher; charging a crushing chamber with a raw material, crushing the raw mineral, determining a grain-size of a crushing product, and correcting the size of said slot to obtain a required grain-size of the product, there are operations according to the invention as follows: first, setting the discharging slot size to zero, followed by charging the crushing chamber with the raw material, followed by starting the crusher, followed by increasing the discharging slot size to achieve the required productivity, and obtaining the required grain-size of the finished product by adjusting a rotational frequency of a drive eccentric.

[0017] The method can be realized in a conical eccentric-drive crusher.

Figure 1 shows a longitudinal section of said crusher in the steady state.

Figure 2 shows a working part of the crusher in one of working conditions.

[0018] We shall understand the term "discharging slot" (reference numerals 11 in Figures 1 and 2) as a sum of radial distances between bases of internal and external cones.

[0019] Before the start of operating the plant, a size of a discharging slot (11) is set to zero. This makes it possible to charge a crushing chamber a row material that will not get spilled through the crusher without treatment. The start of the crusher takes place after the charge because it is known from the prior art that the idle operation of the crushing plant is undesirable since the friction of cones with each other results in the premature wear thereof. A necessary size of the discharge slot (11) is set with taking into account that the greater is the discharging slot size, the greater is the clear opening of the crushing chamber and the higher is the crushing process productivity. At the same time, such an important parameter as a grain-size of the finished product is monitored by adjusting a rotational frequency of the eccentric: change of this parameter makes it possible to adjust a value and an application frequency of a crushing force.

[0020] As contrasted to the offered technical solution, the initial (starting) size of the discharging slot in the similar methods is selected greater than that required by the process. This is made in order to decrease a load to a drive of the eccentric (8) when the crushing chamber is filled with the raw material. There is idle starting the crusher, followed by charging the raw material, followed by decreasing the size of the discharging slot (11) down to a required or minimal possible size depending upon a required grain-size of the finished product.

[0021] Figure 1 shows a structure of an eccentric-drive crusher.

[0022] The crusher comprises a frame (1) with an outer crushing cone (2) in which an inner crushing cone (3) is located whose shaft (4) is supported via a spherical support (5) (consisting of a pivot journal and an end thrust bearing) to a piston (6) of a hydraulic cylinder (7) located in the frame (1). An eccentric (8) is rotary mounted on the shaft (4) within a bearing cylindrical sleeve (9) with a radial clearance (10) that is higher then a size of a discharging slot (11) between the cones (2) and (3).

[0023] The cylindrical sleeve (9) mates with an electrical motor (14) via a gear pair (13).

[0024] An upper portion of the shaft (4) is located using a hinge (15) in a cross-arm (16). One side of a drive member (12) is rigidly secured on the cylindrical sleeve (9) while another side thereof is inserted to a groove (17) of the eccentric (8).

[0025] The crusher operates as follows.

[0026] The torque of the electrical motor (14) is transferred via the gear pair (13) to the cylindrical sleeve (9) which rotates the eccentric (8) by means of a system of the drive member (12) inserted to the groove (17). The latter develops a centrifugal force and involves the inner cone in circular vibrations. The cone (3) also acquires a centrifugal force that is summed with the centrifugal force of the eccentric to obtain a crushing force due to which the intra-layer destruction of the raw material takes place in a plane formed by the crushing cones.

[0027] By realization of the claimed sequence of operations, it is possible to adjust the crushing ratio within the range of 4 to 30. In other words, it is possible to produce 100 % of the product smaller than 20 mm or smaller than 5 mm from the same original piece having a size, for example, of 100 mm.

[0028] Thus, the method allows replacement of the fine crushing step and the first reducing step, for example, a rod mill, that is, allows solution of the problem posed in full measure.

[0029] One embodiment relates to a method for crushing in a conical eccentric-drive crusher, comprising: setting a size of a discharging slot between crushing cones; starting the crusher; charging a crushing chamber with a raw material; crushing the raw material; determining a grain-size of a crushing product; and correcting the discharging slot size to obtain a required grain-size of the product, characterized by first, setting the discharging slot size to zero; followed by charging the crushing chamber with the raw material and starting the crusher; followed by increasing the discharging slot size to achieve the required productivity of the crusher, and obtaining the required grain-size of the finished product by adjusting a rotational frequency of a drive eccentric.

Claims

1. Method for crushing and reducing material by at least one fine crushing step and at least one first reducing step, comprising

   - charging a crushing chamber of a conical eccentric-drive crusher with raw material;
   - rotating an eccentric (8) of the conical eccentric-drive crusher to develop a centrifugal force to obtain a crushing force between an inner cone (3), to a shaft (4) to which the eccentric (8) is rotary mounted, and an outer cone (2) of the conical eccentric-drive crusher,
   - performing, in an integrated manner, under the influence of said crushing force generated by said centrifugal force, said crushing step and said reducing step in said conical eccentric-drive crusher,
   - crushing and reducing the raw material; and
   - discharging reduced material from said conical eccentric-drive crusher.

2. Method for crushing and reducing material according to claim 1, wherein at least a portion of said raw material has a size of at least 100 mm, and wherein the reduced material is smaller than 20 mm.

3. Method for crushing and reducing material according to claim 2, wherein at least a portion of said raw material has a size of at least 100 mm, and wherein the reduced material is smaller than 5 mm.

4. System for performing the function of the combina-

tion of a fine crushing step and a first reducing step of a raw material, **characterized in that** the system comprises a conical eccentric-drive crusher comprising an outer crushing cone (2), an inner crushing cone (3), and a motor (14) operative for rotating an eccentric (8) rotary mounted on a shaft (4) of the inner crushing cone (3) of the conical eccentric-drive crusher to develop a centrifugal force to obtain a crushing force causing intra-layer destruction of the raw material between the cones (2, 3) generating a reduced material, integrating in said conical eccentric-drive crusher the fine crushing step and the first reducing step.

5. Use of a conical eccentric-drive crusher for replacing a combination of a fine crushing step and a first reducing step, the conical eccentric-drive crusher comprising a motor (14) operative for rotating an eccentric (8) of the conical eccentric-drive crusher so as to develop a centrifugal force to obtain a crushing force between an inner cone (3), to a shaft (4) of which the eccentric (8) is rotary mounted, and an outer cone (2) of the conical eccentric-drive crusher generating in said conical eccentric-drive crusher a fine crushing step and a first reducing step.

6. Use of a conical eccentric-drive crusher according to claim 5, comprising replacing a combination of a fine crushing step performed in a crusher and a first reducing step performed in a rod mill or ball mill.

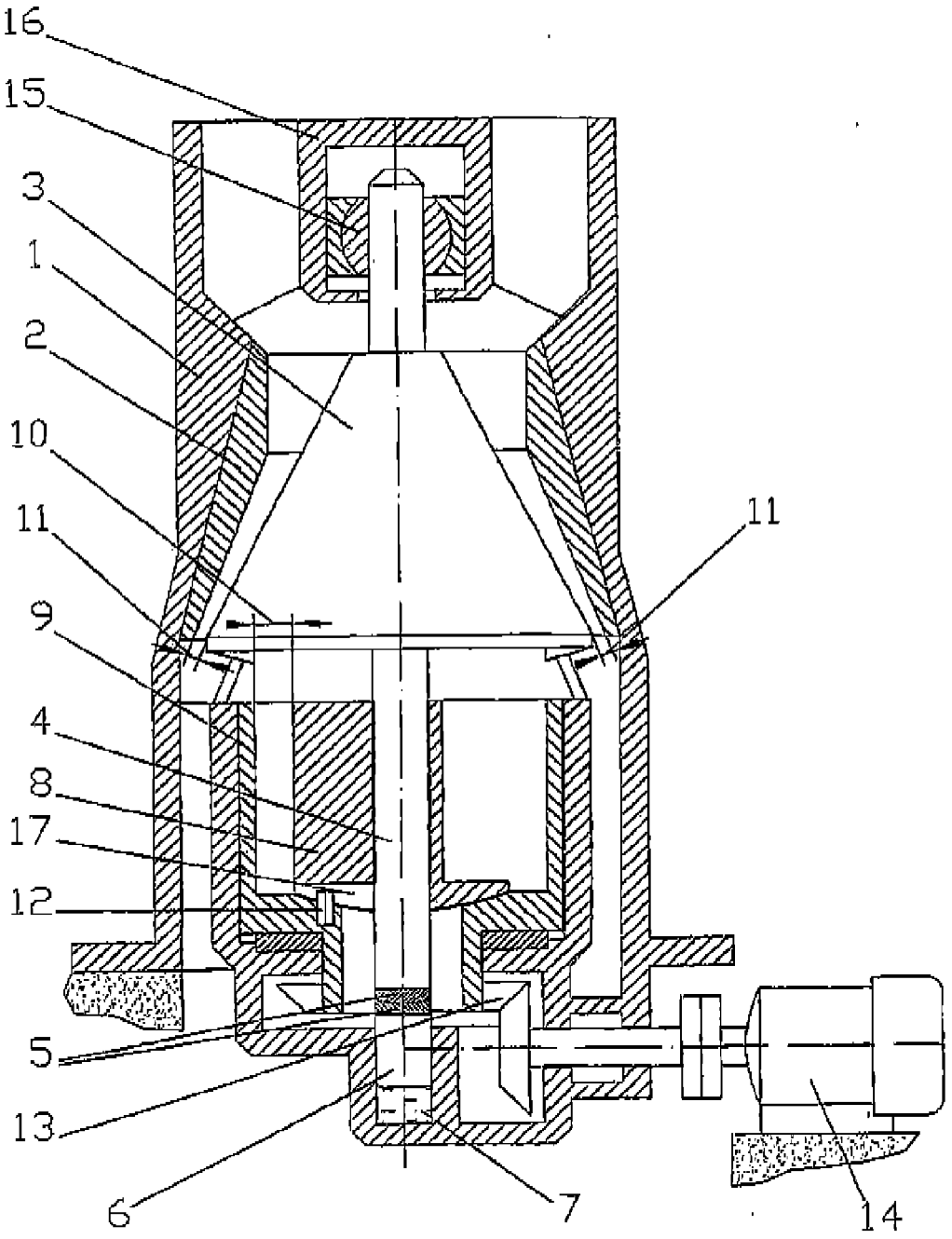

FIG 1

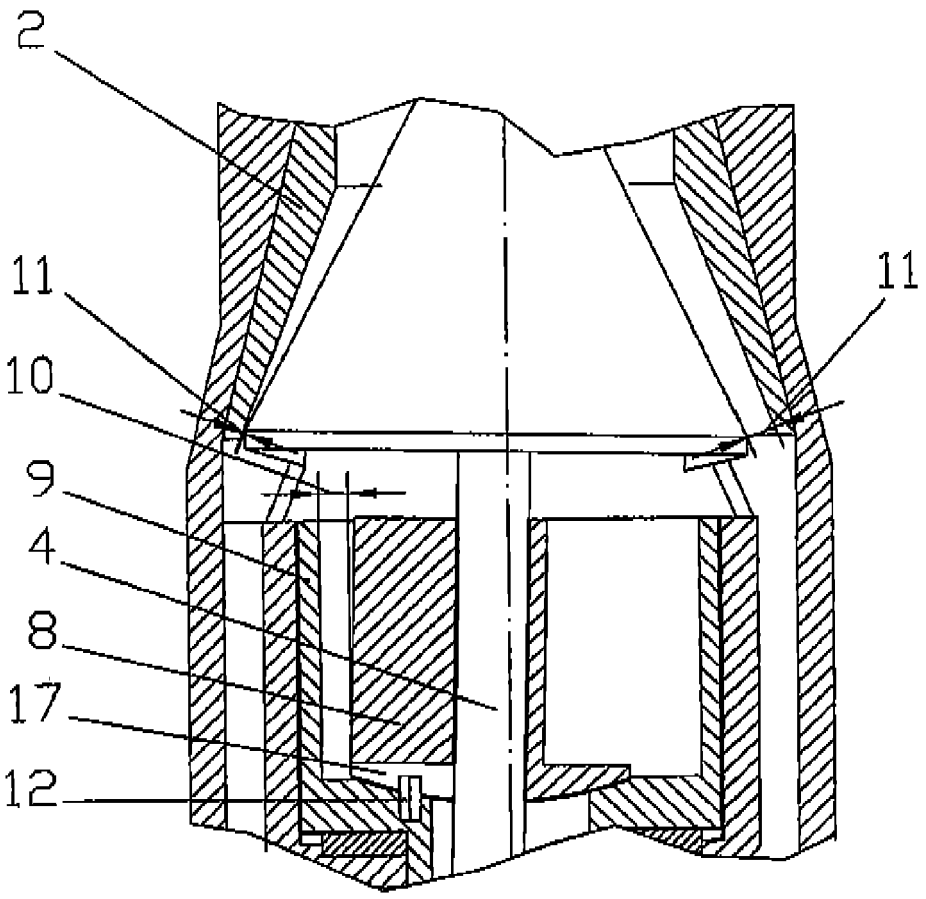

FIG 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- RU 589895 **[0008]**
- RU 625770 **[0009]**
- US 3456889 A **[0010]**