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(54) ROADHEADER AND CUTTER HEAD THEREFOR

(57) The invention is directed to a transverse cutter head (20) for a mining machine, wherein the cutter head (20) has an outer surface (25) comprising a plurality of cutting tools (27), wherein the tips (31) of the plurality of cutting tools (27) define a virtual contour line (30, 30') when viewed in a cutter boom longitudinal direction and a rotation of the cutter head is considered, wherein the contour line (30) is formed by at least four sections, namely a first section (A, A'), a second section (B, B'), a third section (C, C') and a fourth section (D, D'), the four sections are located adjacently in this order, wherein the first section (A, A') is located closest to the cutter boom (10) and the fourth section (D, D') forms the side wall cutting area, wherein the first section (A, A') and/or the fourth section (D, D') run substantially straight, preferably each one of the first section (A, A'), the second section (B, B') and the third section (C, C') has a pitch angle different from the pitch angle of the other two sections. The invention further relates to a roadheader having such a cutter head.

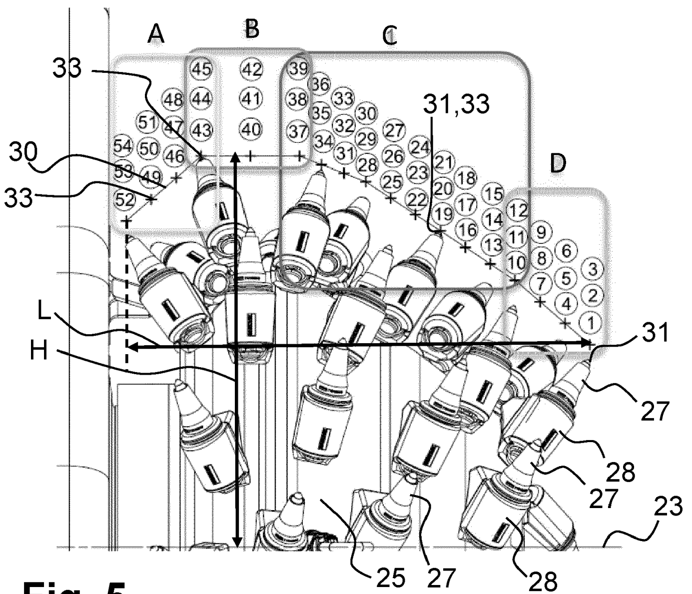

Fig. 5

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Description

[0001] The invention refers to a roadheader and a transverse cutter head therefor, wherein the cutter head has an outer surface comprising a plurality of cutting tools, wherein the tips of the cutting tools define a contour.

[0002] For the excavation of tunnels, galleries and the like, including rock and seam sections in underground mining operations, and mineral production, e.g. of coal, rock, gypsum, potash, salt and metal, roadheaders are used which are equipped with a cross-cutting head mounted on a boom. One type of roadheader typically comprises two transverse cutter heads mounted on a cutter boom which are driven to rotate about an axis transverse to a longitudinal direction represented by the cutter boom axis. The boom extends from a main body of the roadheader and can be swivelled in different directions. Such roadheader is able to cut rock with a high compressive strength. For that, the cutter head comprises a plurality of cutting tools arranged at the outer surface of each cutter head.

[0003] Document EP 2 208 856 discloses another type of roadheader comprising a longitudinal cutter head having a rotation axis that is generally parallel to or aligned with the axis of a cutter boom. At the outer surface of the cutter head, cutting tools are arranged forming a contour. The known cutter head has a particularly adapted contour design for this type of cutter head. For a better break-in behaviour, the cutter head comprises hard rock breakers arranged on the front side of the cutting head close to the axis of rotation, which are offset inwards in the axial direction of the cutter head.

[0004] A transverse cutter head for a roadheader is disclosed in document DE 38 06 335 A1. One cutter head comprises several annular discs which are welded together in surface contact with each other both on the outer circumference and on the inner circumference. The cutter head further comprises chisel holders for replaceable chisels which generally consist of round shank chisels, wherein the chisel holders are welded to the outer casing of the base body of the cutter head formed by the annular discs. Document CN 113565502 A shows another transverse cutter head comprising a plurality of cutting tools at its outer surface. As one can derive from this document, the cutting tools are arranged at and fixed along spiral grooves provided at the outer surface of the cutter head.

[0005] The above known transverse cutter heads comprise a rounded cutting contour formed by cutting tool tips rotating about the rotation axis of the respective cutter head, for example at a section close to the rotation axis of the cutter head (side wall cutting area). Such rounded contour leads to irregular wear of the cutting tools located within this section.

[0006] Accordingly, it is an object of the invention to provide a cutter head for transverse cutting that has regular wear. Furthermore, it is an object to provide a respective roadheader having such cutter head.

[0007] The above object is solved by a transverse cutter head having the features of claim 1 and a road header having the features of claim 14. The cutter head is configured to be mounted onto a cutter boom e.g. via a shaft (which may include drive/gear mechanism).

[0008] In particular, the above object is solved by a transverse cutter head for a mining machine (e.g., a roadheader) with an outer surface comprising a plurality of cutting tools, wherein the tips of the plurality of cutting tools define a virtual contour line e.g. when viewed in a cutter boom longitudinal direction and a full rotation of the cutter head is considered, wherein the contour line is formed by at least four sections, namely a first section, a second section, a third section and a fourth section, the four sections are located adjacently in this order, wherein the first section is located closest to the cutter boom (i.e. toward the gear of the cutter head, or, on the inner side) and the fourth section forms the side wall cutting area (i.e. departing away from the gear of the cutter head, or, on the outer side), wherein the first section and/or the fourth section run substantially straight and preferably each one of the first section, the second section and the third section has a pitch angle different from the pitch angle of the other two sections. The pitch angle is understood as an angle between a section of the contour line and a rotation axis of the cutter head. To provide additional clarification on the matter mentioned above, the rotation of the cutting tool tips leaves a series of traces that delineates a hypothetical surface or contour or periphery (i.e. delineates a continuous surface which is achieved through interpolation); a contour line e.g. in a form of curve or polyline is understood as a 2-dimensional entity (e.g. curve or polyline) defined by the intersection of the hypothetical surface with a plane running through the rotation axis of the cutter head. To put it differently, intersecting of adjacent traces with a plane running through the rotation axis of the cutter head leaves 2 points, these 2 points are connected by a line which forms a part of the contour line.

[0009] The cutter head is composed of a cylindrical and/or conical cutter head housing rotatably mounted on the cutter boom and the plurality of cutting tools attached to the outer surface of the cutter head housing. In one embodiment, each one of the plurality of the cutting tools is fixed at the outer surface of the cutter head such that a longitudinal axis of the respective cutting tool runs inclined to the outer surface (e.g. a tangent at the outer surface within the fixing area) and that the cutting tool tip points towards the rotation direction of the cutter head. These may be realized using one cutting tool holder for each cutting tool in the way that each cutting tool of the plurality of cutting tools is accommodated within and fixed to a cutting tool holder, wherein the plurality of cutting tool holders is, for example, welded to the outer surface of the cutter head housing. For accommodation of the cutting tool, each cutting tool holder comprises an opening or recess for insertion and fixing of the cutting tool shaft. The cutting tool may be detachably accommodated within the opening of the respective cutting tool holder. The fixing may be provided by an internal or external retaining ring or an internal friction retainer. Each cutting tool may be accommodated within the cutting tool holder or the opening may be provided with an oblique course such that the cutting tool protrudes from the outer surface of the cutter head housing and runs inclined to the outer surface of the cutter head and the respective circumferential direction. The pointing direction of the cutting tools is generally the rotation direction, wherein in one embodiment a longitudinal axis of each cutting tool is inclined by an angle equal to or less than 70° against a tangent on the outer surface of the cutter head housing at the position of the cutting tool holder.

[0010] The cutting tool may be, for example, a point attack pick, a radial pick or a chisel type pick.

[0011] The tip of the respective cutting tool is the end tip of the cutting tool that is farthermost from the outer surface of the cutter head housing. The plurality of tips of all the cutting tools of one cutter head span a virtual outer contour which is a line in particular a polyline that can be drawn above and below the rotation axis of the respective cutter head with respect to any longitudinal section of the cutter head. This line contains all the positions of all the cutting tool tips of the cutter head when the respective cutting tool tip crosses the plane of the respective longitudinal section correspondingly above or below the rotation axis during one full rotation of the cutter head. All the determined positions of the cutting tool tips are connected by a line - the contour line. By means of the contour line and its structure the features of the cutter head will be explained in the following in more detail.

[0012] The virtual contour line is formed by the plurality of tips of all cutting tools of one cutter head thereby representing the mining position of all the cutting tools relative to the rotation axis of the cutter head. The contour line has at least four sections, wherein the first section of the contour is located closest to the gearbox of the cutter head, e.g. closest to the cutter boom of the roadheader. The second section of the contour is the one realizing the maximum cutting diameter of the cutter head, when performing a sumping operation, this section contacts and cuts the mining seam first. The third section is located between the second section and the fourth section and is usually the main cutting section, wherein the fourth section forms the side wall cutting area that is located radially farthermost from the cutter boom. With regard to the present invention "adjacently in this order" means that they are provided in this sequence. It does not necessarily mean that these sections are located directly adjacently. For example, in one embodiment, the cutter head has the four sections only that are located directly adjacently, whereas in another embodiment, the cutter head has more than four sections, e.g., it may have an additional section between the third section and the fourth section and/or between the second section and the third section.

[0013] The substantially straight contour form of a section (e.g. the first section and/or the fourth section) leads to particular less irregular wear of the cutting tools of this section. This is because in the straight section, the pitch is the same over the whole section (pitch is used interchangeably with pitch angle). Accordingly, the cutting tools of the fourth section, and in the same manner the cutting tools of the first section, equally interact with the rock and seam section so that the wear of the cutting tools is equal, as well. In connection with this feature the definition "substantially straight contour" means that over 80 % of the respective section of the contour line, for example over 90% of the respective section, is straight. Additionally, the pitch angle of the at least three sections (second, third and fourth sections) of the cutter head may be better adapted/adjusted to the cutting task of the cutter head. With this cutter head design the same cutting parameters are realized at every cutting tool position inside the whole cutting area. This is not possible with a bended or curved contour. The advantage of equal cutting conditions for all cutting tools is that the maintenance efforts can be reduced. This is because all the cutting tools will wear down more or less simultaneously. Additionally, this results in a smoother torque consumption curve, which has a positive influence on the service lifetime of all parts of the roadheader, not just the cutter drive and gear box. Another advantage is that it is possible to design a cutter head for each geology according to optimum results, found during rig tests. This leads to optimum production rates due to reduced maintenance and optimum cutting behaviour.

[0014] In one embodiment, the first section of the contour line has a length L1 and the third section has a length L3, wherein $L3 \geq 2.2 \times L1$, for example $L3 = 2.2 \times L1 \ldots 2.8 \times L1$ (i.e. $2.2 \times L1 \leq L3 \leq 2.8 \times L1$, L3 is a multiple of L1, where the multiplier is within the range of 2.2 to 2.8). In this embodiment the third section is the main cutting section. Accordingly, it has a substantially greater length L3 than the length L1 of the first section, or L3 must be at least as long as L1. Alternatively, the length L1 of the first section approximately corresponds to the length L3 of the third section. This embodiment is used for sump in operation.

[0015] It is noted that the terms "length of a contour line" (L1, L2, L3, L4) and "contour length" are synonymous and can be used interchangeably. Each of them represents: the extension of the cutting tool contour line determined in a direction parallel to the rotation axis of the cutter head from the cutting tool group located closest to the cutter boom to the cutting tool group arranged farthest away from the cutter boom; in other words, it represents the extent of the contour line (e.g. incl. one or more sections) projected onto the rotation axis of the cutter head.

[0016] It is understood that, the longer L1, the deeper the cutter head may sump into the rock before a swivelling operation of the cutter head is needed. The reason behind this is, considering the horizontal distance between an outermost pick whose tip has the maximal radius (departing from the rotation axis of the cutter head) and the gear box housing (or the boom side face), the bigger this distance, the deeper the cutter head may sump into the rock. This fact (deeper sump distance) may increase the production rate of the whole machine system.

[0017] For the same reason, L3 shall be maintained larger, as L3 is the main production area, L3 plays significant role in the production rate of the cutter head, in order to maximize production rate, L3 is at least be as long as L1, and preferably longer as L1 and also not shorter than all other lengths of the contour line (L1, L2, L4),as other sections (L1, L2, L4) are for secondary activities only.

[0018] In one embodiment, the second section of the contour line has a length L2, wherein $L3 \geq 2.2 \times L2$, for example $L3 = 2.2 \times L2 \ldots 2.8 \times L2$ (i.e. $2.2 \times L2 \leq L3 \leq 2.8 \times L2$). The main cutting section (third section) is greater than the second section for the same reason that it is greater than the first section.

[0019] In one embodiment, the fourth section of the contour line has a length L4, wherein $L3 \geq 2.2 \times L4$, for example $L3 = 2.2 \times L4 \ldots 2.8 \times L4$ (i.e. $2.2 \times L4 \leq L3 \leq 2.8 \times L4$). The main cutting section (third section) is greater than the fourth section (side wall cutting area) for the same reason that it is greater than the first section.

[0020] With regard to above embodiments, the lengths L1, L2, L3 and L4 are determined along the respective line section.

[0021] In one embodiment, the second section of the contour line is a substantially straight section. In one embodiment, the second section may be substantially parallel to the rotation axis of the cutter head and may, accordingly, have a pitch angle A2, wherein $0.5\,° \geq A2 \geq -0.5\,°$. Each pitch angle A1, A2, A3, A4 mentioned in this document is measured in a plane of a longitudinal section containing the contour and the rotation axis of the cutter head and with respect to the rotation axis of the cutter head.

[0022] According to the geology of the material to be cut using the cutter head, the first and/or third sections of the contour line may be adapted. Accordingly, in one embodiment, the third section has a pitch angle A3, wherein 28 ° =< A3 <= 42 ° e.g. chosen according to geology of the material to be cut using the cutter head, and/or in one embodiment, the first section has a pitch angle A1, wherein -42 ° =< A1 <= -28 ° e.g. chosen according to geology of the material to be cut using the cutter head (20).

[0023] In the same manner, the pitch angle of the fourth section of the contour line (i.e. the side wall cutting area) may be adapted to the width of a roadway to be cut using the cutter head. In one embodiment, the fourth section has a pitch angle A4, wherein 33 ° =< A4 <=55°, e.g. chosen according to a width of a roadway to be cut using the cutter head (20). In one embodiment the pitch angle A4 of the fourth section of the contour line is greater than the pitch angle A3 of the third section of the contour line.

[0024] In one embodiment, within at least one of the first section, the second section, the third section and the fourth section of the contour line at least two groups of cutting tools, each cutting tool group comprising at least two cutting tools, are arranged such that the tips of the cutting tools of the same group form a virtual circle around the outer surface of the cutter head, wherein two adjacent groups of cutting tools of the at least one section have a pre-defined distance, wherein the distance is measured in a direction parallel to the rotation axis of the cutter head. Within the same section, the distance between two adjacent groups of cutting tools is substantially equal to that between other adjacent groups of cutting tools. This arrangement of cutting tools provides a uniform distribution of cutting tools within the at least one section. This contributes to the even wear of the cutting tools. For example, three cutting tools, four cutting tools or five cutting tools form one group of cutting tools. In one embodiment, the cutting tools of adjacent groups may be arranged offset to one another relative to the circumferential direction. This leads to a further more uniform distribution of torque at the cutter head.

[0025] In one embodiment, the cutting tool tips of the second section have the greatest distance from the rotation axis compared to the cutting tools of first section, the third section and the fourth section, wherein, for example, a ratio of a contour height (the contour height is measured at the middle position of the section and measured radially from the rotation axis of the cutter head or determined as ½ of the contour diameter at the middle position) to a contour length (i.e. the extension of the cutting tool contour determined in a direction parallel to the rotation axis of the cutter head from the cutting tool group located closest to the cutter boom to the cutting tool group arranged farthest away from the cutter boom) is greater than or equal to 0.3. In one embodiment, the ratio of the contour height and the contour length is greater than or equal to 0.3 and less than or equal to 1.0. In a more preferred embodiment, the ratio of the contour height and the contour length is greater than or equal to 0.4 and less than or equal to 0.85. In another more preferred embodiment, the ratio of the contour height and the contour length is greater than or equal to 0.43 and less than or equal to 0.7.

[0026] In one embodiment, the third section of the contour line is a substantially straight section.

[0027] The above task is further solved by a roadheader having a main body and a cutter boom extending therefrom, wherein the roadheader further comprises two above described cutter heads rotatable about an axis extending transversally relative to a cutter boom longitudinal direction, wherein each cutter head extends from opposite side faces of the cutter boom at a cutter boom end section located opposite the main body. This roadheader has the advantages explained for the cutter head above. Accordingly, it is referred to the above description. The main body of the roadheader comprises, for example, a driving unit, a control unit, a pair of endless tracks for propelling the roadheader over the ground, e.g. within a mine, and a conveyor belt, for example, for transport of the mined rock or minerals.

[0028] In one embodiment, the cutter boom is pivotable into horizontal and/or vertical direction. This pivoting /swivelling allows a flexible and wide (horizontally and/or vertically) excavation / mining of material. In this case, the roadheader main body comprises a driving unit for driving the horizontal and/or vertical movement of the cutter boom. In one embodiment, the cutter boom is telescopically extendable thereby providing a greater cutting range.

[0029] While embodiments of the present invention have been illustrated, and described, it will be understood that changes and modifications may be made therein without departing from the invention in its broader aspects.

[0030] The invention will now be described in further detail with reference to the accompanying schematic drawings, wherein

Fig. 1 depicts a first embodiment of a roadheader in a perspective front view,

Fig. 2 shows a cutter boom with an embodiment of a cutter head provided at both sides of the cutter boom in a front view as well as the corresponding contour lines,

Fig. 3 illustrates the cutter boom with the cutter head of Fig. 2 in a side view,

Fig. 4 shows a longitudinal section of the cutter boom and the two cutter heads of Fig. 2 along the plane B-B (see Fig. 3) without cutting tool holders and cutting tools,

Fig. 5 shows a section of Fig. 2 depicting the cutter head and the contour line in more detail, and

Fig. 6 illustrates a contour line of another embodiment of a cutter head.

[0031] Fig. 1 shows a roadheader 1 with a main body 3 supporting and moving a cutting assembly 5. The main body 3 comprises, for example, a gear box and an onboard control unit. Further, the roadheader 1 comprises a travelling mechanism comprising a pair of endless tracks 6 for propelling the roadheader 1 over the ground within a mine into a heading direction 8. The heading direction 8 defines the front end of the roadheader 1 and of all its elements: the respective front end is in front when the roadheader 1 moves into the heading direction 8. Accordingly, the opposite end of the roadheader 1 comprising a conveyor belt 9 for mined rock or mineral transport forms its back end.

[0032] The cutting assembly 5 comprises a cutter boom 10 which is vertically and horizontally pivotable mounted at the main body 3. The cutter boom 10 is, for example, pivotable about a first horizontal axis 11 and a second vertical axis 12. Further, the cutter boom 10 may be telescopically extendable and retractable along a direction of a longitudinal axis 15 of the cutter boom 10.

[0033] Two cutter heads 20 are rotatably mounted to a front end section of the cutter boom 10 opposite the main body 3. Both cutter heads 20 are jointly driven by a drive gear accommodated within the cutter boom 10 and a joint driven shaft 21 (see Fig. 4). Accordingly, the rotation of the two cutter heads 20 is provided about a joint rotation axis 23. The two cutter heads 20 are mounted mirror-inverted to the front end section of the cutter boom 10, wherein the mirror plane comprises the longitudinal axis 15 of the cutter boom 10.

[0034] Each cutter head 20 comprises a housing 24 with an outer surface 25. As one can derive at best from Fig. 2 and 4, the outer form of the housing 24 is conical. The embodiment of one cutter head 20 shown in Fig. 2 to 4 comprises at its outer surface 25 a number of (e.g. in total 54) cutting tools (picks) 27. The cutting tools 27 are numbered, wherein the numbers of the cutting tools 27 are marked with a circle encircling the respective number to distinguish them from the reference numbers of this description (see Fig. 3 and 5). The reference numbers do not comprise any marking. Each one of the 54 cutting tools 27 are fixed to the surface 25 of the cutter head 20 by means of a holder 28 that is welded to the outer surface 25 of the housing 24. Each holder comprises an opening into which the respective cutting tool 27 is removably mounted. The cutting tools 27 are mounted such that they point into the rotation direction, wherein the rotation direction is depicted in Fig. 3 by arrow 29. The cutting tools 27 are inclined with regard to a tangent at the outer surface 25 of the housing 24 at the position of the holder 28 by an angle in the range of 40° to 55°.

[0035] As one can best derive from Fig. 5, with regard to each cutter head 20 a contour line 30 may be drawn, wherein the contour line 30 is defined within the plane of one longitudinal section of the cutter head 20 and contains the positions of all the tips 31 of the cutting tools 27 within this plane when the cutter head 20 provides a full rotation about its rotation axis 23. The position of the tips 31 of the cutting tools 27 are marked by crosses 33 at the contour line 30. In Fig. 2 and 5, above each cross 33 the numbers of the respective three cutting tools 27 to which the respective cross 33 belongs to are shown. Accordingly, the cutting tools 27 are grouped into 18 groups of three cutting tools 27 each of which are located at the outer surface 25 of the cutter head 20 such that they form a virtual circle when the cutter head 20 rotates. Adjacent groups of cutting tools 27 have a distance ranging from 15 mm to 65 mm, depending on the rock type to be cut and the available cutter motor power (determined in a direction along the contour line 30). As one can derive from the structure of the contour line shown in Fig. 2 and 5, the distances of the groups of cutting tools 27 are approximately similar indicating that the cutting tools are uniformly distributed over the outer surface 25 of the cutter head 20. Further, as one can derive from Fig. 3, the cutting tools 27 of adjacent groups are arranged off-set relative to the circumferential direction.

[0036] As indicated in Fig. 5, the contour line 30 comprises four sections, namely a first section A (closest to the cutter boom 10 and its drive gear), a second section B, a third section C and a fourth section D (farthest from the cutter boom 10). All the four sections A, B, C and D are substantially straight, wherein the pitches of the second section B, the third section C and the fourth section D are different. The overlapping of the frames depicting the four sections A, B, C and D show, that some points 33 of the contour line 30 belong to two different, directly adjacent sections, for example the point 33 of the cutting tools 27 with the numbers 43, 44, 45 belong to the first section A and the second section B. The same applies to the point 33 of the cutting tools with the numbers 37, 38, 39 (sections B and C), and the point 33 of the cutting tools with the numbers 10, 11, 12 (sections C and D). In this embodiment, the pitch of the first section A is -40°, the pitch of the second section B is 0 ° (i.e. the second section B of the contour line 30 runs horizontally, parallel to the rotation axis 23), the pitch of the third section C (main section) is 30° and the pitch of the fourth section D is 40°, wherein the pitch is measured in relation to the rotation axis 23 of the cutter head 20.

[0037] The contour height H at section B (i.e. distance of section B from the rotation axis 23) is, for example, 690 mm and the contour length L is, for example, 820 mm (see Fig. 5). Accordingly, the ratio of the contour height and contour length is 0.84.

[0038] A second embodiment of a cutter head is depicted in Fig. 6 by means of its contour line 30' drawn through points 33' representing the position of cutting tool tips within one longitudinal section of the respective cutter head considering one full rotation of this cutter head. The second embodiment comprises a longer first section A' compared to the first section A of the first embodiment (see Fig. 5). Accordingly, the third section C' is shorter than the third section C of the first embodiment. In this embodiment, the pitch of the first section A' is 32°, the pitch of the second section B' is 0 °, the pitch of the third section C' (main section) is 32° and the pitch of the fourth section D' is 53°. Further, contour height at section B' is, for example, 650 mm and the contour length is, for example,940 mm. Accordingly, the ratio of the contour height and contour length is about 0.7.The advantage of a cutter head having such contour line 30' is that, optimum cutting parameters at all periods of the cutting process can be achieved; which ends up in optimum cutting rates at minimum and equal wear of cutting tools, reduced maintenance, and optimum cutting behavior, which means minimum vibration of cutting head, cutting boom and cutting machine.

Claims

1. A transverse cutter head (20) for a mining machine, wherein the cutter head (20) has an outer surface (25) comprising a plurality of cutting tools (27), wherein the tips (31) of the plurality of cutting tools (27) define a virtual contour line (30, 30') when a rotation of the cutter head is considered, wherein the contour line (30) is formed by at least four sections, namely a first section (A, A'), a second section (B, B'), a third section (C, C') and a fourth section (D, D'), the four sections are located adjacently in this order, wherein the first section (A, A') is located closest to the cutter boom (10) and the fourth section (D, D') forms the side wall cutting area, wherein the first section (A, A') and/or the fourth section (D, D') run substantially straight, preferably each one of the first section (A, A'), the second section (B, B') and the third section (C, C') has a pitch angle different from the pitch angle of the other two sections.

2. The cutter head of claim 1, wherein the first section (A) has a length L1 and the third section (C) has a length L3, wherein $L3 \geq 2.2 \times L1$, for example L3 is a multiple of L1, where the multiple is within the range of 2.2 to 2.8.

3. The cutter head of any one of the previous claims, wherein the second section (B, B') has a length L2, wherein $L3 \geq 2.2 \times L2$, for example L3 is a multiple of L2, where the multiple is within the range of 2.2 to 2.8.

4. The cutter head of any one of the previous claims, wherein the fourth section (D) has a length L4, wherein $L3 \geq 2.2 \times L4$, for example L3 is a multiple of L4, where the multiple is within the range of 2.2 to 2.8.

5. The cutter head of any one of the previous claims, wherein the second section (B, B') is a substantially straight section.

6. The cutter head of any one of the previous claims, wherein the second section (B, B') has a pitch angle A2, wherein $0.5\,° \geq A2 \geq -0.5\,°$.

7. The cutter head of any one of the previous claims, wherein the third section has a pitch angle A3, wherein 28 ° =<A3 <= 42 °.

8. The cutter head of any one of the previous claims, wherein the first section (A, A') has a pitch angle A1, wherein -42 ° <= A1 <= -28 °.

9. The cutter head of any one of the previous claims, wherein the fourth section (D, D') has a pitch angle A4, wherein 33° =< A4 <=55°.

10. The cutter head of any one of the previous claims, wherein each cutting tool (27) is fixed at the outer surface (25) of the cutter head (20) such that a longitudinal axis (23) of the respective cutting tool (27) runs inclined to the outer surface (25) and that the cutting tool tip (31) points towards the rotation direction of the cutter head.

11. The cutter head of any one of the previous claims, wherein within at least one of the first section (A, A'), the second section (B, B'), the third section (C, C') and the fourth section (D, D') at least two groups of cutting tools (27), each cutting tool group comprising at least two cutting tools (27), are arranged such that the tips (31, 31') of the cutting tools (27) of the same group forms a virtual circle around the outer surface of the cutter head (20), wherein two adjacent groups of cutting tools (27) of the at least one section have a pre-defined distance, wherein the distance is measured substantially along the contour line (30, 30'), preferably, within the same section, the distance between two adjacent groups of cutting tools is substantially equal to that between other adjacent groups of cutting tools.

12. The cutter head of any one of the previous claims, wherein the cutting tool tips (31, 31') of the second section (B, B') have the greatest distance from the rotation axis (23) of the cutter head compared to the cutting tools of first section (A, A'), the third section (C, C') and the fourth section (D, D'), wherein, for example, a ratio of a contour height (H) to a contour length (L) is greater than or equal to 0.3, preferably the ratio is in a range of 0.3 to 1.0.

13. The cutter head of any one of the previous claims, wherein the third section (C, C') is a substantially straight section.

14. A roadheader (1) having a main body (3) and a cutter boom (10) extending therefrom, wherein the roadheader further comprises two cutter heads (20) of any one of the claims 1 to 13 rotatable about an axis (23) extending transversally relative to a cutter boom longitudinal direction, wherein each cutter head (20) extends from opposite side faces of the cutter boom (10) at a cutter boom end section located opposite the main body (3).

15. The roadheader of claim 14, wherein the cutter boom (10) is pivotable into horizontal and/or vertical direction.

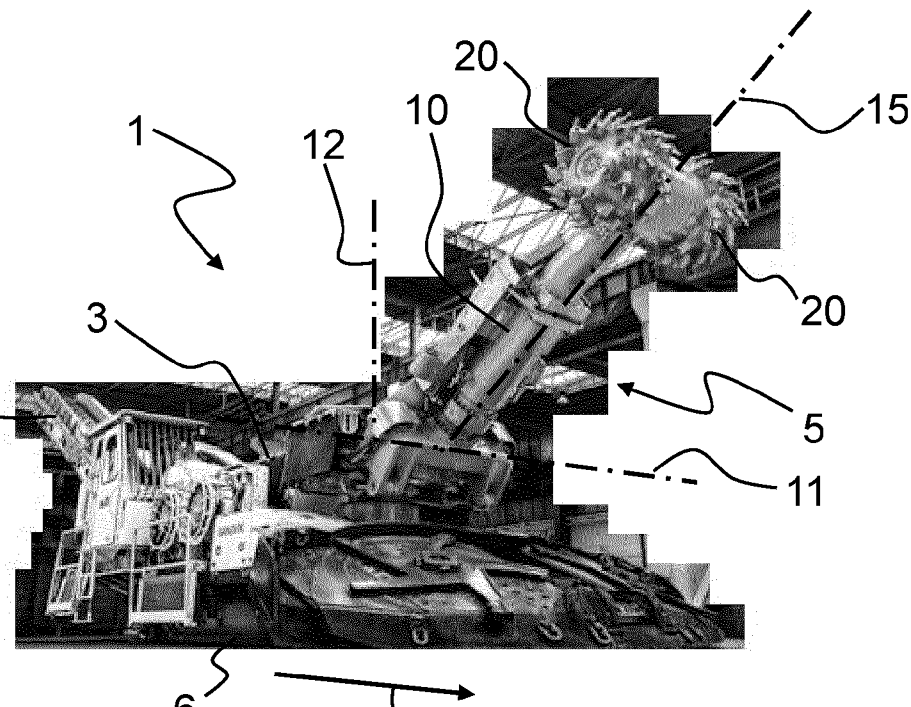
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Fig. 1

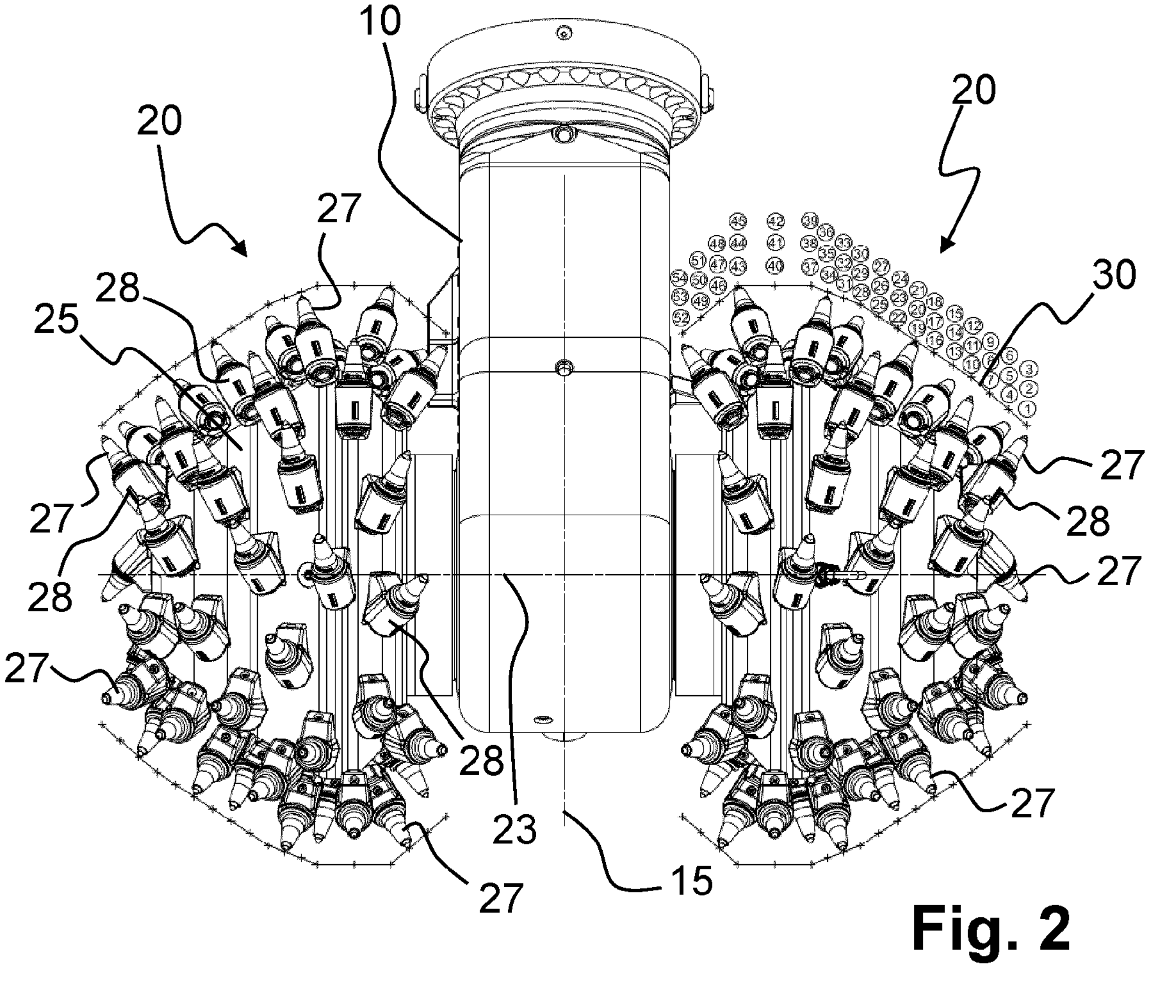
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Fig. 2

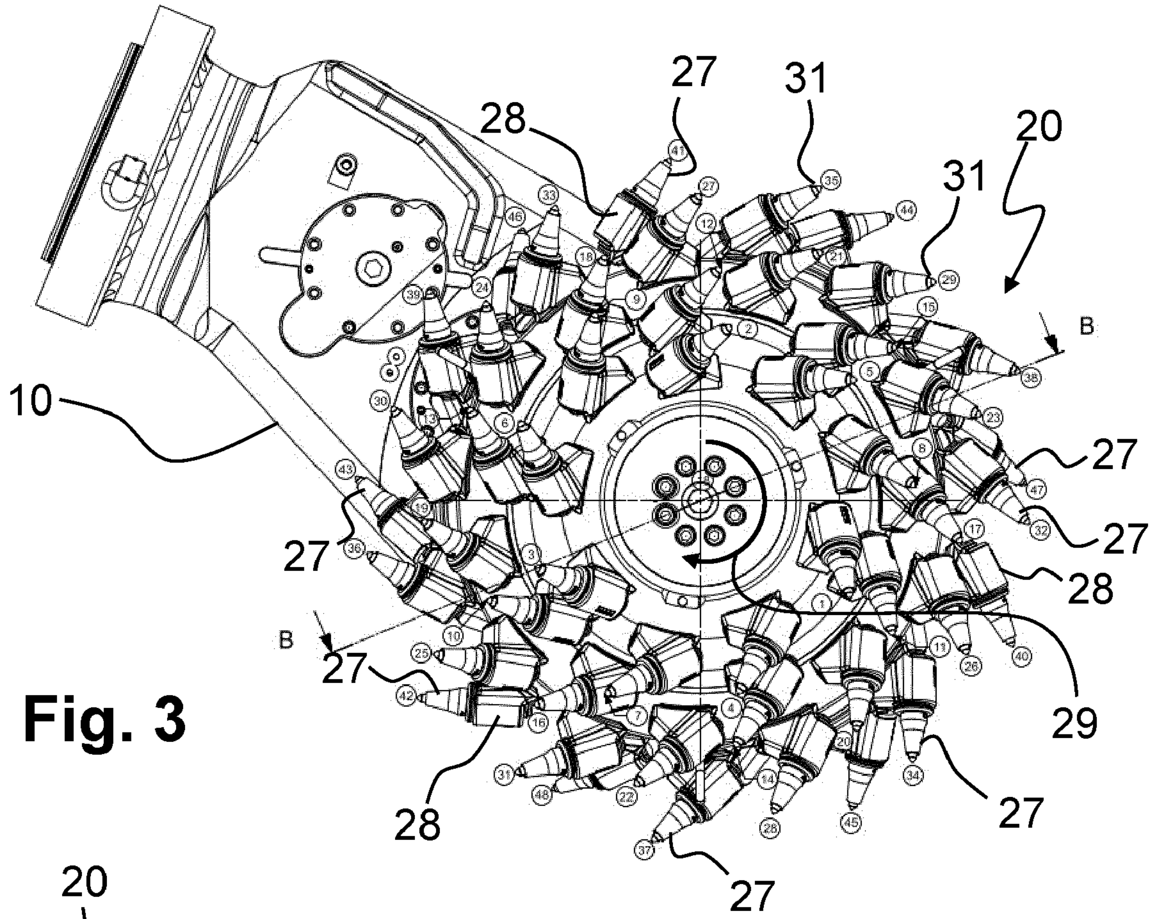

Fig. 3

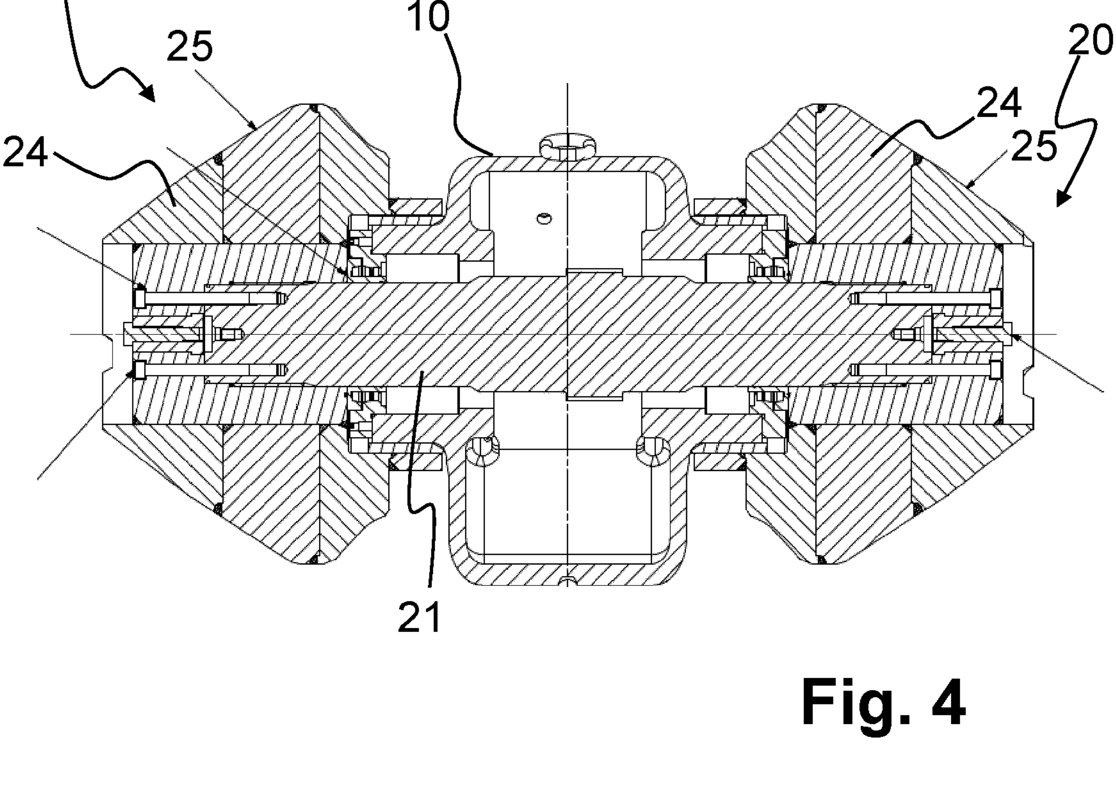

Fig. 4

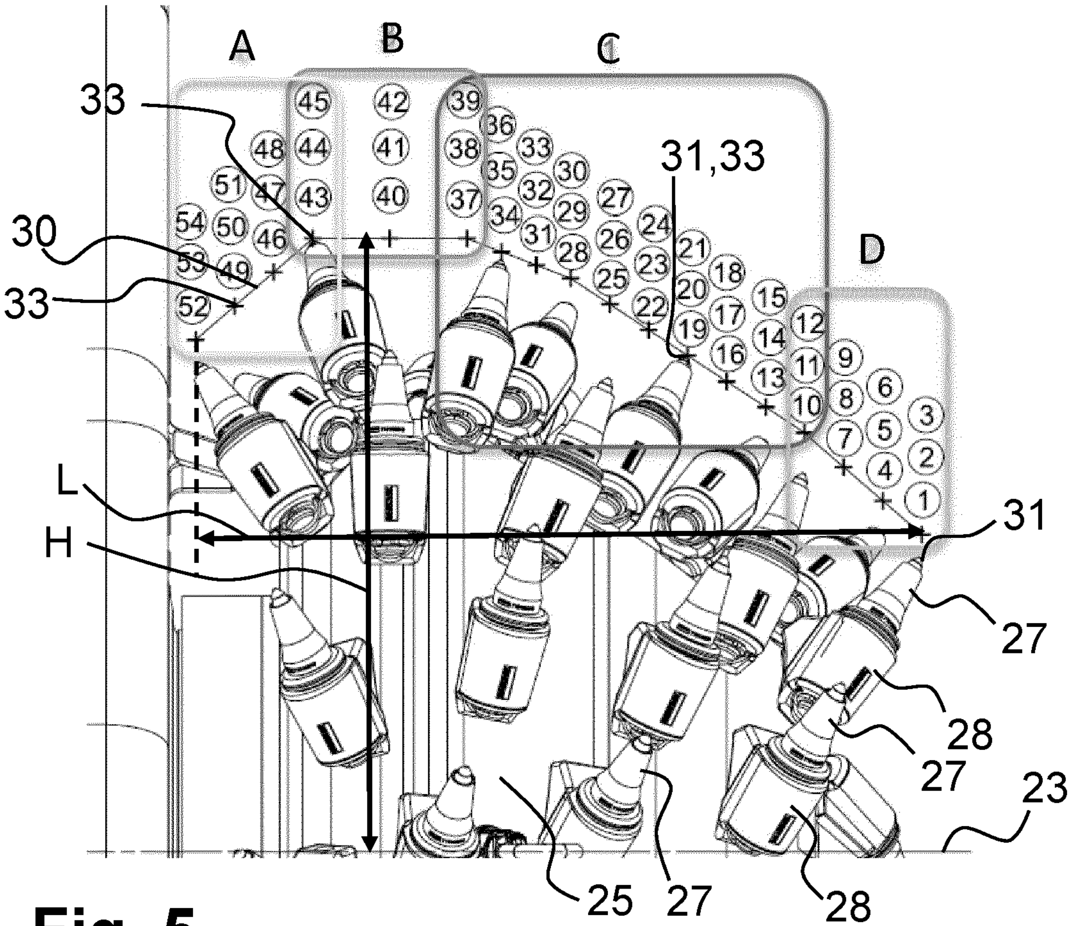

Fig. 5

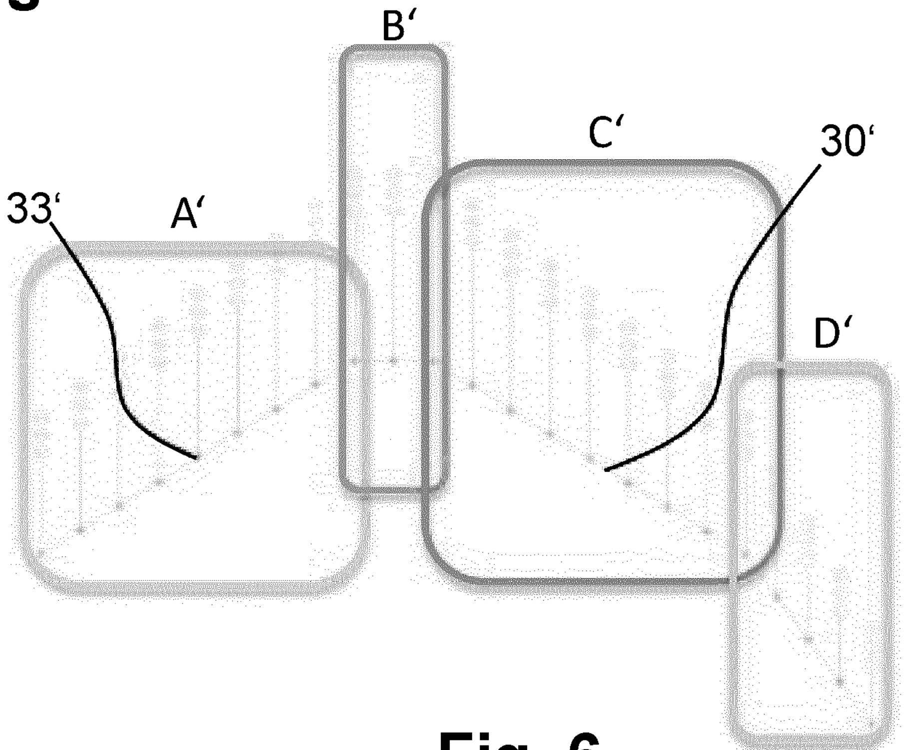

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 9951

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X	PIOTR CHELUSZKA: "Excavation of a Layered Rock Mass with the Use of Transverse Cutting Heads of a Roadheader in the Light of Computer Studies", ARCHIVES OF MINING SCIENCES, 31 January 2018 (2018-01-31), XP093169237, ISSN: 0860-7001, DOI: 10.24425/ams.2018.124981 Retrieved from the Internet: URL:https://www.researchgate.net/figure/Transverse-cutting-head-equipped-with-54-picks-used-in-simulation-tests_fig3_330656257 > [retrieved on 2024-05-31]	1-10, 12-15	INV. E21C25/10 E21C29/22 E21D9/10 E21C27/24
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	31 May 2024	Brassart, P

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