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(54) **HYDRAULIC CRUSHER CONCAVE RETAINING SYSTEM**

(57) A key liner segment (3k) for use in a topshell (1) of a gyratory or cone crusher is provided. The topshell (1) comprises a frame (4) and a plurality of replaceable liner segments (3) arranged in at least one tier or row along the inner circumference of the frame (4), with side

surfaces of each liner segment (3) facing adjacent liner segments (3) in the tier or row. The side surfaces (3k) of the key liner segment (3) converge in a radially outward direction of the topshell (1).

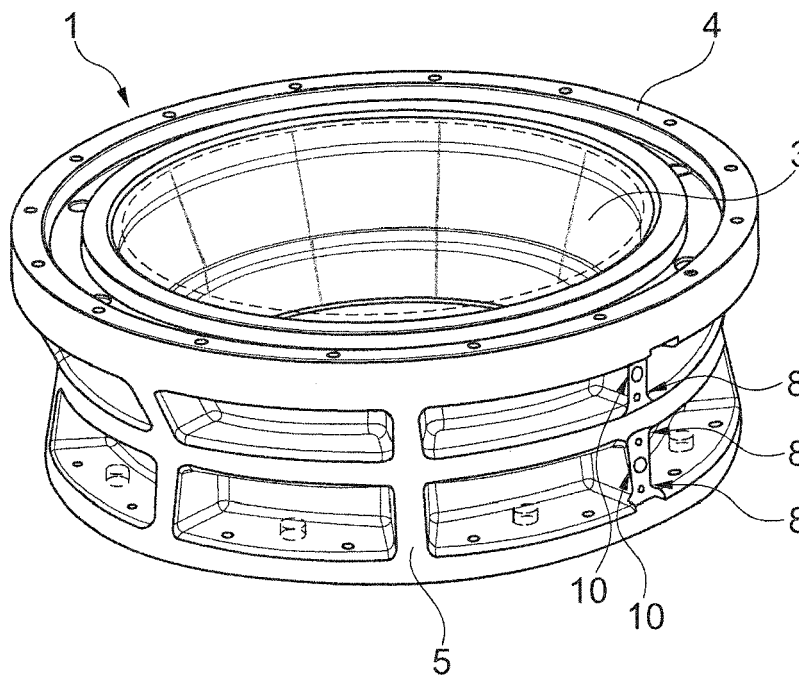


Fig. 1

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Description

Field of the invention

[0001] The present invention relates to replaceable liner segments for use in a topshell of a gyratory or cone crusher.

[0002] Gyratory crushers and cone crushers are two types of rock crushing systems which generally break apart rock, stone or other material in a crushing gap between a stationary element and a moving element.

[0003] A gyratory or cone crusher is comprised of a head assembly including a crusher head that gyrates about a vertical axis within a stationary bowl attached to a main frame of the rock crusher. The crusher head is assembled surrounding an eccentric that rotates about a shaft to impart the gyratory motion to the crusher head which crushes rock, stone or other material as the material travels through a crushing gap between the crusher head and the bowl. The crushed material exits the crusher through the bottom of the crushing gap.

[0004] The eccentric can be driven by a variety of power drives, such as an attached gear, driven by a pinion and countershaft assembly, and a number of mechanical power sources, such as electrical motors or combustion engines.

[0005] While gyratory crushers and cone crushers operate according to the same principles, the longer shaft or spindle of a gyratory crusher regularly has its upper end supported by a spider bearing, whereas the shorter spindle of the cone crusher is not suspended but supported in a bearing below the gyratory head or cone. Gyratory crushers are often used as primary crushers, i.e. heavy-duty machines designed to process large material sizes. Secondary and tertiary crushers are intended to process relatively smaller feed materials. Cone crushers are often utilised as downstream crushers.

Prior Art

[0006] Gyratory and cone crushers utilize wear parts to protect the machine from damage and perform the actual crushing of the material. The two types of wear part are the mantle and a set of several liner segments, often concave liner segments. The mantle is fixed to the main shaft, and the concave liners (or simply "concaves") are fixed to the frame of the topshell of the crusher. The concaves are arranged in several rows sitting on top of each other.

[0007] Wear parts may be made from chilled cast iron or from steel alloy, such as manganese steel, depending on the character of the material to be crushed and the particular class of service for which the machine is intended. Manganese steel combines extreme toughness with high wear resistance and has therefore developed into the universal choice for crushing hard, tough rock, even regardless of the class of service or the type of crusher. A common material is 12-14% manganese steel,

also known as Hadfield steel. Different alloys have been used for liner segments in upper, middle and bottom parts of the crushing chamber.

[0008] Typically, both the mantle and the concaves wear and distort due to the significant pressures and impact loading forces they transmit. It is common to use backing compounds, e.g. an epoxy backing, to structurally reinforce the concaves and assist with contact between the radially outward facing surface of the concaves and the radially inward facing surface of the topshell or frame. In fact, the crushing forces must be transferred to the liners from the structural crusher parts which they protect, and for that, intimate contact is needed between the back of the liners and the surface of the topshell or frame.

[0009] The aforementioned wear parts are changed regularly, i.e. in intervals of 12, 18 or 24 months. The replacement is a relatively fast process for the mantle, which is usually replaced by swapping for a spare main shaft assembly. In contrast, the replacement of the concave liners is cumbersome. Typically, one unit per row - the so-called 'keystone' or 'key segment' - is removed first so as to release any hoop stresses stored in the respective row of concaves. This is commonly done by using a thermal lance to cut a valley in the concave which therefore allows it to be chiselled off with a rock breaker or other such hammer system. Once the 'keystone' is removed, the remaining concaves in the row are removed one by one along the circumferential direction - a rock breaker, i.e. a hydraulic or pneumatic hammer, is driven behind the concaves at the top leading edge to break the epoxy backing between the concaves and the supporting frame of the crusher and to remove the concaves one by one.

[0010] In a large primary gyratory crusher, there are several rows of concaves to replace, such as e.g. four tiers (rows) with 20 segments per tier. The existing methodology for the removal and replacement of concave liners - a process also known as a "re-metal" - is very time consuming, often taking multiple days to complete. This equals downtime and lost production for the operator of the mine. As explained above, gyratory crushers are frequently used for first stage sizing in the minerals processing industry, so that any associated downtime can have serious consequences for downstream processing and therefore the overall plant productivity.

[0011] The removal of concaves requires the use of hot works as well as the operation of a large rock breaker. Also, workers have to be specially trained to be able to operate inside the topshell area of the crusher.

[0012] WO 01/28688 A1 discloses securement means for fixing and locating a head liner on the head bearing housing of a gyratory crusher. The securement means includes an inner substantially annular band and an outer substantially annular band. The inner band has an inner circumferential surface for contacting the external surface of the housing and an outer circumferential surface which tapers frusto-conically. The outer band has an out-

er circumferential surface for contacting an internal surface of the liner and an inner circumferential surface which tapers frusto-conically. The securement means defines a circumferential array of axially extending holes intermediate the inner and outer surfaces whereby, fasteners such as bolts are able to be inserted into the securement means to enable application of axial forces to the securement means. The outer and inner frusto-conical surfaces of said bands are adapted to interact whereby the axial forces force the inner band to contract radially and force the outer band to expand radially.

[0013] From US 720,853 a rock crusher is known which has concaves with parallel side edges whereby they may be reversed end for end. Longitudinally tapering keys are provided between adjacent concaves to lock the concaves together.

[0014] Also known is a concave removal press sold by Tri Star Design (<https://tristardesign.com/product/concave-removal-press/>). Said press attaches to the outside of the frame of the gyratory crusher and has a push rod extending into the crusher through a hole drilled into the frame in the area of the concave to be removed. The push rod is actuated by a hydraulic cylinder to push against the outer surface of the worn concave, thereby loosening the concave from the frame.

Summary of the invention

[0015] In view of the above, an object underlying the invention is to facilitate the removal of worn liner segments from a gyratory or cone crusher.

[0016] To achieve this object, the present invention provides, on the one hand, a key liner segment for a gyratory or cone crusher as recited in claim 1.

[0017] The key liner segment of the invention is for use in a topshell of a gyratory or cone crusher. The topshell comprises a frame and a plurality of replaceable liner segments arranged in at least one tier or row along the inner circumference of the frame, with side surfaces of each liner segment facing adjacent liner segments in the tier or row.

[0018] According to the invention, the side surfaces of the key liner segment converge in a radially outward direction of the topshell.

[0019] The invention thereby provides a specially configured key segment or key concave having sidewalls which converge in the radially outward direction. Due to this wedge-shaped configuration, the key segment can be dismounted from the frame by being pressed radially inwards. This removes the need for hot-works on the inside of the crusher requiring the use of a thermal lance to cut away the key segment in order to allow the remainder of the set to be removed.

[0020] The key segment of the invention is particularly useful in combination with at least one complementary liner segment as recited in claim 2, which is configured to be arranged adjacent to the key liner segment in a tier or row along the inner circumference of the topshell,

wherein facing side surfaces of the key liner segment and at least one complementary liner segment are essentially parallel to each other in the mounted state of the segments. In this constellation, the complementary sidewalls of the key segment and the complementary segment(s) provide for a wedge effect which creates a force perpendicular to the adjacent side walls of the segments, thereby forcing the segments further together in the hoop direction and providing for a tight joint between the individual segments in a tier or row of segments in which the key segment and complementary segment(s) are installed. This effect can be influenced by manufacturing the key segment and/or the complementary segment(s) to a tight tolerance. The wedge effect is particularly pronounced if two complementary liner segments are configured to be arranged adjacent to the key liner segment at either side thereof in the mounted state of the segments.

[0021] The combination of the key liner segment and the complementary liner segment(s) may have a shape which substantially corresponds to the shape of at least one further liner segment of the set. In an embodiment, the set of liner segments has a series of liner segments which are all substantially identical with each other, wherein one of the identical segments is replaced by a combination of a key liner segment and at least one complementary segment, such as a combination of a key liner segment and two complementary liner segments at either side thereof. In practice, a tier or row of segments could for example include 20 identical segments, one of which is replaced by a combination of a key liner segment and two complementary liner segments, so that 19 identical segments remain.

[0022] The set of liner segments may further comprise means for tightening the key liner segment against the frame, such as at least one bolt configured to extend through a bolt hole in the frame from the outside of the frame and to be fastened, e.g. threadingly fastened, to the key liner segment. Instead of said bolt or bolts, alternative tightening means could be used, including e.g. slotted rods cooperating with wedges or spreaders.

[0023] The invention also provides a topshell for a gyratory or cone crusher as claimed in claim 7. The topshell comprises a frame and a plurality of replaceable liner segments arranged in at least one tier or row along the inner circumference of the frame, with side surfaces of each liner segment facing adjacent liner segments in the tier or row. According to the invention, the plurality of replaceable liner segments include at least one key liner segment which is configured as described above, i.e. which has side surfaces which converge in a radially outward direction of the topshell.

[0024] The plurality of replaceable liner segments may further comprise at least one complementary liner segment configured to be arranged adjacent to the key liner segment in a tier or row along the inner circumference of the frame of the crusher, wherein facing side surfaces of the key liner segment and at least one complementary

liner segment are essentially parallel to each other in the mounted state of the segments. Specifically, the plurality of replaceable liner segments may include two complementary liner segments adjacent to the key liner segment at either side thereof. The combination of the key liner segment and the complementary liner segment(s) preferably has a shape which substantially corresponds to the shape of at least one further liner segment in the set of liner segments.

[0025] The topshell may further comprise means for tightening the key liner segment against the frame. The tightening means may include at least one bolt configured to extend through a bolt hole in the frame from the outside of the frame and to be fastened, e.g. threadingly fastened, to the key liner segment. To accommodate the tightening means, a portion of an outer circumferential surface of the frame at a location radially outward of the key liner segment may be formed with a mounting seat for an installation tool.

[0026] Also, in a manner known per se, backing such as an epoxy backing may be disposed between the outer surface of the liner segment and the inner surface of the frame.

[0027] Alternatively or in addition, a through hole may be formed through a wall of the frame of the crusher at a location radially outward of the key liner segment, the through hole being sized for an installation tool to pass through. The tool could be the tool of a hydraulic push/pull ram.

[0028] The invention further provides a gyratory or cone crusher as recited in claim 14, comprising a key liner segment, a set of liner segments, and/or a topshell as described above. The gyratory or cone crusher as such may comprise a head assembly including a crusher head provided with a first crushing shell or mantle, and a topshell comprising a frame provided with a second crushing shell or bowl, wherein the mantle and bowl define a crushing gap between them. The bowl is constituted by a plurality of liner segments, with outer surfaces of the liner segments facing an inner surface of the frame.

[0029] The invention also provides a method for installing replaceable liner segments to an inner wall of a frame of a topshell of a gyratory or cone crusher as claimed in claim 15. The method comprises:

- arranging a plurality of replaceable liner segments in at least one tier or row along the inner circumference of the frame, with an inner surface of each liner segment facing towards the center of the topshell, an outer surface of each of the liner segments facing an inner surface of the frame, and side surfaces of each liner segment facing adjacent liner segments in the tier or row, wherein a gap is left between two of the liner segments which are placed next to each other in the hoop direction of the topshell, and
- installing at least one key liner segment in the gap between the two liner segments, the key liner segment having side surfaces which converge in a ra-

dially outward direction of the topshell.

[0030] The step of installing the key liner segment may include pulling the key liner segment in a radially outward direction of the frame, preferably by providing an installation tool at the outside of the frame, passing the tool through a wall of the frame towards the key liner segment, engaging the tool with the key liner segment, and operating the tool to apply a pulling force to the key liner segment.

[0031] The wedge shape of the key liner segment resulting from the converging side walls thereof can be suitably made use of by arranging, prior to installing the key liner segment, at least one complementary liner segment in the tier or row, wherein the said gap is left between the complementary liner segment and another liner segment placed next to it in the hoop direction of the topshell. When the key liner segment is then installed in the gap and adjacent to the complementary liner segment so that facing side surfaces of the key liner segment and the complementary liner segment are essentially parallel to each other in the mounted state of the segments, the key liner segment applies a force onto the adjacent complementary segment in a direction perpendicular to the adjacent side walls of the segments. This can result in a tight joint between the adjacent segments, removing the need to shim the liner segments as it is necessary with conventional arrangements.

[0032] Finally, the invention also provides a method for removing replaceable liner segments from an inner wall of a frame of a topshell of a gyratory or cone crusher as claimed in claim 18, the liner segments being arranged in at least one tier or row along the inner circumference of the frame, with an inner surface of each liner segment facing towards the center of the topshell, an outer surface of each of the liner segments facing an inner surface of the frame, and side surfaces of each liner segment facing adjacent liner segments in the tier or row. The method comprises removing at least one key liner segment from the tier or row of liner segments, the key liner segment having side surfaces which converge in a radially outward direction of the topshell.

[0033] Considering that the converging side walls of the key liner segment allow for a removal of the key liner segment towards the interior of the frame (which is not possible with conventional, self-retaining segments), the step of removing the key liner segment may suitably include pushing the key liner segment in a radially inward direction of the frame, preferably by providing an installation tool at the outside of the frame, passing the tool through a wall of the frame towards the key liner segment, engaging the tool with the key liner segment, and operating the tool to apply a pushing force to the key liner segment.

[0034] Removing the key segment releases any hoop stresses in the tier or row of segments. Thereafter, the remaining liner segments can be separated from the frame.

[0035] If several rows of liners are provided, as is usually the case in gyratory crushers, the removal of the rows of segments would start with the uppermost row of segments in the crusher.

[0036] Upon completion of the dismantling of one row of segments, the dismantled liner segments can then be removed from the crusher in any known manner. For example, a removal tray or bin may be positioned below the row of liner segments being ejected, and an entire tier or row of segments may be lifted out of the crusher at the same time.

[0037] The installation tool used for installing and/or removing the segments may be operated pneumatically or hydraulically. Also conceivable in principle are mechanically operated tools, though.

Brief description of the drawings

[0038] The above, as well as additional objects, features and advantages of the present invention will be better understood through the following illustrative and non-limiting detailed description of preferred embodiments of the present invention, with reference to the appended drawings, where the same reference numerals will be used for similar elements, wherein:

Figure 1 illustrates a topshell of a gyratory crusher equipped with liner segments;

Figure 2 is a sideview of a crusher;

Figure 3 is a top view of a topshell of a conventional crusher;

Figure 4 is a top view of the topshell of Figure 1;

Figure 5 is a cross sectional view of the topshell of Figure 1 in the area of a key liner segment according to the invention;

Figure 6 is a partial view of Figure 4;

Figure 7 is a top view of the topshell of Figure 1 with a key segment partially removed; and

Figure 8 shows schematically a gyratory crusher of the prior art.

Detailed description of a preferred embodiment

[0039] Figure 8 schematically illustrates a previously known gyratory crusher 100 in section.

[0040] The sole purpose of this illustration is to explain the basic operating principle of a gyratory or cone crusher, and it is not to be understood to imply any limitation of the present invention.

[0041] The gyratory crusher 100 has a vertically extending main shaft 102 and a frame 104. The shaft 102

has a longitudinal axis coinciding with a central axis A of the crusher. Other than most gyratory crushers which have their main shaft suspended from a spider bearing, the one illustrated here is spider-less. The crusher includes an eccentric assembly which in this previously known embodiment is provided in the form of two eccentric rings 106, 108 rotatably supported about the shaft 102. A crusher head 110 is radially supported by and rotatable about the eccentric rings 106, 108.

[0042] A drive shaft 112 is connected to a drive motor and is provided with a pinion 114. The drive shaft 112 is arranged to rotate the lower eccentric ring 108 by the pinion 114 engaging a gear rim 116 mounted on the lower eccentric ring 108. When the drive shaft 112 rotates the lower eccentric ring 108, the crusher head 110 executes a gyrating movement.

[0043] An inner crushing shell 118, also designated a mantle, is mounted on the crusher head 110. Crusher head 110 and mantle 118 are parts of an overall head assembly. An outer crushing shell 120, also designated a bowl, is mounted on the frame 104. A crushing gap 122 is formed between the two crushing shells 118, 120. When the crusher 100 is operated, material to be crushed is introduced in the crushing gap 122 and is crushed between the mantle 118 and the bowl 120 as a result of the gyrating movement of the crusher head 110, during which movement the mantle 118 approaches the bowl 120 along a rotating generatrix and moves away therefrom along a diametrically opposed generatrix.

[0044] Figure 1 illustrates a topshell 1 of a gyratory crusher which is constructed in accordance with the present invention.

[0045] The topshell 1 includes an outer frame 4 which is substantially annular, and a bowl which is constituted by a plurality of liner segments 3 (only hinted at in Figure 1), with inner surface of each liner segment 3 facing towards the center of the bowl, and outer surfaces of the liner segments 3 facing an inner circumferential surface of the frame 4.

[0046] The liner segments 3 are arranged in at least one tier or row along the inner circumference of the frame 4. In the present case, the liner segments are provided in the form of concave liners, also designated concaves, in view of their concave shape which follows the concave shape of the inner circumference of the frame 4. The expressions "concaves", "liners" and "segments" may therefore be used interchangeably to designate the liner segments.

[0047] In the operational state of the crusher, an epoxy backing (not specifically illustrated) would be poured into the remaining gap between the outer surfaces of the liner segments 3 and the facing inner circumferential surface of the frame 4. The epoxy backing is, in a manner known per se, provided to structurally reinforce the concaves 3 and assist with contact between the radially outward facing surfaces of the concaves 3 and the radially inward facing surfaces of the frame 4. The backing material fills the void between the concaves 3 and the frame 4 to pro-

vide a solid assembly.

[0048] For the position and arrangement of the topshell 1 in a crusher, reference is made to Figure 2: Figure 2 illustrates a crusher having an upper topshell 101 and a lower topshell 102. The topshell 1 of the invention could be used as the upper 101 and/or the lower topshell 102 or as the only topshell of a crusher.

[0049] Figure 3 schematically illustrates a topshell of a conventional crusher from above. It is apparent from this illustration that the liner segments 3 are arranged adjacent to each other in a tier or row along the circumference of the frame 104 of the topshell. The side surfaces of the segments 3 are generally aligned along radial lines, which makes the side surfaces of each of the individual segments 3 diverge in a radially outward direction of the frame (see the diverging lines "d" in Figure 3). Due to this configuration, the segments 3 are self-retaining (i. e. cannot easily be moved towards the radial center of the topshell, as indicated by the crossed-out arrow in Figure 3). If the liner segments 3 are worn and need to be exchanged, a first liner segment 3 - the so-called "key segment" - must therefore be cut away before the remaining concaves can be disassembled. The removal of the "key segment" releases any hoop stresses stored in the respective row of concaves. Once the "key segment" is removed, the remaining concaves in the row are removed one by one along the circumferential direction.

[0050] Conventional crushers therefore require the gouging out of one concave in order to allow the remainder of the set to be removed. Conventionally, the key concave is often removed by thermal lancing.

[0051] In contrast, according to the present invention, the key segment is specifically configured to facilitate its removal from the frame and to avoid the need to use a thermal lance. This will be described with reference to Figure 4 which shows the topshell 1 of Figure 1 from above.

[0052] Similar as in the conventional topshell, the frame 4 of the topshell 1 of the invention is equipped with a series of liner segments 3, most of which correspond to standard liner segments 3 similar to the ones used in the conventional topshell of Figure 3. The standard liner segments 3 are arranged in a tier or row along the inner circumference of the frame 4, with their side surfaces adjacent to each other. Similar as in the conventional case, the side surfaces of each of the standard liner segments 3 diverge as seen in a radially outward direction of the frame 4 (see the diverging lines "d" in Figure 4).

[0053] Between two of the standard liner segments 3 which are arranged next to each other in the hoop direction of the topshell 1, a key liner segment 3k is located, and two complementary liner segments 3c are provided in the embodiment illustrated here.

[0054] The key liner segment 3k has side surfaces SK which converge as seen in a radially outward direction of the frame 4 (see the converging lines "c" in Figure 4).

[0055] The complementary liner segments 3c are arranged to both sides of the key liner segment 3k in the

circumferential or hoop direction of the frame 4, and each of the two side surfaces SK of the key liner segment 3k is essentially parallel to the facing side surface SC of the respective adjacent complementary liner segment 3c in the mounted state of the segments. At the sides facing away from the key liner segment 3k in the hoop direction of the frame 4, the side surfaces of the complementary liner segments 3c are in turn parallel to the side surfaces of the respective adjacent standard segments 3.

[0056] In the embodiment, the key segment 3k and the complementary segments 3c to both sides thereof together have a shape which is basically identical with the shape of a standard concave 3. In other words, it can be said that a standard concave 3 has been divided into three parts 3c, 3k, 3c; or that a standard concave 3 has been replaced by the combination of the key liner segment 3k and the two complementary liner segments 3c.

[0057] Due to its converging side walls SK, the key concave 3k can easily be forced radially inwards, unlike the standard segments 3 which are self-retaining and therefore require the use of a thermal lance or the like to remove a key segment.

[0058] The angle which the converging side surfaces SK of the key liner segment 3k form with each other is suitably chosen according to the individual case and considering the overall geometric configuration of the topshell. Suitable angles may for example be in the range of up to 45 degrees, or up to 30 degrees, or between 5 and 25 degrees, or between 10 and 20 degrees, or at about 15 degrees.

[0059] Figure 5 provides further details as to the installation and fastening of the key liner segments 3k according to the invention. Figure 5 is a cross sectional view of that part of the topshell 1 of Figure 1 which accommodates the key liner segments 3k of two tiers or rows of segments. In the present embodiment, the key liner segments 3k are located at approximately the same location in the hoop direction of the frame 4.

[0060] In the mounted state of the segments including the key liner segments 3k which is illustrated in Figure 5, two threaded bolts 6 are used to fasten each of the key liner segments 3k to the frame 4. The threaded bolts 6 extend from the outside of the frame 4 through corresponding bolt openings 8 (Figure 1) provided in the frame 4. The heads 7 of the bolts 6 rest against a seating surface machined for this purpose on the outward facing surface of one of a series of vertically extending stays 5 formed on the outside of the frame 4. Due to the wedge shape of the key segment 3k created by the converging side walls SK thereof, the key segment 3k in its fastened state acts on the adjacent complementary segments 3c in a direction perpendicular to the side walls thereof, thereby pushing the segments 3 in the tier or row further together in the hoop direction of the topshell 1.

[0061] The technical effects achieved by the invention will become further apparent from the following description of a process of installing a series of segments 3 including the key liner segment 3k and the complementary

segments 3c of the invention to the topshell of a crusher, wherein reference is further made to Figures 1 to 7.

[0062] In a first step, a tier or row of standard liner segments 3 is assembled to the frame 4 in a manner known per se wherein, however, a gap or space is left between a first and a last liner segment 3 in a hoop direction of the frame 4. A combination of the above described key liner segment 3k and two complementary segments 3c is then installed within said space, so that the two complementary segments 3c come to rest with their side surfaces SC facing the key liner segment 3k and their opposite side surfaces facing adjacent standard segments 3.

[0063] The key segment 3k and complementary segments 3c are installed at a specific location of the frame 4, i.e. so that the key segment 3k is aligned with one of the aforementioned mounting seat surfaces provided to the frame 4. In addition to the aforementioned bolt holes 8, each of the two mounting seat surfaces associated with the key liner segments 3k also accommodates a further through hole 10 which is provided in this embodiment between the two bolt openings 8 as seen in a vertical direction. This further through hole 10 is provided to allow for the rod-shaped tool 21 of a ram to pass through. A corresponding ram 20 including tool 21 is very schematically illustrated in Figure 5. A hydraulic push/pull ram can suitably be used, or e.g. a jacking bolt.

[0064] To fasten the key liner segment 3k to the frame 4, the tool 21 of the hydraulic ram 20 is engaged with to the key liner segment 3k, and the hydraulic ram 20 is then operated in its pull mode to force the key segment 3k towards the outer circumference of the topshell 1. Due to the wedge shape of the key segment 3k created by the converging side walls SK thereof, one component of the pull force applied to the key segment 3k acts on the adjacent complementary segments 3c in a direction perpendicular to the side walls thereof, thereby pushing the segments 3 in the tier or row further together in the hoop direction of the topshell 1. In Figure 6 which is a partial enlarged view of Figure 4, the pull force is illustrated at Fpull, and the force component acting on the complementary segments 3c is illustrated by way of a series of smaller arrows.

[0065] The key segment 3k is preferably dimensioned so that a tight joint between the individual segments 3, 3k, 3c in the row is achieved when wedging the key segment 3k in between the complementary segments 3c. This removes the need to shim concave segments during installation. The pulling force which is applied onto the key segment 3k can be monitored by e.g. detecting the pressure in a hydraulic circuit of the ram 20. When a predetermined force has been reached which signals that the segments in the tier or row have achieved the desired tight fit, the key segment 3k is fastened to the frame 4 using the aforementioned bolts 6 or other tightening elements. The ram 20 may be de-energised and stored.

[0066] The push/pull ram 20 is suitably also used to remove the key concave 3k when the liner segments are

to be replaced. To remove the key concave 3k, the ram 20 is reconnected, the fasteners 6 are removed and the ram 20 is operated in its push mode. The ram 20 applies a pushing force onto the key concave 3k which is sufficient to overcome the strength of the epoxy backing holding the key concave 3k in place, and the key concave 3k will come loose. Due to its converging side walls SK, the key concave 3k can easily be forced radially inwards (see Figure 7), unlike the standard segments 3 which are self-retaining (see Figure 3) and therefore require the use of a thermal lance or the like to remove a key segment. The invention thereby removes the need for hot-works on the inside of the crusher requiring gouging out of one concave in order to allow the remainder of the set to be removed.

[0067] The dismounted liner segments 3, 3k, 3c are then removed from the crusher in any known manner. For example, a removal tray or bin (not shown) could be positioned below the row of liner segments being ejected, and an entire tier or row of segments could be lifted out of the crusher at the same time.

[0068] It is apparent from the above that the invention requires certain modifications to the structure of the topshell. In the embodiment illustrated above, holes 8, 10 are to be drilled for allowing the bolts 6 and the tool 21, respectively, to pass through. The flat mounting seat surfaces are to be machined into the topshell.

[0069] The key liner segment 3k is customized, too: apart from the converging side walls SK which differentiates it from the standard liner segments 3, the key liner segment 3k in the illustrated embodiment also requires threaded openings receiving the bolts 6 as well as a portion for engagement with the tool 21 of the push/pull ram 20.

[0070] The invention will result in an overall improvement in shutdown efficiency and effectiveness for all concave re-metal works. The user will also be able to recognise a financial benefit by reducing maintenance shutdown duration.

[0071] While one embodiment of the invention has been described with reference to Figures 1 to 7, the scope of the invention is not restricted to this embodiment but defined by the appended claims. Various modifications are included within the scope.

Claims

1. A key liner segment (3k) for use in a topshell (1) of a gyratory or cone crusher, the topshell (1) comprising a frame (4) and a plurality of replaceable liner segments (3) arranged in at least one tier or row along the inner circumference of the frame (4), with side surfaces of each liner segment (3) facing adjacent liner segments (3) in the tier or row, characterized in that the side surfaces (3k) of the key liner segment (3)

- converge in a radially outward direction of the topshell (1).
2. A set of liner segments (3, 3k, 3c) for use in a topshell (1) of a gyratory or cone crusher, the set including the key liner segment (3k) of claim 1 and at least one complementary liner segment (3c) configured to be arranged adjacent to the key liner segment in a tier or row along the inner circumference of the topshell (1), wherein facing side surfaces of the key liner segment and at least one complementary liner segment are essentially parallel to each other in the mounted state of the segments.
 3. The set of liner segments of claim 2, including two complementary liner segments configured to be arranged adjacent to the key liner segment at either side thereof in the mounted state of the segments.
 4. The set of liner segments of claim 2 or 3, wherein the combination of the key liner segment and the complementary liner segment or segments has a shape which substantially corresponds to the shape of at least one further liner segment (3) of the set.
 5. The set of liner segments of any one of claims 2 to 4, further comprising means for tightening the key liner segment against the frame (4).
 6. The set of liner segments of claim 5, wherein the tightening means include at least one bolt configured to extend through a bolt hole in the frame (4) from the outside of the frame and to be fastened, e.g. threadingly fastened, to the key liner segment (3k).
 7. A topshell (1) for a gyratory or cone crusher, comprising a frame (4) and a plurality of replaceable liner segments (3) arranged in at least one tier or row along the inner circumference of the frame (4), with side surfaces of each liner segment (3) facing adjacent liner segments (3) in the tier or row, **characterized in that** the plurality of replaceable liner segments (3) include at least one key liner segment (3) having side surfaces which converge in a radially outward direction of the topshell (1).
 8. The topshell (1) of claim 7, wherein the plurality of replaceable liner segments (3) further comprise at least one complementary liner segment (3c) configured to be arranged adjacent to the key liner segment in a tier or row along the inner circumference of the frame (4) of the crusher, wherein facing side surfaces of the key liner segment and at least one complementary liner segment are essentially parallel to each other in the mounted state of the segments.
 9. The topshell (1) of claim 8, wherein the plurality of replaceable liner segments (3) include two complementary liner segments adjacent to the key liner segment at either side thereof, wherein the combination of the key liner segment and the two complementary liner segments preferably has a shape which substantially corresponds to the shape of at least one further liner segment (3) in the set of liner segments (3).
 10. The topshell (1) of any one of claims 7 to 9, further comprising means for tightening the key liner segment to the frame (4).
 11. The topshell (1) of claim 10, wherein the tightening means include at least one bolt configured to extend through a bolt hole in the frame (4) from the outside of the frame and to be fastened, e.g. threadingly fastened, to the key liner segment (3k).
 12. The topshell (1) of any one of claims 7 to 11, wherein a portion of an outer circumferential surface of the frame (4) of the crusher at a location radially outward of the key liner segment (3k) is formed with a mounting seat for an installation tool.
 13. The topshell (1) of any one of claims 7 to 12, wherein a through hole (10) is formed through a wall of the frame (4) of the crusher at a location radially outward of the key liner segment (3k), the through hole (10) being sized for an installation tool to pass through.
 14. A gyratory or cone crusher comprising
 - a key liner segment (3k) as recited in claim 1,
 - a set of liner segments (3, 3k, 3c) as recited in any one of claims 2 to 6, and/or
 - a topshell as recited in any one of claims 7 to 13.
 15. A method for installing replaceable liner segments (3, 3k, 3c) to an inner wall of a frame (4) of a topshell (1) of a gyratory or cone crusher, the method comprising:
 - arranging a plurality of replaceable liner segments (3) in at least one tier or row along the inner circumference of the frame (4), with an inner surface of each liner segment (3) facing towards the center of the topshell (1), an outer surface of each of the liner segments (3) facing an inner surface of the frame (4), and side surfaces of each liner segment (3) facing adjacent liner segments (3) in the tier or row, wherein a gap is left between two of the liner segments which are placed next to each other in the hoop direction of the topshell (3), and
 - installing at least one key liner segment (3) in the gap between the two liner segments (3), the

key liner segment (3k) having side surfaces which converge in a radially outward direction of the topshell (1).

16. The method of claim 15, wherein the step of installing the key liner segment (3k) includes pulling the key liner segment in a radially outward direction of the frame (4), preferably by providing an installation tool (21) at the outside of the frame (4), passing the tool (21) through a wall of the frame (4) towards the key liner segment (3k), engaging the tool (21) with the key liner segment (3k), and operating the tool (21) to apply a pulling force to the key liner segment (3k).
17. The method of claim 15 and 16, wherein, prior to installing the key liner segment (3k), at least one complementary liner segment (3c) is arranged in the tier or row, the said gap is left between the complementary liner segment (3c) and another liner segment placed next to it in the hoop direction of the topshell (3), and the key liner segment (3k) is then installed in the gap and adjacent to the complementary liner segment (3c) so that facing side surfaces of the key liner segment and the complementary liner segment are essentially parallel to each other in the mounted state of the segments.
18. A method for removing replaceable liner segments (3, 3k, 3c) from an inner wall of a frame (4) of a topshell (1) of a gyratory or cone crusher, the liner segments (3) being arranged in at least one tier or row along the inner circumference of the frame (4), with an inner surface of each liner segment (3) facing towards the center of the topshell (1), an outer surface of each of the liner segments (3) facing an inner surface of the frame (4), and side surfaces of each liner segment (3) facing adjacent liner segments (3) in the tier or row, the method comprising:
 - removing at least one key liner segment (3) from the tier or row of liner segments (3), the key liner segment (3k) having side surfaces which converge in a radially outward direction of the topshell (1).
19. The method of claim 18, wherein the step of removing the key liner segment (3k) includes pushing the key liner segment in a radially inward direction of the frame (4), preferably by providing an installation tool (21) at the outside of the frame (4), passing the tool (21) through a wall of the frame (4) towards the key liner segment (3k), engaging the tool (21) with the key liner segment (3k), and operating the tool (21) to apply a pushing force to the key liner segment (3k).
20. The method of claim 18 or 19, wherein the remaining liner segments are separated from the frame (4) subsequent to the removal of the key liner segment (3k).

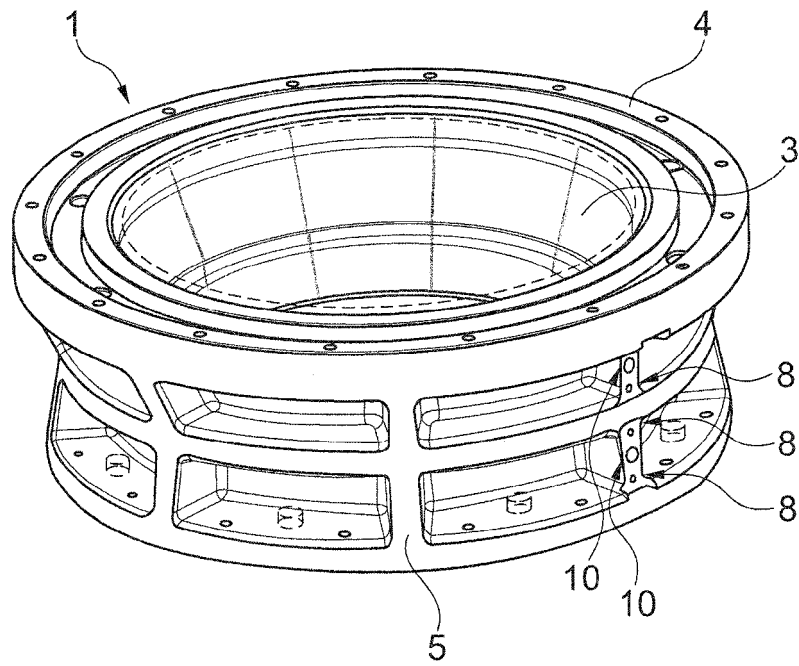


Fig. 1

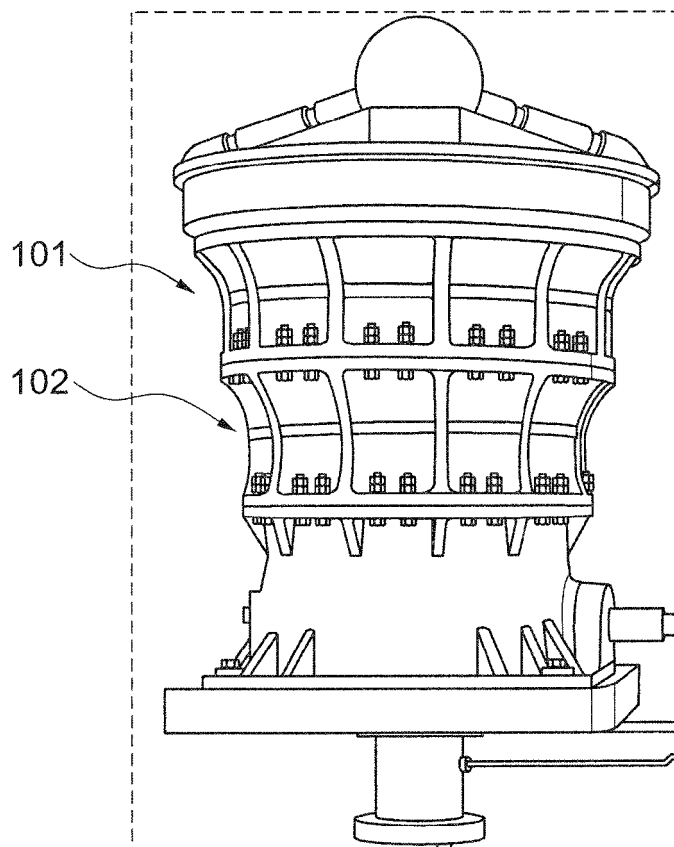


Fig. 2

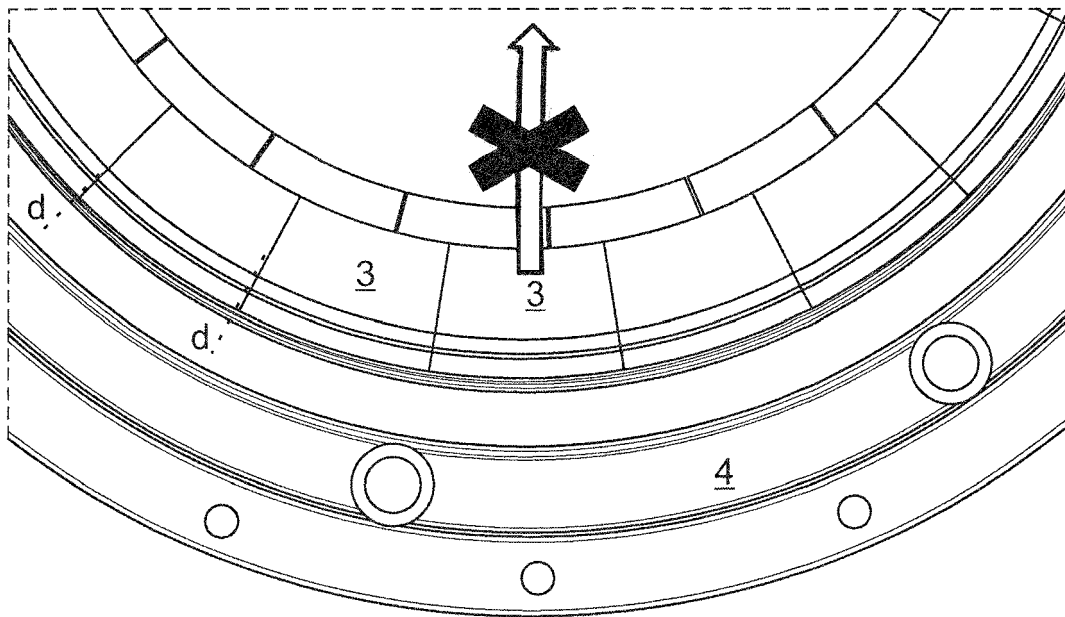


Fig. 3

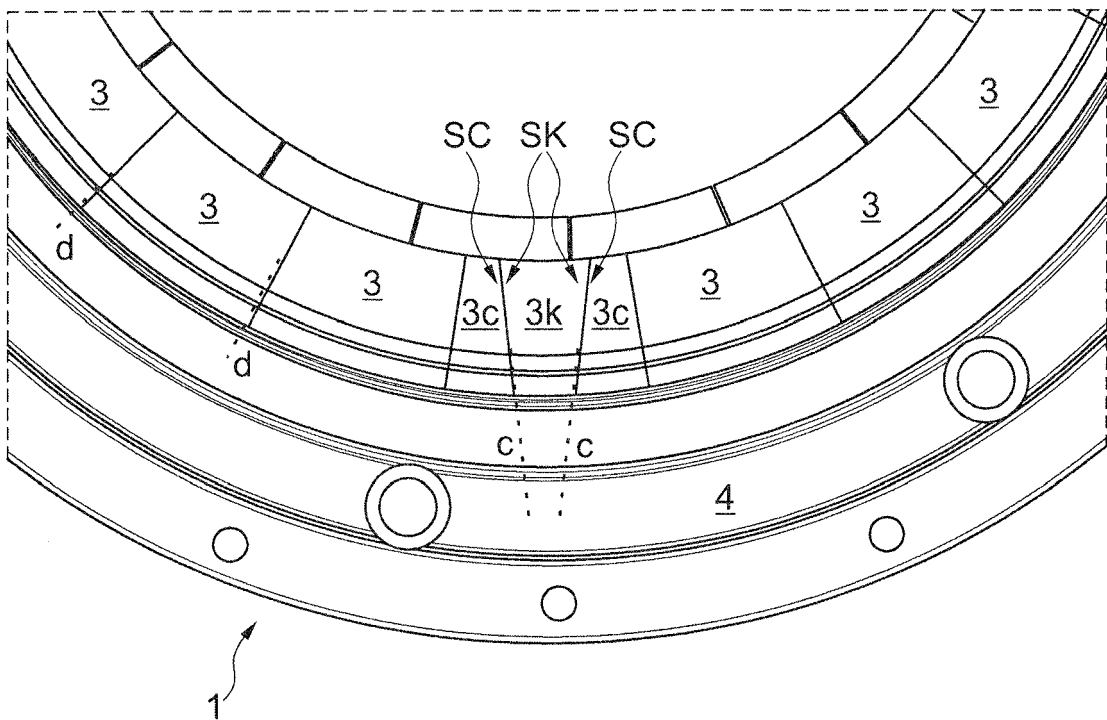


Fig. 4

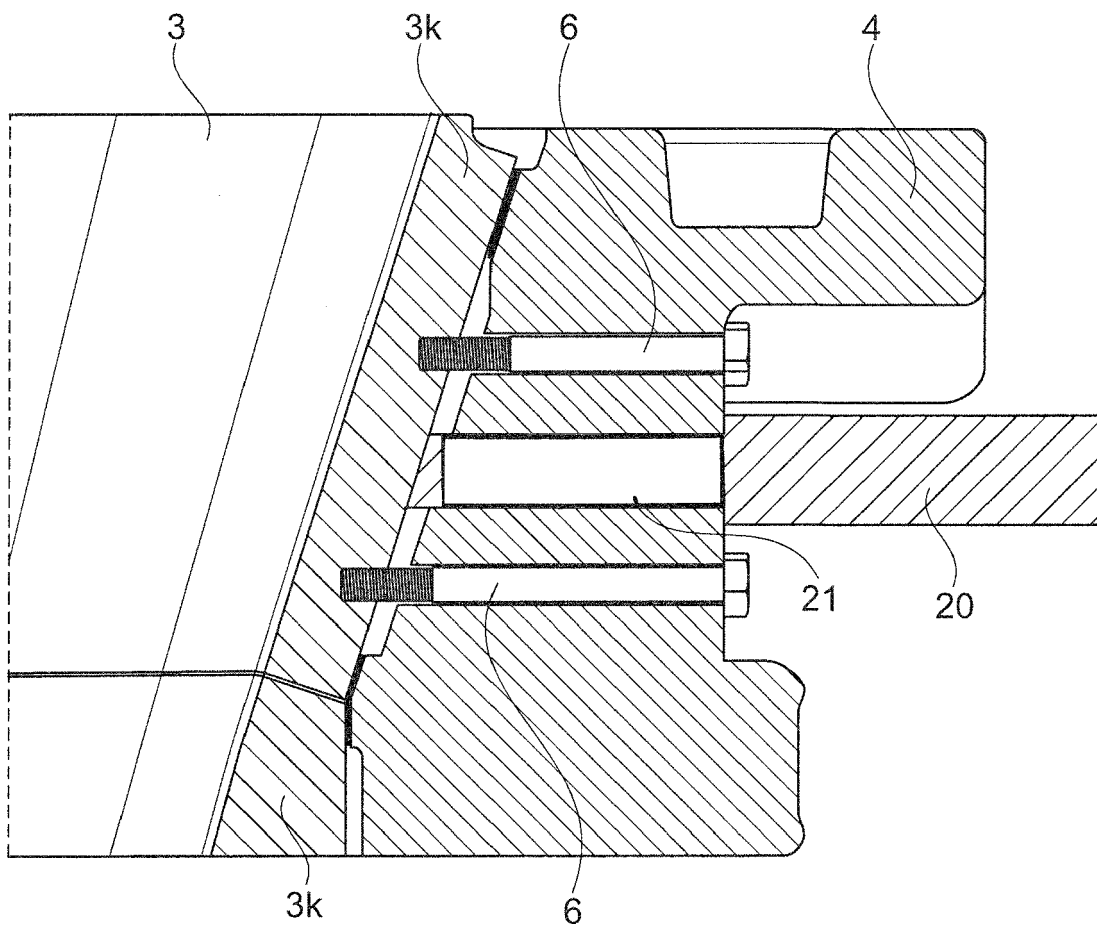


Fig. 5

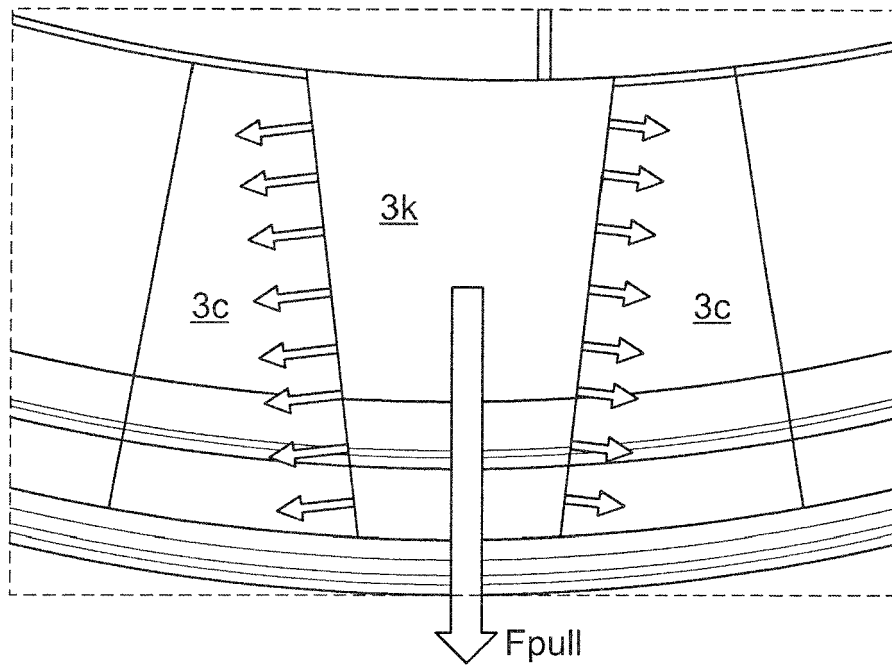


Fig. 6

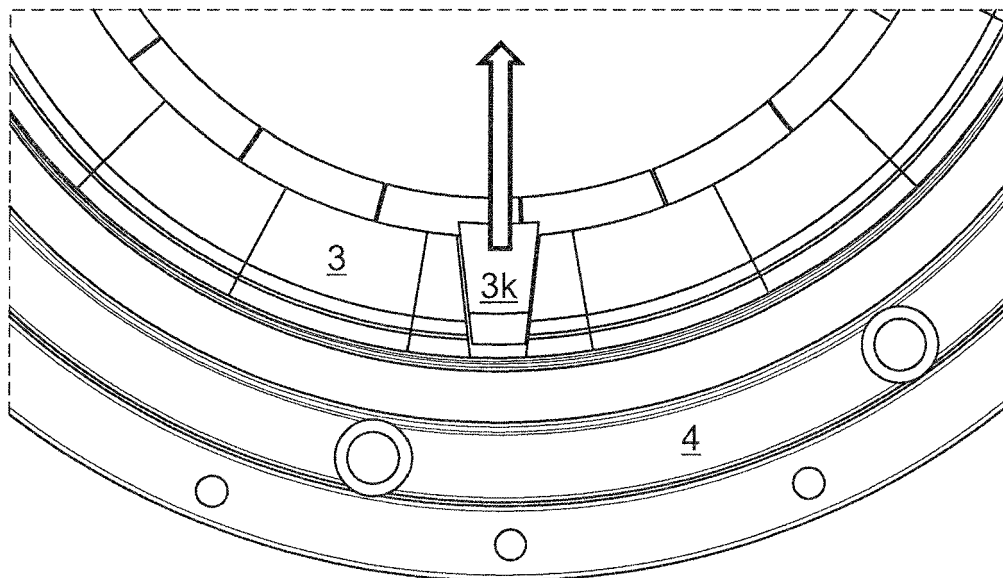


Fig. 7

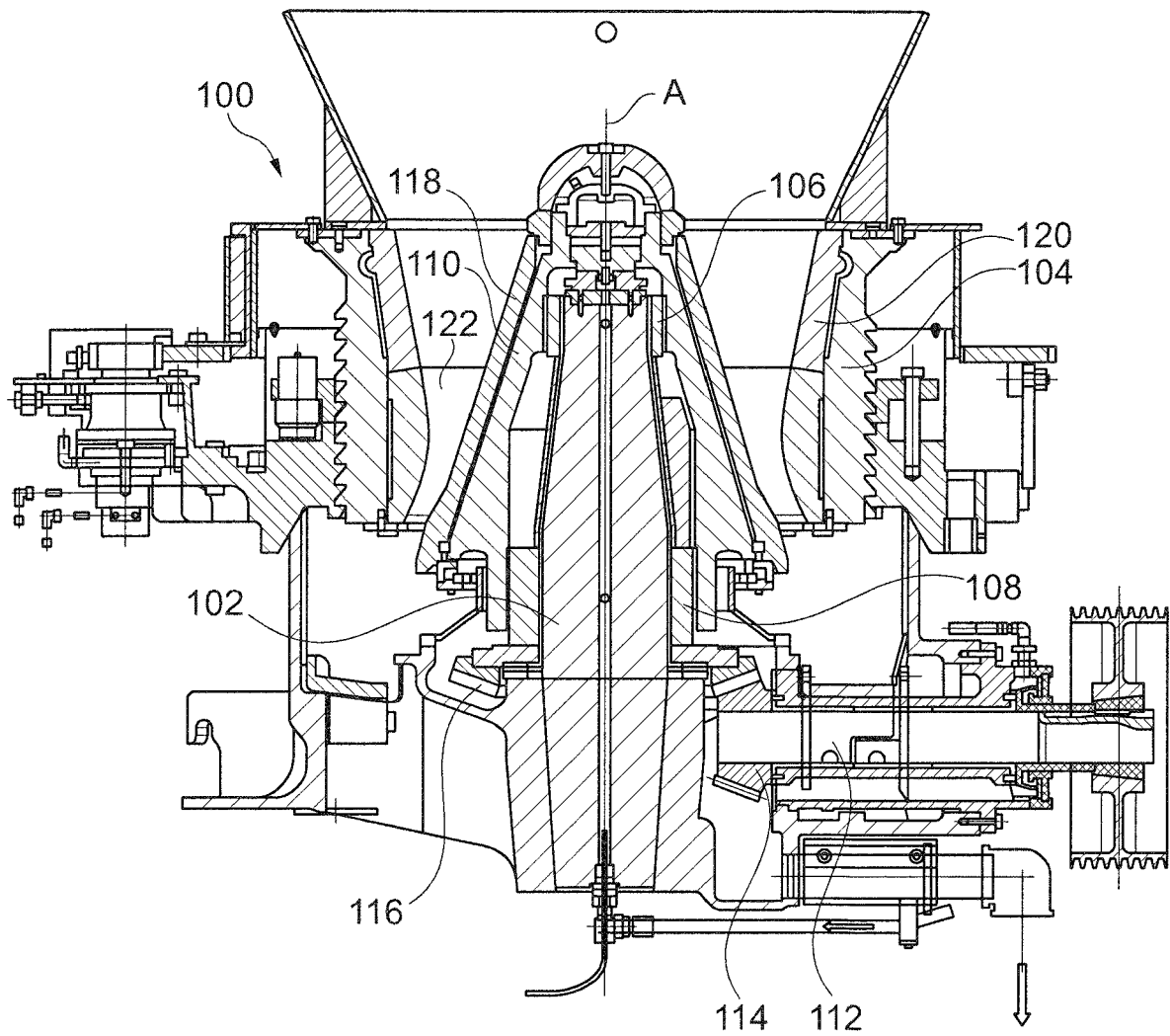


Fig. 8



EUROPEAN SEARCH REPORT

Application Number
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Y	* page 3, line 14 - page 5; figures 1,2A,3A,3b,4a,4b,5a,5b *	12,13, 16,19	
A	-----	4,9	
Y	JP S62 197156 A (KAWASAKI HEAVY IND LTD) 31 August 1987 (1987-08-31) * abstract; figures 1-4 * -----	12,13, 16,19	
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			B02C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 January 2021	Examiner Iuliano, Emanuela
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