(12) STANDARD PATENT (11) Application No. AU 2013269844 B2
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Low-vibration jaw crusher

(51) International Patent Classification(s)
B02C 1/04 (2006.01)

(21) Application No: **2013269844** (22) Date of Filing: **2013.05.23**

(87) WIPO No: **WO13/178532**

(30) Priority Data

(31) Number	(32) Date	(33) Country
10 2012 104 623.9	**2012.05.29**	**DE**

(43) Publication Date: **2013.12.05**
(44) Accepted Journal Date: **2017.07.06**

(71) Applicant(s)
ThyssenKrupp Industrial Solutions AG

(72) Inventor(s)
Schneider, Frank;Papajewski, Detlef;Szczelina, Piotr

(74) Agent / Attorney
Shelston IP Pty Ltd., Level 21, 60 Margaret Street, Sydney, NSW, 2000, AU

(56) Related Art
US 1936742 A

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
5. Dezember 2013 (05.12.2013)

WIPO | PCT

(10) Internationale Veröffentlichungsnummer
WO 2013/178532 A3

(51) Internationale Patentklassifikation: *B02C 1/04* (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2013/060653

(22) Internationales Anmeldedatum: 23. Mai 2013 (23.05.2013)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität: 10 2012 104 623.9 29. Mai 2012 (29.05.2012) DE

(71) Anmelder: THYSSENKRUPP RESOURCE TECHNOLOGIES GMBH [DE/DE]; ThyssenKrupp Allee 1, 45143 Essen (DE).

(72) Erfinder: SCHNEIDER, Frank; Stresemannstrasse 11, 47051 Duisburg (DE). PAPAJEWSKI, Detlef; Karl-Wagener-Strasse 129, 44879 Bochum (DE). SZCZELINA, Piotr; Sunderkamp 8, 59269 Beckum (DE).

(74) Anwalt: BRAUN-DULLAEUS, Karl-Ulrich; Platz der Ideen 2, 40476 Düsseldorf (DE).

(81) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, RU, TJ, TM), europäisches (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT,

[Fortsetzung auf der nächsten Seite]

(54) Title: LOW-VIBRATION JAW CRUSHER

(54) Bezeichnung : SCHWINGUNGSARMER BACKENBRECHER

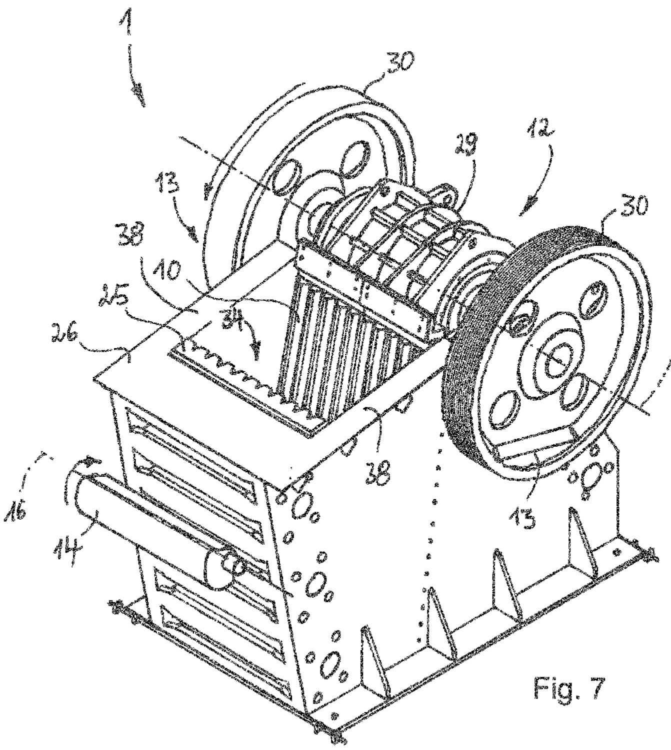

Fig. 7

(57) Abstract: The present invention relates to a jaw crusher (1) for comminuting materials, with at least one moving crushing jaw (10) which is brought into connection with an eccentric unit (12) having a drive shaft (11) in such a manner that the crushing jaw (10) performs a periodic rotary stroke movement, and wherein the eccentric unit (12) has at least one compensating mass (13) rotating about the drive shaft (11). According to the invention, at least one additional compensation mass (14) is provided, which performs a rotational movement opposite to the rotational movement of the compensation mass (13).

(57) Zusammenfassung: Die vorliegende Erfindung betrifft einen Backenbrecher (1) zur Zerkleinerung von Materialien mit wenigstens einer bewegten Brechbacke (10), die mit einer eine Antriebswelle (11) aufweisende Exzentereinheit (12) so in Verbindung gebracht ist, dass die Brechbacke (10) eine periodische Drehhubbewegung ausführt, und wobei die Exzentereinheit (12) wenigstens eine um die Antriebswelle (11) rotierende Ausgleichsmasse (13) aufweist. Erfindungsgemäß ist wenigstens eine Zusatzausgleichsmasse (14) vorgesehen, die eine Rotationsbewegung ausführt, die der Rotationsbewegung der Ausgleichsmasse (13) entgegensetzt ist.

WO 2013/178532 A3

LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eingehen (Regel 48 Absatz 2 Buchstabe h)*

(88) Veröffentlichungsdatum des internationalen Recherchenberichts:

23. Januar 2014

LOW-VIBRATION JAW CRUSHER

DESCRIPTION

[0001] The present invention relates to a jaw crusher for the comminution of materials, with at least one moved crushing jaw which is connected to an eccentric unit having a drive shaft, such that the crushing jaw executes a periodic rotary reciprocal movement, and the eccentric unit having at least one balancing mass rotating about the drive shaft.

PRIOR ART

[0002] Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

[0003] Figure 1 shows by way of example a generic jaw crusher 1 for the comminution of materials, such as minerals, bulk stock, broken material and the like. The jaw crusher 1 possesses a moved crushing jaw 10 and a stationary crushing jaw 25, the latter being accommodated rigidly in a frame 26 of the jaw crusher 1. The moved crushing jaw 10 is set in periodic rotary reciprocal movement by means of an eccentric unit 12, the rotary reciprocal movement being formed as a result of the superposition of a rotary movement 22 and of a reciprocal movement 24. The rotary movement 22 takes place about a center of rotation 23 which, however, according to the superposed reciprocal movement 24, likewise executes a reciprocal movement in the direction of the longitudinal extent of the crushing jaw 10. For this purpose, the crushing jaw 10 is connected via a pressure plate 27 to a gap adjustment device 28, so that the pressure plate 27 likewise executes an oscillating movement in the direction of the arrow shown. This gives rise to a movement which is akin to the movement of a connecting rod in a reciprocating piston engine.

[0004] The eccentric unit 12 is located at the upper end of the crushing jaw 10, the crushing jaw 10 comprising a crushing rocker 29, on which the crushing jaw 10 is accommodated and via which the crushing jaw 10 is connected to the eccentric unit 12. The dynamically moved unit composed of the crushing jaw 10 and of the crushing rocker 29 is designated below only as a crushing jaw 10 for the sake of simplicity.

[0005] The eccentric unit 12 comprises a drive shaft 11, and a portion of the eccentric unit 12 rotates about the drive shaft 11 for the purpose of coupling the crushing rocker 29, the

2013269844 22 May 2017

portion having an eccentricity e. When the drive shaft 11 is set in rotation, the crushing rocker 29 corotates with the crushing jaw 10 in its upper portion about the mid-axis of the drive shaft 11 with the eccentricity e. In order to balance the mass forces arising in this case from the movement of the crushing jaw 10, it is known to attach a balancing mass 13 to a flywheel 30.

[0006] Figure 2a shows diagrammatically the crushing jaw 10 in two positions. It is indicated here that the crushing jaw 10 is accommodated in the lower region in an oscillating manner via the pressure plate 27, and in the upper region the crushing plate 10 is arranged at the eccentric unit 12 at a distance from the axis of rotation of the drive shaft 11 according to the eccentricity e. As a result of the rotation of the drive shaft 11, the eccentricity e at the upper end of the crushing jaw 10 can be doubled, so that the maximum range of movement of the upper end of the crushing jaw 10 corresponds to double the eccentricity 2e. On account of the position of the center of gravity S of the crushing jaw 10 at half the height of the crushing jaw 10 between the upper end and the lower connecting point to the pressure plate 27, a maximum approximately horizontal deflection of the single eccentricity e is obtained for the center of gravity S. The balancing mass 13 can consequently be determined such that the movement of the center of gravity S of the crushing jaw 10 and of the crushing rocker 29 is balanced correspondingly by means of the balancing mass 13.

[0007] Figure 2b shows the reciprocal movement 24 of the crushing jaw 10, and it can be seen that the center of gravity S of the crushing jaw 10 and of the crushing rocker 29 has a stroke which corresponds to double the eccentricity 2e. The balancing mass 13 must therefore have a value which is determined such that the mass forces of the crushing jaw 10 which arise from the translational movement with double the eccentricity 2e are balanced.

[0008] In the comparison of the rotary movement 22 and the reciprocal movement 24 of the center of gravity S of the crushing jaw 10 and of the crushing rocker 29, it becomes clear that, in the horizontal direction, only mass forces arising due to the single eccentricity e have to be balanced, and, in the vertical direction, mass forces formed as a result of double the eccentricity 2e have to be balanced. It becomes clear, at the same time, that, according to the prior art, the balancing mass 13 cannot be determined such that the mass forces can be correctly balanced both in the horizontal and in the vertical direction. On the contrary, the balancing mass 13 has to be determined such that balance in the horizontal direction is overdimensioned and balance in the vertical direction is underdimensioned. The result of this is that the vibration damping of the jaw crusher 1 is unsatisfactory.

2013269844 22 May 2017

[0009] DE 1 190 772 A discloses, for example, a jaw crusher having a dummy rocker which causes the oscillating movement of the moved crushing jaw and which serves merely for balancing the mass of the moved crushing jaw. However, this entails considerable outlay in structural terms, and the dummy rocker does not perform any other technical function.

[0010] Jaw crushers of the present type may be designed as stationary, as semimobile or as mobile jaw crushers. Mobile jaw crushers are accommodated on an undercarriage and, for example self-propelled, can be moved to an appropriate place of use. Jaw crushers of this type, which are arranged on an undercarriage, present considerable problems during operation when vibrations cannot be absorbed via a foundation, as, for example, in the case of a stationary-installation jaw crusher which can be accommodated via a mass foundation.

DISCLOSURE OF THE INVENTION

[0011] It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

[0012] The present invention, advantageously develops further a jaw crusher for the comminution of materials, in such a way that it can be operated with especially low vibration. In particular, at least one preferred embodiment of the present invention advantageously provides a jaw crusher for the comminution of materials as a mobile jaw crusher which can be operated with especially low vibration.

[0013] Accordingly to a first aspect of the invention, there is provided a jaw crusher for the comminution of materials, with at least one moved crushing jaw which is connected to an eccentric unit having a drive shaft, such that the crushing jaw executes a periodic rotary reciprocal movement, and the eccentric unit having at least one balancing mass rotating about the drive shaft, wherein at least one additional balancing mass is provided, wherein the additional balancing mass is mounted on and rotates about the drive shaft, and wherein the additional balancing mass executes a rotational movement which is opposite to the rotational movement of the balancing mass.

[0014] According to another aspect of the invention, there is provided a method for operating a jaw crusher for the comminution of materials, with at least one moved crushing jaw which is driven by means of an eccentric unit having a drive shaft, such that the crushing jaw executes a periodic rotary reciprocal movement, and the eccentric unit having at least one balancing mass rotating about the drive shaft, the method being wherein at least one

2013269844 22 May 2017

additional balancing mass is provided and is driven rotationally, the additional balancing mass being driven in a direction of rotation which is opposite to the direction of rotation of the balancing mass, wherein the additional balancing mass is mounted on and rotates about the drive shaft.

[0015] Unless the context clearly requires otherwise, throughout the description and the claims, the words “comprise”, “comprising”, and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to”.

[0016] The invention includes the technical teaching that at least one additional balancing mass is provided, which executes a rotational movement which is opposite to the rotational movement of the balancing mass.

[0017] The invention is based on the notion that a reduction of mass forces arising from the rotary reciprocal movement of the crushing jaw can be markedly improved by means of at least one further additional balancing mass in addition to the balancing mass on the drive shaft. The basic notion in this case is that the unbalance forces from the balancing masses can be added to one another or subtracted from one another, depending on the phase position of the two rotating masses, while, due to the rotation of the balancing masses the resulting mass balance likewise changes periodically with the rotary reciprocal movement.

[0018] The phased addition or subtraction of the mass forces is possible when the additional balancing mass executes a rotational movement which is opposite to the rotational movement of the balancing mass. Over a full revolution of the drive shaft, the balancing mass and the additional balancing mass can be located, for example, on opposite sides in relation to the drive shaft, thus giving rise to a resulting balancing mass force which corresponds to the difference between the balancing mass force and the additional balancing mass force on account of subtraction which is to take place. When the balancing mass and the additional balancing mass are located on a common side in relation to the drive shaft, the mass forces are added together to form an overall balancing mass on account of addition which is to take place.

[0019] According to a first advantageous exemplary embodiment of the jaw crusher according to the invention, the additional balancing mass can rotate about the drive shaft and, in particular, can be mounted on the latter. The weight of the additional balancing mass

2013269844 22 May 2017

may in this case differ from the weight of the balancing mass, for example the weight of the additional balancing mass may be lower than the weight of the balancing mass.

[0020] In respect of the horizontal, the balancing mass and the additional balancing mass may, for example, be located at the same height as the drive shaft at a certain time point. In this case, the additional balancing mass may have in its rotation about the drive shaft a phase position which, in the horizontal, lies opposite the phase position of the balancing mass in relation to the drive shaft. An effective mass force is consequently formed which corresponds to the mass force difference between the balancing mass force and the additional balancing mass force. By means of this effective mass force, a mass balance of the rotary movement of the crushing jaw about its center of rotation can take place. On account of the eccentricity e, which describes the maximum deflection of the center of gravity S of the crushing jaw, only a lower effective balancing mass force is required in the horizontal.

[0021] In the present context, the horizontal describes simply an approximately horizontal region, and this may extend somewhat out of the vertical due to the inclination of the crushing jaw, so that the rotary movement does not occur exactly in the horizontal. However, the balancing mass and the additional balancing mass may lie opposite one another in relation to the drive shaft when the connecting lines between the opposite positions of the balancing masses lie approximately perpendicularly to the direction of extent of the crushing jaw.

[0022] Furthermore, the additional balancing mass may, in its rotation about the drive shaft, have at another time point a phase position which is designed such that, in the vertical, said additional balancing mass lies on the same side as the balancing mass in relation to the drive shaft. The vertical in this case likewise describes simply an approximately vertical run, and the masses which lie on the same side in relation to the drive shaft may give rise to a resulting direction relative to the axis of rotation of the drive shaft which corresponds to the direction of extent of the crushing jaw. By the masses composed of the balancing mass and of the additional balancing mass lying on the same side, there is an addition of the mass forces into an overall balancing mass force which can be determined such that the mass forces arising from the reciprocal movement of the crushing jaw are balanced. On account of the stroke which corresponds to double the eccentricity 2e, a higher balancing force is required, which can be provided by the addition of the two balancing mass forces when these are located on the same side in relation to the drive shaft.

2013269844 22 May 2017

[0023] According to an advantageous development of the invention, the additional balancing mass can be coupled to the balancing mass mechanically and, in particular, by means of a synchronizing gear. The synchronizing gear may in this case be configured such that the additional balancing mass mounted together with the balancing mass on the drive shaft has an opposite direction of rotation to the direction of rotation of the drive shaft. For example, the synchronizing gear may comprise a double bevel wheel stage with a bevel wheel which is in engagement simultaneously with two opposite toothed rings connected to the respective masses.

[0024] According to a further optional exemplary embodiment of the invention, at least one balancing shaft may be provided, which is arranged parallel to and spaced apart from the drive shaft and on which the at least one additional balancing mass is accommodated rotationally. In particular, a plurality of balancing shafts in each case with a plurality of additional balancing masses may be provided, which are accommodated in each case parallel to and spaced apart from the drive shaft in the frame of the jaw crusher. By a separate balancing shaft being designed in this way to be spaced apart from the drive shaft, it can be become possible that, in addition to a minimization of the horizontal and vertical mass forces themselves, a balance of resulting moments arising from these mass forces is also achieved.

[0025] One possible type of drive of the balancing shaft is obtained if the at least one balancing shaft is driven by the drive shaft. The drive may be provided, for example, via a coupling gear, via which the balancing shaft is connected to the drive shaft in order to be driven. The direction of rotation of the balancing shaft is in this case opposite to the direction of rotation of the drive shaft.

[0026] Advantageously, further, a discrete drive unit may be provided, by means of which the at least one additional balancing mass is driven so as to rotate independently about the balancing shaft. To activate the drive unit, a recording sensor for recording the phase position of the balancing mass on the drive shaft may be provided, and the recording sensor may be connected to a control of the drive unit via a signal line. Particularly when a plurality of separate balancing shafts with respective additional balancing masses are accommodated in the frame of the jaw crusher, mechanical coupling between the balancing shafts and the drive shaft is complicated in structural terms. Consequently, via the signal which can be provided by the recording sensor, the respective balancing mass can be activated in order to generate the correct phase position, by means of which the additional balancing mass rotates.

2013269844 22 May 2017

[0027] By a balancing shaft being arranged parallel to and spaced apart from the drive shaft on which an additional balancing mass is accommodated, the advantage is achieved that, in addition to the compensation of mass forces arising from the rotary movement and from the reciprocal movement of the crushing jaw, furthermore, moments which arise can be balanced. Particularly when it is not possible for structural reasons to mount the balancing shaft in a theoretically optimum position, the desired balancing effect can also be achieved by means of further balancing shafts, and therefore a plurality of balancing shafts are then, in particular, expedient. A further possibility for optimization is to install additional balancing shafts which rotate at double or at an integral multiple of the working rotational speed of the drive shaft, so that fractions of the harmonic multiple of the fundamental oscillation of the crushing jaw can also be eliminated. If synchronization of the at least one balancing shaft by means of a recording sensor on the drive shaft and corresponding activation of the control of a discrete drive unit are provided, mechanical coupling, susceptible to faults and subject to wear, between the drive shaft and the balancing shaft can be dispensed with.

[0028] Particularly when a jaw crusher is equipped with an additional balancing mass according to the invention, it can be operated with low vibration in such a way that the jaw crusher can be used preferably as a mobile jaw crusher. Where mobile jaw crushers are concerned, an appropriate foundation for the absorption of vibrations of the jaw crusher necessarily has to be dispensed with, since the jaw crusher is accommodated solely on an undercarriage, for example a chain-driven undercarriage, which does not allow vibration absorption. However, the jaw crusher according to the invention may also be designed as a semimobile or a stationary jaw crusher.

[0029] The present invention is aimed, furthermore, at a method for operating a jaw crusher for the comminution of materials, with at least one moved crushing jaw which is driven by means of an eccentric unit having a drive shaft, such that the crushing jaw executes a periodic rotary reciprocal movement, and the eccentric unit having at least one balancing mass rotating about the drive shaft, the method providing, furthermore, an additional balancing mass which is driven rotationally, the additional balancing mass being driven in a direction of rotation which is opposite to the direction of rotation of the balancing mass.

[0030] The periodic rotary reciprocal movement of the crushing jaw comprises a rotary movement about a center of rotation of the crushing jaw, the method providing, according to the invention, for the additional balancing mass to have in its rotation about the drive shaft a phase position which, in the horizontal, lies opposite the phase position of the balancing

2013269844 22 May 2017

mass in relation to the drive shaft, so that, from the difference between the mass forces of the balancing masses, an effective balancing mass is formed, which serves for balancing the mass forces of the periodic rotary movement of the crushing jaw about its center of rotation.

[0031] The periodic rotary reciprocal movement of the crushing jaw has, furthermore, an essentially vertical reciprocal movement. In this case, the method for operating the jaw crusher provides, furthermore, for guiding the additional balancing mass in its rotation about the drive shaft in a phase position such that, in the vertical, said additional balancing mass lies on the same side as the balancing mass in relation to the drive shaft, so that, from the addition of the mass forces of the balancing masses, an effective overall balancing mass force is formed which serves for balancing the mass forces of the periodic reciprocal movement of the crushing jaw.

[0032] Consequently, subtraction of the balancing forces by the balancing masses in the horizontal and addition of the balancing forces of the balancing masses in the vertical can be utilized in order to provide a balancing force which changes periodically over the full revolution of the drive shaft.

[0033] As regards the designations of a horizontal and a vertical position or direction of movement or direction of action of forces, it is pointed out that these designations are merely one example of an arrangement of a crushing jaw which runs approximately vertically. Of course, in any direction of space, a corresponding movement or acting forces may prevail, in so far as the design of the jaw crusher has, for example, differently arranged crushing jaws. For example, the designations “horizontal” and “vertical” and “top” and “bottom” can be interchanged if the crushing jaw has in its installation position a reclining, that is to say horizontal extent.

PREFERRED EXEMPLARY EMBODIMENT OF THE INVENTION

[0034] Further measures improving the invention are illustrated in more detail below, together with the description of preferred exemplary embodiments of the invention, by means of the figures in which:

[0035] figure 1 shows a jaw crusher in a cross-sectional view according to the prior art,

[0036] figure 2a shows a diagrammatic view of a crushing jaw in conjunction with an eccentric unit, rotary movements of the rotary reciprocal movement being illustrated,

2013269844 22 May 2017

[0037] figure 2b shows a diagrammatic view of a crushing jaw in conjunction with an eccentric unit, reciprocal movements of a rotary reciprocal movement being illustrated,

[0038] figure 3 shows a first exemplary embodiment of a jaw crusher according to the invention with a balancing mass and with an additional balancing mass which are both accommodated on a drive shaft of the jaw crusher,

[0039] figure 4 shows a diagrammatic view of a synchronizing gear between a balancing mass and an additional balancing mass,

[0040] figure 5 shows a further exemplary embodiment of a jaw crusher with an additional balancing mass which is arranged on a separate balancing shaft and is coupled mechanically to the drive shaft,

[0041] figure 6 shows a further exemplary embodiment of a jaw crusher with an additional balancing mass on a balancing shaft which is driven via a discrete drive unit, and

[0042] figure 7 shows a perspective view of a jaw crusher with the diagrammatic illustration of an additional balancing mass.

[0043] Figure 1 shows a view of a jaw crusher 1 according to the prior art and has already been assessed, together with figures 2a and 2b, in the introduction to the present description.

[0044] Figure 3 shows an exemplary embodiment of a jaw crusher 1 having features of the present invention in a cross-sectional view. The jaw crusher 1 has a basic structure which is formed from a frame 26. A crushing jaw 25 is accommodated rigidly in the frame 26, and the crushing jaw 25 forms with a moved crushing jaw 10 an approximately V-shaped material hopper 34 into which material to be comminuted, such as minerals, that is to say rocks and the like, but also broken material or mining material, can be fed. The crushing jaw 10 is connected to an eccentric unit 12, and the eccentric unit 12 has a drive shaft 11, to which the top part of the crushing jaw 10 is fastened by means of a crushing rocker 29 so as to rotate with an eccentricity e about the mid-axis of the drive shaft 11 (see, in this respect, figure 1). At the lower end, the crushing jaw 10 or the crushing rocker 29 is connected to a pressure plate 27, so that, when the drive shaft 11 and consequently the eccentric are rotated, the crushing jaw 10 can execute a periodic rotary reciprocal movement. The crushing jaw 10 is shown, arranged on a crushing rocker 29, the crushing jaw 10 being

2013269844 22 May 2017

connected to the eccentric unit 12 via the crushing rocker 29. Here, by naming the crushing jaw 10, the present description also designates the crushing rocker 29. In particular, the crushing jaw 10 and the crushing rocker 29 form a common mass which is designated above and below as the mass of the crushing jaw 10.

[0045] Jaw crushers 1 comprising a moved crushing jaw 10 which is driven by means of an eccentric unit 12 to execute a periodic rotary reciprocal movement are also designated as what are known as single toggle crushers and are therefore to be contrasted with what are known as double toggle crushers. The present jaw crusher 1 is designed as a single toggle crusher and the moved crushing jaw 10 executes a defined crank-and-rocker movement. The crushing jaw 10, to form the V-shaped material hopper 34, does not extend exactly in the vertical, and in the present linguistic context the vertical designates, for example, the direction of extent of the crushing jaw 10 at an inclination angle to form the material hopper 34.

[0046] The flywheel 30 accommodates a balancing mass 13 which forms a counterweight to the mass of the crushing jaw 10. Only half the flywheel 30 is shown, and, according to the first exemplary embodiment shown, an additional balancing mass 14 is mounted rotatably on the drive shaft 11 and is accommodated, for example, in a reception disk 33, half of which is likewise shown. The reception disk 33 may have, for example, a similar configuration to the flywheel 30.

[0047] According to the invention, the flywheel 30 with the balancing mass 13 executes a rotary movement in a first direction of rotation, the reception disk 33 with the additional balancing mass 14 executing a rotary movement in an opposite direction of rotation on the drive shaft 11. In the positions of the flywheel 30 and of the reception disk 33 which are shown, the balancing masses 13 and the additional balancing mass 14 are located in positions lying opposite one another. As a result of the mass forces, that is to say the centrifugal forces, which arise due to the rotation of the masses 13 and 14, the balancing forces of the balancing masses 13, 14 partially cancel one another out. For example, the balancing mass 13 is larger than the additional balancing mass 14, so that the subtraction of the two mass forces gives an effective balancing force. By means of this balancing force acting in the horizontal, the rotary movement 22 of the crushing jaw 10 can be balanced. When the flywheel 30 and the reception disk 33 continue to rotate in each case through 90°, the two masses 13 and 14 are located together on the lower side of the eccentric unit 12, so that the mass forces of the balancing masses 13 and 14 are added together. By means of this resulting overall balancing mass, the reciprocal movement 24 of the crushing jaw 10,

2013269844 22 May 2017

which is superposed upon the rotary movement 22 as a result of the periodic rotary reciprocal movement, can be balanced. This results in a periodic addition and subtraction of the mass forces of the balancing masses 13 and 14 over the full revolution of the drive shaft 11, the rotary movement 22 of the crushing jaw 10 requiring only a lower balancing mass, so that, as shown in the figure, the balancing masses 13 and 14 can be subtracted in that they stand opposite one another. The reciprocal movement 24 requires a higher balancing mass which is obtained when the two balancing masses 13 and 14 are located together on the same side of the drive shaft 11, as is illustrated, for example, in the following figure 4 with reference to the synchronizing gear 15 shown.

[0048] Figure 4 shows diagrammatically a view of a synchronizing gear 15 on the drive shaft 11 which is accommodated rotatably via a mounting 35 in the frame 26 of the jaw crusher 1. By means of the synchronizing gear 15, the reception disk 33 can be driven in an opposite direction of rotation on the drive shaft 11. For this purpose, the flywheel 30 is connected rigidly to the drive shaft 11, whereas the reception disk 33 is accommodated rotatably on the drive shaft 11 via a further mounting 36. When the drive shaft 11 is set in rotary movement in a first direction of rotation, the flywheel 30 rotates in the same direction of rotation as the drive shaft 11. Via the toothed ring 32 which is firmly connected to the flywheel 30, a bevel wheel 31 is set in rotation, which is accommodated rigidly in the frame 26 of the jaw crusher 1 via a bearing pin 37. The bevel wheel 31 is meshed with a further toothed ring 32 which is connected rigidly to the reception disk 33. By virtue of this arrangement, the further toothed ring 32 executes with the reception disk 33 a rotary movement about the drive shaft 11 which is opposite to the rotary movement of the drive shaft 11 and consequently to the flywheel 30. The balancing mass 13 is arranged on the flywheel 30, and the additional balancing mass 14 is arranged on the reception disk 33. The two masses 13 and 14 are located, for example, in an identical angular position above the drive shaft 11, and the centrifugal forces of the masses 13 and 14 which arise are added together in order to compensate the reciprocal movement 24 of the crushing jaw 10.

[0049] Figure 5 shows a further exemplary embodiment of a jaw crusher 1 with an additional balancing mass 14 which is not mounted on the drive shaft 11, but instead a balancing shaft 16 is provided which, spaced apart from the drive shaft 11, is accommodated rotatably in the frame 26 of the jaw crusher 1 and on which an additional balancing mass 14 is accommodated rotationally. The arrangement of the balancing shaft 16 parallel to and spaced apart from the drive shaft 11 makes it possible, over and above the compensation of the rotary movement 22 and the reciprocal movement 24 of the crushing jaw 10, to compensate torques which are likewise generated as a result of the periodic rotary reciprocal movement of the crushing jaw 10. In this case, only one further balancing shaft 16 and one further additional balancing mass 14 accommodated on it are shown, although a plurality of additional balancing masses 14 on respective balancing shafts 16 may also be provided in the frame 26 of the jaw crusher 1.

[0050] The exemplary embodiment shows a drive of the rotary movement of the additional balancing mass 14 via a coupling gear 17 which connects the balancing shaft 16 to the drive shaft 11 on which the flywheel 30 with the balancing mass 13 is accommodated rotatably. The coupling gear 17 is shown, for example, with a coupling shaft which is connected both to the drive shaft 11 and to the balancing shaft 16, for example, in each case via end-face bevel wheel stages. The rotary movement of the additional balancing mass 14 about the separate balancing shaft 16 takes place opposite to the rotary movement of the flywheel 30 with the balancing mass 13. The position of the balancing shaft 16 can be numerically determined by computer, in order to achieve as optimal a compensation as possible both of the rotary movement, of the reciprocal movement and of the moments arising during the operation of the jaw crusher 1.

[0051] Figure 6 shows a further exemplary embodiment of a jaw crusher 1 with an additional balancing mass 14 according to the invention which, mounted rotatably via a separate balancing shaft 16, is accommodated in the frame 26 of the jaw crusher 1. The balancing shaft 16 with the additional balancing mass 14 is driven via a discrete drive unit 18 which is likewise accommodated in the frame 26 of the jaw crusher 1. The drive is shown, merely by way of example, via a traction means, and the drive unit 18 may also be formed in an integrated manner on the balancing shaft 16.

[0052] In order to ensure a correct phase position of the additional balancing mass 14 in relation to the phase position of the balancing mass 13 on the flywheel 30 of the eccentric unit 12, a recording sensor 19 is provided, by means of which the phase position of the drive shaft 11 and consequently of the flywheel 30 with the balancing mass 13 can be sensed. The signal is delivered to a control 21 of the external drive unit 18, via which the phase position of the additional balancing mass 14 in rotation about the output shaft 16 is determined. The connection between the recording sensor 19 and the control 21 is in this case shown, for example, via a signal line 20. If a plurality of balancing shafts 16 are provided, respective signal lines 20 and assigned controls 21 may be provided.

[0053] Finally, figure 7 shows a perspective view of a jaw crusher 1 with a stationary crushing jaw 25 which is accommodated in the frame 26 of the jaw crusher 1, and with a

2013269844 22 May 2017

moved crushing jaw 10 which is driven via an eccentric unit 12 and executes a periodic rotary reciprocal movement. A crushing jaw 10 is accommodated on a crushing rocker 29, and an eccentric which is seated on the drive shaft 11 is located in the crushing rocker 29 in a way not shown in any more detail. Furthermore, two flywheels 30 are shown, which act in the same way and in each case corotate with the drive shaft 11. Each of the flywheels 30 has a balancing mass 13, and the balancing mass 13 shown in the previous exemplary embodiments is determined in this case from the sum of the two balancing masses 13 in the two flywheels 30 on the drive shaft 11.

[0054] What can be seen, furthermore, from the perspective view is the material hopper 34 which is delimited laterally by side walls 38 of the frame 26 of the jaw crusher 1. When the jaw crusher 1 is put into operation, the drive shaft 11 starts to rotate in the direction of the arrow shown and the crushing jaw 10 is set in rotary reciprocal movement by the eccentric unit 12, so that, due to the hopper shape of the material hopper 34, material is moved downward in the direction of taper of the hopper. At the same time, the material is crushed to a desired breaking size, and only when the material has reached the desired breaking size can it leave the downwardly open material hopper 34 again.

[0055] According to the invention, an additional balancing mass 14 is shown rotatably about a separate balancing shaft 16 on the front side of the frame 26. The additional balancing mass 14 has an elongate extent in the direction of the balancing shaft 16 and is arranged approximately centrally between the flywheels 30. Force and moment balancing of the jaw crusher 1 with the moved crushing jaw 10 and with the concomitantly moved crushing rocker 29 is thereby obtained.

[0056] The invention is not restricted in its implementation to the preferred exemplary embodiments specified above. On the contrary, a number of variants may be envisaged which make use of the solutions illustrated, even in versions of a fundamentally different type. All features and/or advantages, including structural details or spatial arrangements, which may be gathered from the claims, the description or the drawings, may be essential to the invention both in themselves and in the most diverse possible combinations. Irrespective of the number and arrangement of the additional balancing masses 14, the notion of the invention is based on generating, by means of different phase positions of the two masses 13 and 14, balancing forces which change periodically over the full revolution of the drive shaft 11. Consequently, the balancing forces required in differing magnitude can be provided in the horizontal and the vertical direction, while, furthermore, moments which arise as a result of the rotary reciprocal movement of the crushing jaw 10 can be balanced by the

2013269844 22 May 2017

balancing shaft 16 being arranged so as to be spaced apart from the drive shaft 11. However, the notion of the present invention is fulfilled even when the masses assume, for example over angular segments of the full revolution of the drive shaft 11, different rotational speeds which are generated, for example, by means of corresponding gear stages. Furthermore, the notion of the present invention is fulfilled even when at least two balancing masses 13 and 14 are provided which change their radius about their axis of rotation 11 or 16 over the full revolution of the drive shaft 11, with the result that, according to the invention, changing balancing forces can likewise be generated.

LIST OF REFERENCE SYMBOLS

1	Jaw crusher
10	Crushing jaw
11	Drive shaft
12	Eccentric unit
13	Balancing mass
14	Additional balancing mass
15	Synchronizing gear
16	Balancing shaft
17	Coupling gear
18	Drive unit
19	Recording sensor
20	Signal line
21	Control
22	Rotary movement
23	Center of rotation
24	Reciprocal movement
25	Crushing jaw
26	Frame
27	Pressure plate
28	Gap adjustment device
29	Crushing rocker
30	Flywheel
31	Bevel wheel
32	Toothed ring
33	Reception disk
34	Material hopper
35	Mounting
36	Mounting
37	Bearing pin
38	Sidewall
S	Center of gravity
e	Eccentricity

2013269844 22 May 2017

CLAIMS

1. A jaw crusher for the comminution of materials, with at least one moved crushing jaw which is connected to an eccentric unit having a drive shaft, such that the crushing jaw executes a periodic rotary reciprocal movement, and the eccentric unit having at least one balancing mass rotating about the drive shaft, wherein at least one additional balancing mass is provided, wherein the additional balancing mass is mounted on and rotates about the drive shaft, and wherein the additional balancing mass executes a rotational movement which is opposite to the rotational movement of the balancing mass.

2. The jaw crusher as claimed in claim 1, wherein the additional balancing mass has in its rotation about the drive shaft a phase position which, in the horizontal, lies opposite the phase position of the balancing mass in relation to the drive shaft.

3. The jaw crusher as claimed in claim 1 or 2, wherein the additional balancing mass has in its rotation about the drive shaft a phase position which is designed such that, in the vertical, said additional balancing mass lies on the same side as the balancing mass in relation to the drive shaft.

4. The jaw crusher as claimed in any one of the preceding claims, wherein the weight of the additional balancing mass differs from the weight of the balancing mass.

5. The jaw crusher as claimed in any one of the preceding claims, wherein the additional balancing mass is coupled to the balancing mass mechanically.

6. The jaw crusher as claimed in claim 5, wherein the additional balancing mass is coupled to the balancing mass by means of a synchronizing gear.

7. The jaw crusher as claimed in claim 1, wherein at least one balancing shaft is provided, which is arranged parallel to and spaced apart from the drive shaft and on which the at least one additional balancing mass is accommodated rotationally.

8. The jaw crusher as claimed in claim 7, wherein the balancing shaft is driven by the drive shaft.

9. The jaw crusher as claimed in claim 8, wherein a coupling gear is provided, via which the balancing shaft is connected to the drive shaft in order to be driven.

2013269844 22 May 2017

10. The jaw crusher as claimed in claim 7, wherein at least one discrete drive unit is provided, by means of which the at least one additional balancing mass is driven in rotation about the balancing shaft.

11. The jaw crusher as claimed in claim 10, wherein a recording sensor for recording the phase position of the balancing mass is provided, the recording sensor being connected to a control of the drive unit via a signal line.

12. The jaw crusher as claimed in any one of the preceding claims, designed as a stationary jaw crusher.

13. The jaw crusher as claimed in any one of claims 1 to 11, designed as a semimobile jaw crusher.

14. The jaw crusher as claimed in any one of claims 1 to 11, designed as a mobile jaw crusher.

15. A method for operating a jaw crusher for the comminution of materials, with at least one moved crushing jaw which is driven by means of an eccentric unit having a drive shaft, such that the crushing jaw executes a periodic rotary reciprocal movement, and the eccentric unit having at least one balancing mass rotating about the drive shaft, the method being wherein at least one additional balancing mass is provided and is driven rotationally, the additional balancing mass being driven in a direction of rotation which is opposite to the direction of rotation of the balancing mass, wherein the additional balancing mass is mounted on and rotates about the drive shaft.

16. The method as claimed in claim 15, wherein the periodic rotary reciprocal movement of the crushing jaw comprises a rotary movement about a center of rotation, the additional balancing mass having in its rotation about the drive shaft a phase position which, in the horizontal, lies opposite the phase position of the balancing mass in relation to the drive shaft, so that, from the difference between the balancing masses, an effective balancing mass is formed, which serves for balancing the mass forces of the periodic rotary movement of the crushing jaw about the center of rotation.

17. The method as claimed in claim 15 or 16, wherein the periodic rotary reciprocal movement of the crushing jaw comprises an essentially vertical reciprocal movement, the additional balancing mass having in its rotation about the drive shaft a phase position which

2013269844 22 May 2017

is designed such that, in the vertical, said additional balancing mass lies on the same side as the balancing mass in relation to the drive shaft, so that, from the addition of the balancing masses, an effective overall balancing mass is formed, which serves for balancing the mass forces of the periodic reciprocal movement of the crushing jaw.

PRIOR ART

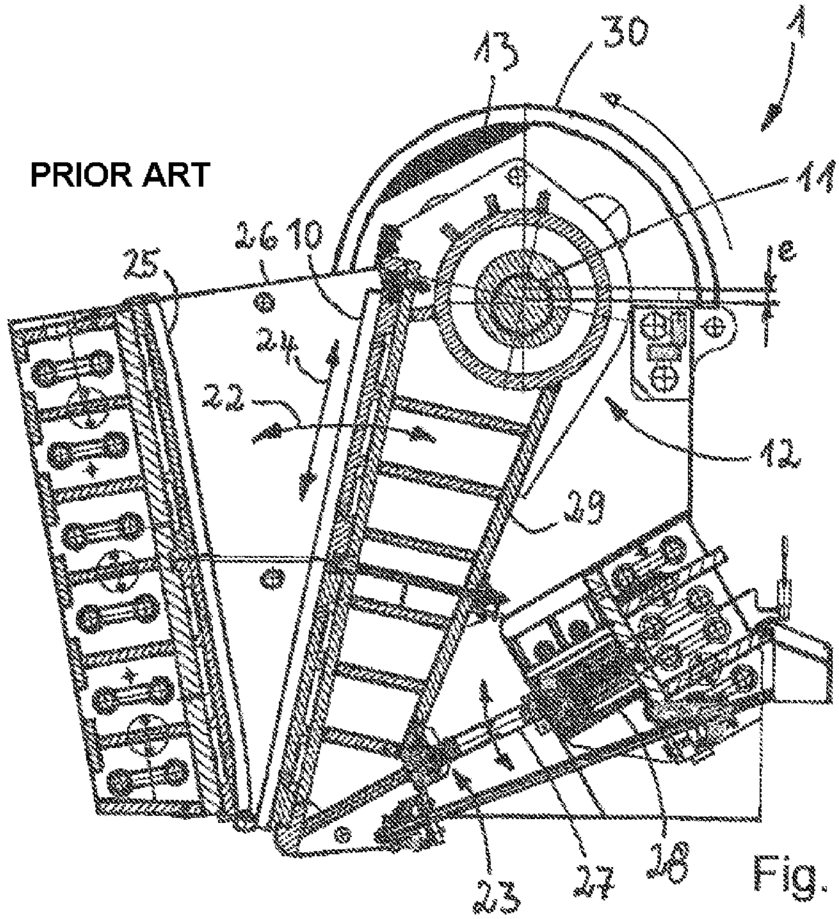

Fig. 1

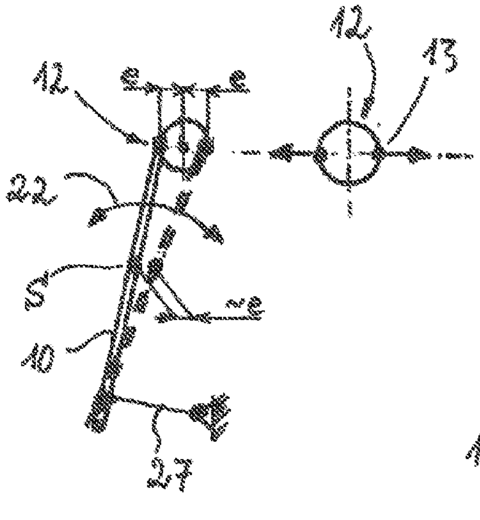

Fig. 2a

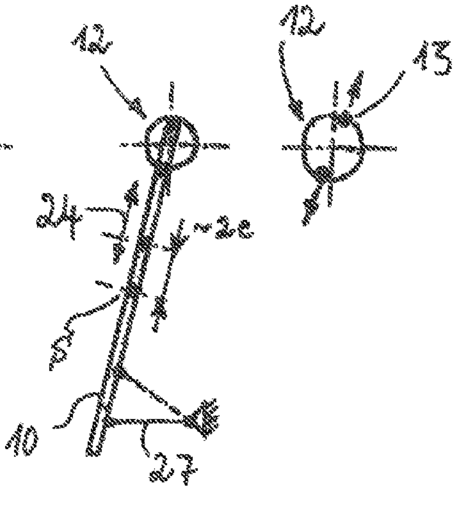

Fig. 2b

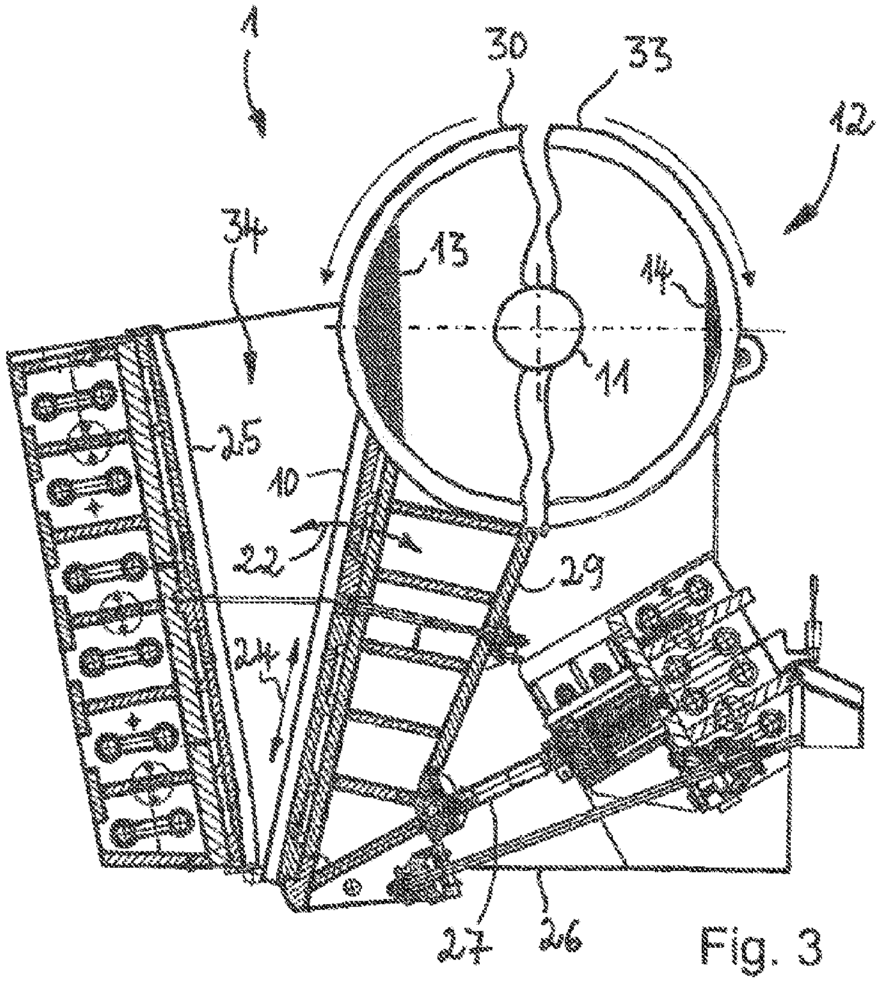
1
30
33
12
34
13
14
11
25
10
22
29
24
27
26

Fig. 3

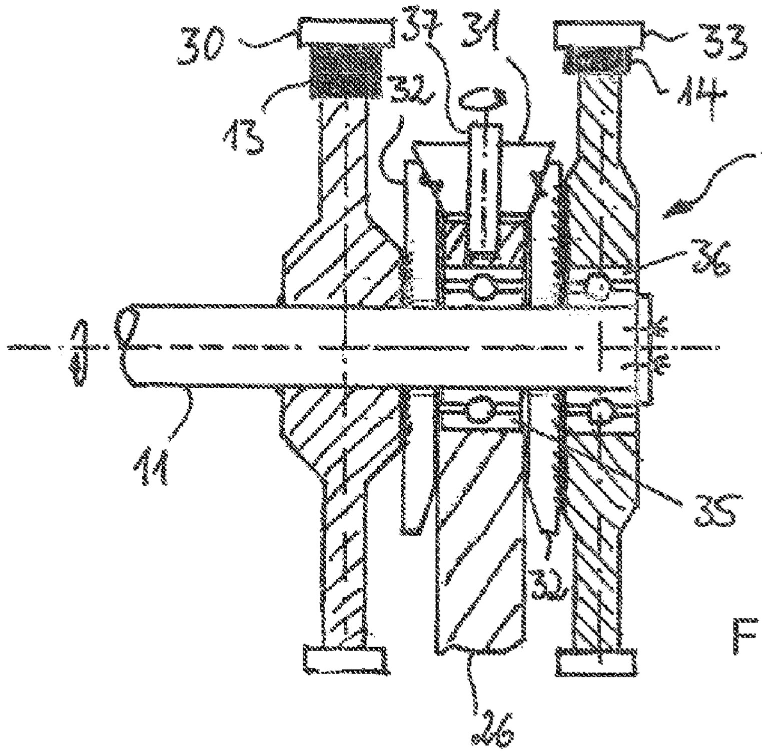
30
37
31
33
13
32
14
15
36
11
35
32
26

Fig. 4

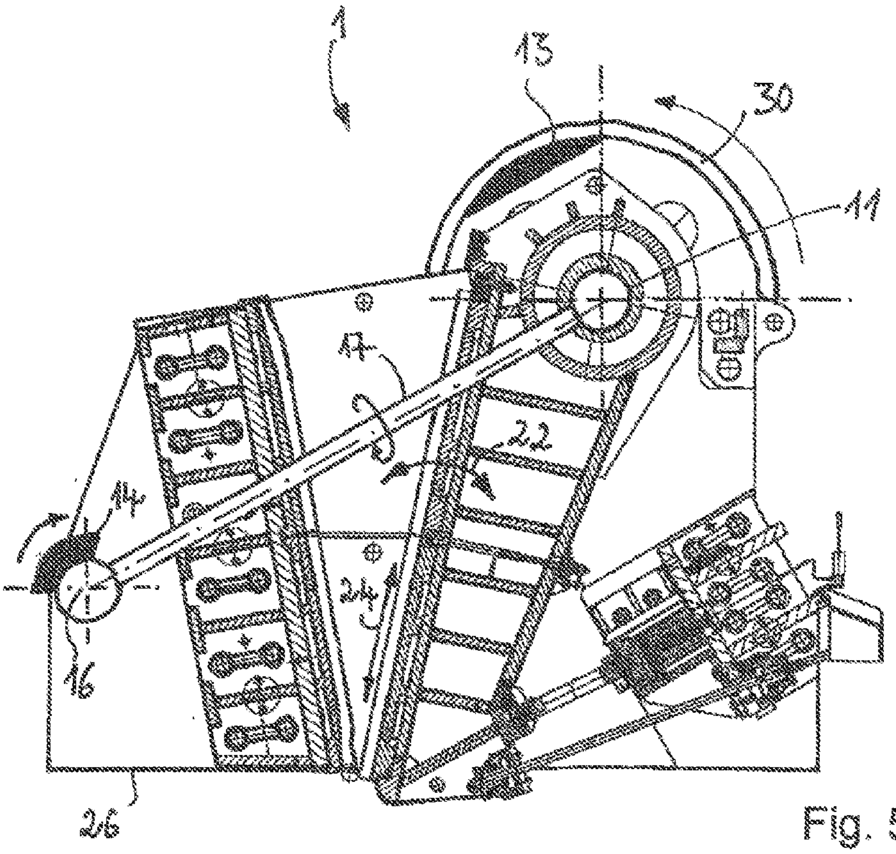

Fig. 5

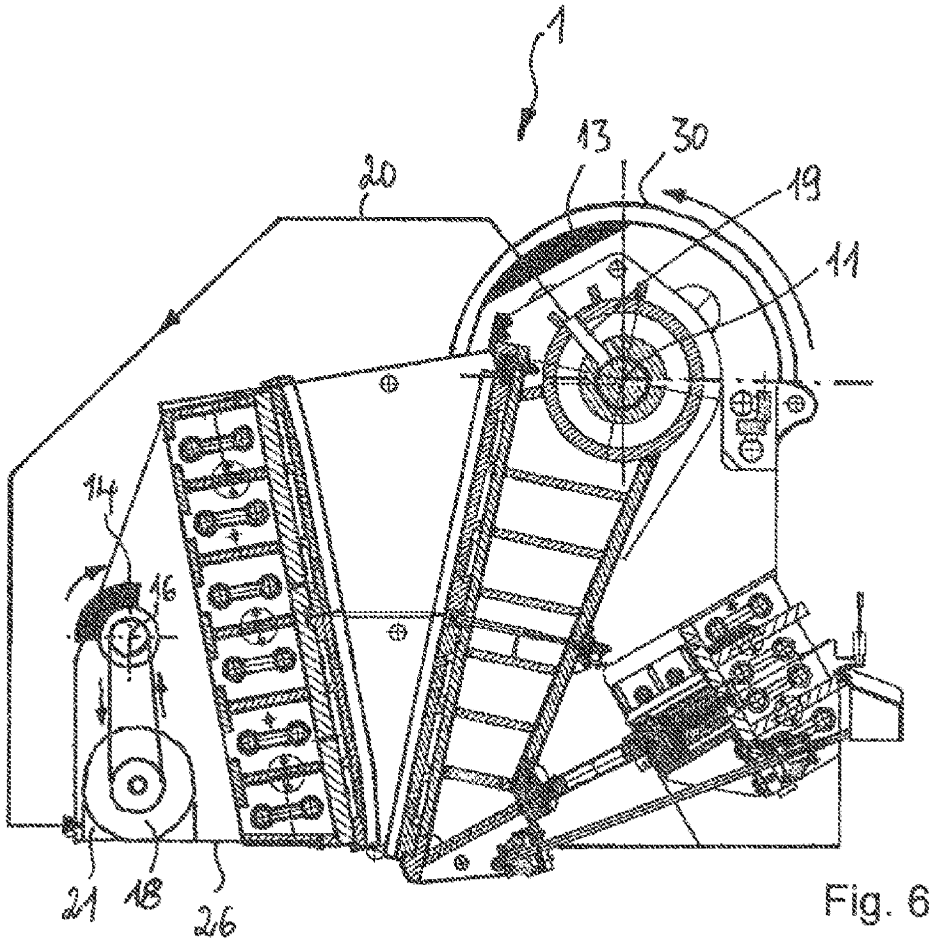

Fig. 6

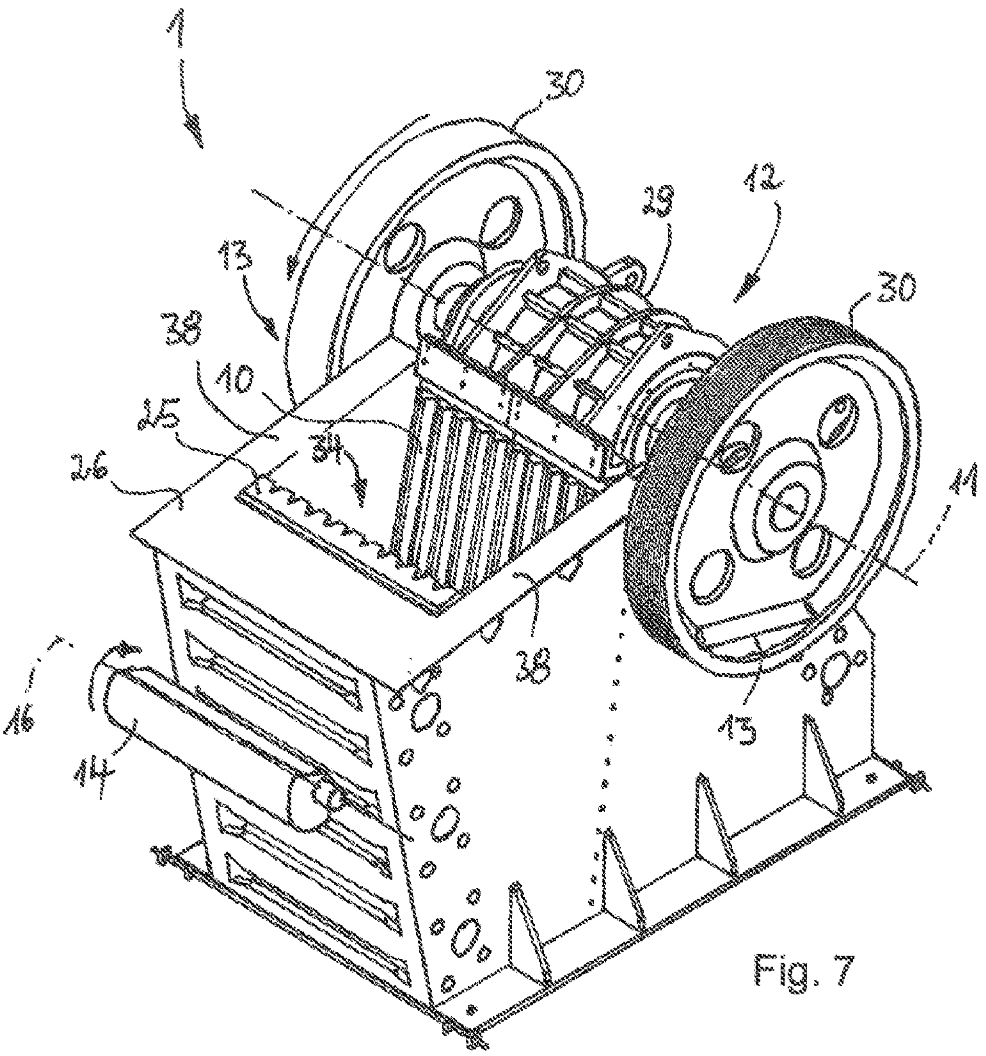

Fig. 7